



21<sup>st</sup> Annual Congress of the  
**EUROPEAN COLLEGE OF SPORT SCIENCE**  
**CROSSING BORDERS THROUGH SPORT SCIENCE**  
6<sup>th</sup> - 9<sup>th</sup> July 2016, Vienna - Austria

Hosted by the Centre for Sport Science and University Sports, University of Vienna



ECSS 2016



# Book of Abstracts

Edited by: Baca A., Wessner B., Diketmüller R., Tschann H., Hofmann M., Kornfeind P., Tsolakidis E.

**21<sup>st</sup> Annual Congress of the**  
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**BOOK OF ABSTRACTS**

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ISBN 978-3-00-053383-9



**European College of Sport Science:**

Book of Abstracts of the 21<sup>st</sup> Annual Congress of the  
European College of Sport Science – 6<sup>th</sup> - 9<sup>th</sup> June 2016, Vienna – Austria.

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IISBN 978-3-00-053383-9

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Conception, DTP: SporTools GmbH – Data management in sports

Corrections: Patera, N., Tsolakidis, K.

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# Welcome

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On behalf of the European College of Sport Science and the Centre for Sport Science and University Sports of the University of Vienna we welcome you to Vienna for the 21st Annual Congress of the ECSS.

The University of Vienna was founded in 1365, is the largest university in Austria and is one of the oldest universities in the German speaking world. The Centre for Sport Science and University Sports is one of the 19 faculties/centres of this university. It includes the Institute of Sport Science representing the scientific sub division and the University Sports Institute, being the central institution for college sports in Vienna.

"Crossing Borders through Sport Science" as the conference theme reflects the long-lasting tradition of Austria in bringing together people from all over the world but also the emphasis of the European College to fully cover all disciplines and topics within Sport Science. The Vienna conference provides a platform for an exchange of views and research ideas, the discussion and presentation of current research results as well as the realisation of joint research projects.

We are proud that due to excellent submissions we have been able to put together an outstanding scientific program that highlights the current state of knowledge in sport science. The program comprises four plenary sessions and 36 invited symposia on topical issues in the field. In total more than 2000 abstracts have been submitted from 66 countries. 1802 abstracts were selected for the final programme and allocated to 100 oral, 70 mini-oral and 36 conventional poster sessions or assigned to E-poster presentation. 95 oral and 21 mini-oral presentations were selected for the Young Investigator Award (YIA).

Visiting a conference not only is to meet other scientists but also to grab the spirit of the hosting city and its surroundings. Vienna has transformed from a Roman settlement to the capital of the Austrian-Hungarian Empire, finally becoming the capital of the modern Austrian state with about 2 million inhabitants. Since several years Vienna is ranked number one concerning the quality of living which reflects not only political and economical factors but also health, education and public service including transportation. Vienna combines historical heritage with modernity not only when visiting museums, concerts and the numerous theatres but also when relaxing at one of the numerous restaurants, bars and of course at the classical "Heurigen" in the vineyards of Vienna.

Enjoy Vienna,

Arnold Baca (University of Vienna)

*Congress President*



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# Tom Reilly Memorial Lecture

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Saturday, July 9th, 2016

## EDUCATION - NOT THE FILLING OF A PAIL, BUT THE LIGHTING OF A FIRE

ATKINSON, G.

*Teesside University*

The above quote is from the great Irish poet, W.B. Yeats, who won the Nobel Prize for literature in 1923. Yeats contributions to poetry were highlighted in 1941 by another great Irish writer, Louis MacNeice. In that same year, yet another great Irish man was born who ultimately came to represent perfectly the words of wisdom in Yeats' quote. That man was Professor Tom Reilly.

Tom never "spoon-fed" his students, but allowed them a tremendous amount of freedom to think for themselves. Tom's unwavering confidence in his student's abilities often led them into challenging, yet very rewarding, activities. Tom had no hesitation in sending his students - sometimes while they were still in their PhD programmes - to international congresses, and sometimes to deliver one of his own overview lectures if the demands for Tom's presentations were especially high, as they often were. And today I find myself honoured to be able to deliver another lecture - this one at the esteemed ECSS Congress - and yet again, all thanks to my great mentor, Tom Reilly.

One of the many sparks that Tom ignited in me was an appreciation of all the different types of research approaches - and how one should never rely on just one of these to ultimately inform practice in exercise science. During my PhD and afterwards, Tom directed me through many laboratory-based experiments into the human body clock. Such was the man's influence on me - I would think nothing of going two days without sleep to get these experiments completed on time. After all, I was working for the great Tom Reilly; a stunning academic and an accomplished athlete, who, in one experiment, completed 100 hours of non-stop exercise - just to further science.

Tom was a great believer in real-world applied research methods and I know I can speak for many of his other students by saying how much he tutored us in undertaking randomised controlled trials of jet lag treatments following actual flights. We completed many such RCTs on Olympic athletes and their support staff, often trying to keep up with Tom's preference for 16-hour working days on these trips, as well as putting up with some really inventive insults from the athletes when we woke them at 5:30am for their first tests of the day!

Tom instilled in me a real sense of wonder about circadian rhythms and jet lag, as well as the importance of not being entrenched in one "camp" or another regarding a certain theory or hypothesis. Often our real world RCTs on jet lag treatments did not result in practically-important or statistically significant effects in the elite athletes - even though evidence from our own laboratory-based studies indicated that these treatments had potential. Tom had no problem with such disagreement between the tightly-controlled laboratory and the more labile "fire" of the real world, knowing that this is essentially evidence translation in action.

Tom - Thank you for lighting up the fire of education in me. I am certainly not the only one in this room who owe you this gratitude.







# Wednesday, July 6th, 2016

## 12:00 - 13:00

### Conventional Print Poster

#### PO-CPP-01 Biomechanics 1

##### KINEMATICS OF SPRINT START FOR MASTERS' ATHLETES

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*1.Osaka University of Health and Sport Sciences, 2.Kansai University, 3.Aichi Shukutoku University, 4.University of Hyogo, 5.Shizuoka University of Welfare, 6.University of Jyväskylä*

The world records of masters' athletes are getting faster and faster. However, the training of masters' athletes has not been specifically considered as compared to the young athletes. Therefore, the purpose of the present study was to examine the characteristics of the support-leg movements for masters' sprinters and the changes of sprint start with aging in order to provide the training concepts for masters' sprinters. Sprint start movements for 17 male masters' sprinters (records: 11.02-19.83 sec) were recorded by two high-speed cameras (210fps) at the 100-m event of the World Masters Athletics Championships (2009, Finland). These subjects were finalists in each 5-yr age category race from 40 to 90 years old. Each step of their start movements were analyzed from the start to 4th steps with the direct linear transformation method and then the following parameters were calculated as the average of the 4 steps during the start phase: running velocity, step length, step frequency, as well as the joint and segment angles and these angular velocities of the support leg. In addition, these parameters of the world top level young sprinters (n=10, records: 9.85-11.16 sec) were added for considering the age-related specificity. At the start phase, the running velocities of masters' sprinters were from 3.50 m/s in 90 yr- to 4.65 m/s in 40-44 yr-old. Their running velocities were decreased with increasing age groups. When considered by the whole athletes, their step frequency did not show any relationship with their running velocities, but their step length was negatively related to their running velocities. In their support leg, the changes of the hip, knee and ankle joint angles and these angular extension velocities were negatively related to their running velocities. Both their upper and lower legs were rotated forward throughout the stance phase. The forward rotation velocity of the upper leg was negatively related to their running velocities. However, that of the lower leg did not show any relationship with their running velocities. These results suggest that the reduction of the running speed of masters' athletes can be related to their lower step length. These low step length of the masters' sprinters can be related by the reduction of the forward rotation velocity of the upper leg and the reduction of the extension velocity of the knee joint due to the decrease in hip extension and its velocity. Therefore, it is important to prevent the decrease of the hip extension and its velocity for training of masters' sprinters.

##### 3D KINEMATIC COMPARISON OF MOTORIZED AND NON-MOTORIZED TREADMILL AND OVERGROUND RUNNING

GAHLEN, M., KRAKOWSKI-ROOSEN, H.

*University of Applied Sciences Hamm-Lippstadt*

The treadmill allows a larger number of steps to be captured and ensures that continuous movement kinematics are obtained. [1][2] The captured data from the treadmill gives a more repeatable pattern of movement in comparison compared to the short discontinuous trial associated with overground analyses. For this analysis a motorized treadmill (h/p/cosmos sports & medical gmbh Nussdorf-Traunstein, Germany) and a non-motorized curved treadmill (Woodway GmbH Weil am Rhein, Germany) were used as well as a 10m walktrack in the laboratory. Ten voluntary participants free from musculoskeletal injury ran with 3.5 m/s  $\pm$  5% on the treadmills and on the walktrack. The kinematic data were captured with an eight camera motion analysis system (Simi Reality Motion Systems GmbH, Unterschleißheim, Germany). Each mode of running were collected with the same camera setup. Based on the PlugInGait-Model the retroreflective marker were positioned on the lower extremities of the participants. The captured data was compared using a paired samples t-test in SPSS. The results indicate that several kinematic differences were observed between the three running modalities. There is an increased range of motion in hip flexion-extension on overground running and a reduced stride length on the treadmills. Further data is needed for enhancement of accuracy and reliability. Literature: [1] Sinclair et al; Three-dimensional kinematic comparison of treadmill and overground running; Sports Biomechanics, Volume 12, Issue 3, 2013 [2] Sinclair J., Taylor P.; Tibiocalcaneal kinematics during treadmill and overground running; The Foot and Ankle Online Journal 7 (2):8; 2014.

##### COORDINATION OF MOVEMENT ON A KAYAK ERGOMETER

JAHN, C.1,2, WARNKE, T.1, UEBERSCHÄR, O.1, FICHTNER, I.1, WITT, M.2

*1: IAT (Leipzig, Germany), 2: IABTW (University Leipzig, Germany)*

**Introduction** The introduction of a sprint event (200 m) in flatwater kayaking into the Olympic program in 2009 encouraged higher boat speeds and therefore necessarily higher propulsive forces and power. This development emphasizes the optimization of the force transfer from athlete to water including the kinetic chain of legs, trunk and arms under the condition of an increased frequency. Begon, Colloud & Lacouture (2009) were the first to measure forces in the horizontal direction of a seat and footrest at an aerobic training pace. To our knowledge no systematic analysis of kinetic parameters under speed (i. e. stroke rate) regulation has been completed. Methods 7 German top athletes preparing for the World Championships in 2015 in Milano were tested on a kayak ergometer at 4 different stroke rates (60, 100, 140 und 160 strokes/min [spm]), corresponding to cycle durations between 2.00 s and 0.75 s. In trials of 15 s we measured forces on the paddle (1D, 100 Hz), seat (3D, 1000 Hz) and footrest (1D, left, right, 1000 Hz). All force curves were time normalized to 100 % and an average paddling cycle was calculated of six consecutive cycles, each beginning at the threshold of 30 N after paddle entry. A Wilcoxon signed-rank test was used to determine group differences. Results For the group a reduction of cycle duration led to a signifi-

cantly delayed development of peak force on the paddle from 8.4 % (median, at 60 spm) to 13.4 % (at 160 spm),  $p = 0.001$ ,  $r = -0.88$ , and contralateral on the footrest from 9.3 % to 13.1 % ( $p = 0.002$ ,  $r = -0.83$ ) respectively. They reached peak forces during the right stroke at the same time on paddle and footrest, except at 160 spm the paddle peak force was developed 2.8 % (n. s.) later than the footrest peak. In left strokes the paddle peak force was developed before the footrest peak force for all paces (n. s.), reducing the gap with increasing stroke rates. Also in left strokes paddle peak forces were reached significantly earlier than in right strokes for all paces. Discussion The relatively small time shift of 5 % and 3.8 % at an enormous reduction of cycle time to one third is achieved through the sharp incline in force development on footrest and paddle. However the athletes show asymmetries in timing the peak forces on paddle and footrest, hinting at limitations in force transfer of the trunk. References Begon, M., Colloud, F., & Lacouture, P. (2009). Measurement of contact forces on a kayak ergometer with a sliding footbar-seat complex. *Sports Engineering*, 11, 67–73. Acknowledgements We thank the German Canoe Federation (DKV) for their support of this Research. Contact Claudia Jahn, Biomechanics, IAT Leipzig, jahn@iat.uni-leipzig.de

## QUANTITATIVE ANALYSIS FOR ACQUISITION OF SNATCH SKILL IN JUNIOR WEIGHT LIFTER

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1:Graduate school of Health and Sport Science, Nippon Sport Science University 2: Nippon Sport Science University 3:Japan Institute of Sports Sciences, 4:Japan Weightlifting Association, Tokyo Japan

Introduction A snatch competition of weightlifting requires explosive power output as well as high skill [1]. In particular explosive power output in 2nd pull phase was important in high level performance in national athlete. Preliminary research indicated it was a characteristic of a top-level athlete snatch skill kinematics data, but there are few reports [2] that they mentioned about snatch skill acquisition and important for a training program in junior weight lifter. The purpose of this study was to perform quantitative analysis of on the changing in snatch skill during eleven months between absolute and relative of weightlifting performance. Methods Six junior high school weight lifters (Male:4, Female:2, Age :  $16.7 \pm 0.6$  yrs, BH:  $164.7 \pm 7.8$  cm, BW:  $69.7 \pm 20.0$  kg.) participated in this study. Subjects performed 80%1RM (Pre) snatch and measurement five times of eleven months total. In final measurement, subjects performed 80%1RM snatch of first time equal condition (Post). Kinematics data were recorded by using two digital video camera (60fps) synchronized by an electrical signal. A digitizing system (FrameDIAS-V, DKH) were used to digitize 5 anatomical landmark points on the body and the barbell. Lower joint (Hip, Knee, Ankle) angle, angular velocity, angular acceleration were calculated each five sub-phases (1st pull, Transition, 2nd pull, Turnover, Catch). All statistical analysis were used by paired t-test performed on selected means to detect significant differences (effective  $p < 0.05$ ) between Pre and Best, Pre and Post respectability (JMP ver. 8.0 : SAS Inc.). Results and Discussion Subject' body composition (BW, %Fat and LBM) were not change during eleven months. On the other hand, Snatch best performance (Pre:  $75.8 \pm 13.6$  kg vs. Best:  $84.8 \pm 17.8$  kg,  $p < 0.01$ ) and 80%1RM (Pre:  $61.8 \pm 12.1$  kg vs. Best:  $69.8 \pm 14.7$  kg,  $p < 0.05$ ) were significantly increased during eleven months. Best ( $71.9 \pm 13.4$  rad/s<sup>2</sup>,  $p < 0.05$ ) and Post ( $76.9 \pm 17.0$  rad/s<sup>2</sup>,  $p < 0.05$ ) peak hip extension angular acceleration during transition phase were significantly increases compared with Pre ( $51.5 \pm 9.9$  rad/s<sup>2</sup>). In Turnover phase, Best ( $-90.3 \pm 14.3$  rad/s<sup>2</sup>,  $p < 0.05$ ) and Post ( $-105.2 \pm 16.7$  rad/s<sup>2</sup>,  $p < 0.05$ ) peak hip flexion angular acceleration were significantly increases compared with Pre ( $-75.9 \pm 12.6$  rad/s<sup>2</sup>). Conclusion Improvement of the snatch skill of junior weight lifter during eleven months was indicated the peak hip extension and flexion angular acceleration during transition and turnover phases, respectively. References [1]Iisaka T. et al., (1996). *J Appl. Biomech.* 12, 508-516. [2]Harbili E. and Alptekin A.,(2014). *J Sports Sci. and Med.* Contact:kashiwagi@nissai.ac.jp

## KNEE HYPEREXTENSION CAUSED BY THE UP-BEAT DOLPHIN-KICK MOVEMENT.

SANO, K., MAKINO, A., KUNIMASA, Y., HIROISHI, T., OZAKI, R., MIYASHITA, A., SAKAMOTO, T., ISHIKAWA, M.

Osaka University of Health and Sport Sciences

Introduction It was expected that the hyperextension of the knee joint in competitive swimmers can be affected by the repetitive action of the downbeat kick movements (Kenal & Knapp,1996). It is also believed that the hyperextension of the knee joint may increase the amplitudes of the down-beat dolphin kick and influence the swimming performance. However, it remains questionable whether the hyperextension of the knee joint can be advantageous for the dolphin kick performance of the competitive swimmers and whether the hyperextension of the knee joint in competitive swimmers would be caused by the congenital and/or acquired factors. Therefore, the purpose of this study was to examine relationships between the dolphin-kick performances, maximal knee extended joint angle on land and the maximal knee extended joint angle during underwater dolphin-kick swimming Methods 8 competitive college male swimmers (Age:  $21 \pm 1$  yr, Height:  $1.74 \pm 0.07$  m, Body mass:  $67.1 \pm 8.1$  kg) were participated in this study. The maximal knee extended joint angles with the standing position and during the 25-m underwater dolphin-kick swimming were measured by the waterproof goniometer. The cross-sectional areas (CSA) of hamstrings muscles with the three parts (distal middle and proximal parts) were measured by ultrasonography. The time of the 25-m underwater dolphin-kick swimming with maximal efforts was used as their swimming performance. Results The swimming performance time was negatively related to the maximal knee extended joint angle during the dolphin-kick swimming ( $r = -0.97$ ,  $p < 0.001$ ) and to the CSA of hamstrings muscles in the proximal part ( $r = -0.78$ ,  $p < 0.05$ ). However, there were not any significant relationships between the maximal knee extended joint angle at the standing position and the maximal knee extended joint angle during the dolphin-kick swimming ( $r = 0.23$ ,  $p = 0.59$ ) and between the maximal knee extended joint angle at the standing position and the swimming performance time. There was a significant positive correlation between maximal knee extended joint angle during the dolphin-kick swimming and the hamstrings muscle CSA in the proximal part ( $r = 0.78$ ,  $p < 0.05$ ). Discussion Our results clearly showed that the CSA of hamstrings muscles in the proximal part can play important roles to dolphin-kick swimming performance as well as the maximal knee extended joint angle during the dolphin-kick swimming. These results suggested that the maximal knee extended joint angle during the dolphin-kick swimming can be caused by the hip extended upbeat movement during the knee extended downbeat kick phase. This greater maximal knee joint extension movement can result in better dolphin-kick performance. References Kenal KA and Knapp LD,1996. *Sports Med* 22:337-347. Contact kanae.04.dec@gmail.com

## KINEMATICS OF JUMP SHOT IN TOP SERBIAN BASKETBALL PLAYERS

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Do not insert authors here The aim was to determine the kinematics of jump shot by using the 94 Fifty Smart Sensor Basketball® methodology in the sample of top Serbian basketball players (N=18). Following kinematics parameters of jump shot from the distance of 6.096 m were measured: Release Angle (in degrees), Ball Rotation (in revolutions per minute) and Shot Release (in seconds). For the purpose of

statistical analysis of the data obtained, SPSS version 11 had been used, and the results are presented by descriptive statistics. The correlation and difference in arithmetic mean depending on the players' height and position were tested by Correlation Analysis (Pearson correlation coefficient) and Analysis of Variance (One-way ANOVA method), respectively. Players performed jump shots at more or less similar manner, regardless of the body height and team position, therefore no significant correlation and difference were determined. Further investigations are needed.

### **CORRELATION BETWEEN MOVEMENT VARIABILITY DURING STATIC STANDING AND ONE-LEGGED STANDING ABILITY IN FRAIL OLDER ADULTS**

YAMAGATA, M., IKEZOE, T., KAMIYA, M., MASAKI, M., ICHIHASHI, N.

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**Introduction** Postural sway such as a trace length of center of pressure (CoP) is used commonly as a quantitative measurement of standing postural control. Recent researches, however, have shown that it is crucial to measure movement variability, which is qualitative alteration in time series (Lockhart T et al., 2013). Sample entropy (SE), a regularity statistic from nonlinear dynamics, is used as a practical method to quantify CoP dynamics. Small SE values indicate great regularity on postural control such as those seen in robots' movement, which is associated with lower degrees of freedom. One-legged standing time is also used commonly to represent postural stability, which is an easy and effective method without expensive instruments in clinical setting. However, no studies have investigated the correlation between movement variability and one-legged standing time in older adults. The aim of the present study was to investigate the associations of movement variability and postural sway during static standing with one-legged standing time in older adults. **Methods** The subjects comprised 36 older adults (age  $82.2 \pm 6.5$  years). CoP during static standing on both legs was measured using a center of foot pressure recorder (Win-Pod, Fingal Link Co., Tokyo, Japan) in eyes open conditions. Standard deviation of CoP in frontal and sagittal planes (X-SD and Y-SD, respectively) was used as a quantitative parameter of postural sway SE in frontal and sagittal planes (SE-X and SE-Y, respectively) was used as a qualitative parameter. One-legged standing (OLS) time on the dominant foot with eyes open was measured for a maximum of 60 seconds. The trial was performed twice and the longer duration was used for analysis. Pearson's correlation coefficient was used to investigate the relationships between CoP measurements and OLS time. Results OLS time was  $6.48 \pm 6.3$  sec. Correlation analysis revealed that OLS time was significantly and negatively correlated with SE-Y ( $r = -0.407$ ), but not with SE-X. Furthermore, no correlation was found between OLS and X-SD or Y-SD. **Discussion** In the present study, there was a significant negative correlation between OLS time and SE-Y, which indicate that older adults who has lower SE-Y can maintain OLS for a longer time. Lower SE values indicate lower degrees of freedom. Our results suggest that older adults with lower standing ability may utilize the strategy that decreases the degree of freedom (increased joint stiffness) in sagittal plane to enable longer one-legged standing. **References** 1) Lockhart T, Stergiou N. (2013). *Ann Biomed Eng.* 41(8):1593-4. Contact yamagata.momoko.82w@st.kyoto-u.ac.jp

### **KINETIC ANALYSIS OF TWO DIFFERENT SPRINT START POSITIONS IN SKILLED SPRINTERS**

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**Introduction** In track sprints, the start is a crucial skill and its efficiency is an important determinant of the final performance. The athlete has to generate forces in the shortest time period to leave the starting blocks and reach the highest running speed as soon as possible (Fortier et al., 2005). Thus, the search of the optimal posture to perform this task is of great relevance to both coaches and athletes. The aim of this study was to assess the effects of two different block settings on kinetic and kinematic parameters in sprint start. **Methods** 27 skilled sprinters involved in regional to international level competitions performed a total of 6 maximal-effort 10-m sprints using two different starting conditions: 1) the athlete's usual personal block setting condition (UC) and, 2) a test condition (TC) in which the start block positions are set according to a calculation on the individual's leg length from the greater trochanter to lateral malleolus, 60% of this length being used for the front block/starting line distance and 45% for the inter-block distance (Schot & Knutzen, 1992). A set of dynamometric sprint blocks (Milanese et al., 2014) was used to measure the magnitude of forces generated by athletes. The time at 5m and 10m was recorded using an infrared photocell. Comparison of kinetics and kinematics variables in the two conditions was performed with paired samples t-test. Alpha was set at .05. **Results** Mean length distances in starting blocks were significantly different in the two setting conditions: starting line/front block distance,  $52.9 \pm 4.6$  cm and  $49.8 \pm 2.4$  cm ( $p = .001$ ); inter-block distance:  $27.4 \pm 2.42$  cm and  $37.3 \pm 1.9$  cm ( $p < .001$ ) in UC and TC, respectively. A significant increase was found in TC for total impulse ( $p < .001$ ) and total block time ( $p = .002$ ) as well as a decrease in the time at 5m ( $p = .005$ ). The horizontal velocity was significantly greater in TC ( $p = .003$ ) and the rear leg showed greater increase in the maximum resultant force and impulse ( $p < .001$ ,  $p = .018$ , respectively). **Discussion** Our results indicate that a block setting based on the individual's leg length (TC) improves sprint start performance by enabling larger rear block forces and impulse; this, in turn, affects the efficiency of the push-off from the blocks. These results may be a consequence to the greater inter-block distance in the TC compared to the UC. Therefore, in sprinters, technical aspects like block positioning, should be considered alongside the usual strength training to maximise performance. **References** Fortier S, Basset FA, Mbourou GA, Favèral J, Teasdale N. (2005). *J Sports Sci Med*, 4, 134-143 Milanese C, Astegno P, Pirlo M, Barbi G, Zancanaro C, Petrone N. ECSS AMSTERDAM, 2014, pp 283 Schot P & Knutzen K. (1992). *Res Q Exerc Sport Contact*: Chiara.milanese@univ.it

## **Conventional Print Poster**

### **PO-CPP-05 Adapted Physical Activity**

#### **BIOMECHANICAL EFFECT OF ROBOTIC EXERCISE FOR BOCCIA PLAYERS WITH CEREBRAL PALSY**

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**Introduction** Boccia is one of the common sports for where chair users. Throwing performance depends on the function of trunk control, which is affected by pelvic control muscles. However, where chair users do not have chances to activate these muscles during the activi-

ties daily livings. We hypothesized that the experiences to activate the Gluteus Maximus, Iliopsoas and Rectus Femoris muscle have positive impacts for throwing performance of boccia players. To control the loads of these exercises for weak muscles, supply of appropriate joint torque is necessary. Therefore, we employed an exoskeletal power assist robot to solve this problem. The purpose of this study is to clarify the effect of robotic exercise for boccia players. Methods Three volunteers of boccia players with cerebral palsy participated in the experiment. The university ethic committee approved the experimental protocol (2014-177). All subjects signed the consent form before experiment. HAL (Hybrid Assistive Limb: Cyberdyne Co. Japan) was employed for the exercise. HAL is an exoskeletal power assist robot, which is controlled by the surface EMG of the hip flexor, hip extensor, knee flexor and knee extensor muscle of the subject. We had conducted the exercise programs once a week for three times. Especially, we focused on the activation of Gluteus Maximus muscle. Subjects could have good feedback from surface EMG. The tasks were squatting and walking. The numbers of the exercises were 500 repetitions and 500 steps. A three dimensional motion capture system (VICON 612) was employed to measure the spatial coordinates of the body joints, which were substituted into the numerical model with human dynamic constants. Joint angles, angular velocities, linear velocities, trunk inclinational angle and deviation of the center of gravity were calculated. Results Ball velocity at release second after exercise was greater than that before exercise in each subject. Ranges of motion of the shoulder during throwing after exercise were greater than those before exercise of two in three subjects. In contrast, range of motion of the anterior inclination of the trunk during throwing after exercise were less than those before exercise in each subject. Discussion Motor learning is defined as the process of improving motor skills through practice, with long-lasting changes in the capability for responding (Schmidt, 1975). After-effect is a process of the motor adaptation (Huang, 2009). We considered that these kinematic changes were after-effects by the robotic exercise. Because the body weight had been excessive load for the weak muscle, wheel chair users could hardly have chances to activate their hip muscles. We concluded that the robotic exercise can be one of the solutions to these problems. References Schmidt, RA. (1975). Psychological Review 82 (4): 225-260. Huang, VS. (2009). J Neuroeng Rehabil 25;6:5. Acknowledgement This work was supported by JSPS KAKENHI Grant Number 26350799. Contact [hatanaka@suzuka-u.ac.jp]

## HEALTH FITNESS AND DAILY PHYSICAL ACTIVITY LEVELS OF ADULTS WITH MILD AND MODERATE INTELLECTUAL DISABILITIES

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Introduction Adults with intellectual disabilities (ID) tend to have low fitness levels and high obesity rate (Grondhuis and Aman, 2013) and they are mostly sedentary (Heller et al., 2011). Therefore, the aim of this study was to determine the health fitness and daily habitual physical activity (PA) levels in a sample of adults with mild and moderate ID living in two supported hostels. All participants work full-time in a shelter workshop which is in the same building with the hostel. While at work, they are mostly in sitting position doing tasks such as stick on product labels and packaging. Methods Sixty-three adults (30 in Hostel A, 33 in Hostel B) with mild (n=19) and moderate (n=44) ID (20 females, 43 males) participated in the study. These baseline health fitness measures were taken by test administrators: height, weight, percent body fat, waist and hip circumferences, sit and reach test, 30-sec bicep curl test, and 6-min walk test (25m distance). Furthermore, each participant wore the accelerometer (GT3X model, ActiGraph, Florida, USA) clipped onto the right waist for 8 consecutive days or 5 consecutive weekdays with one following weekday. They were told to wear it in waking hours except in shower and they were told to resume their usual daily activities during data collection period. Daily PA data were presented in light PA percentage (%LPA) and moderate-to-vigorous PA percentage (%MVPA) based on the accelerometer cut-off counts (Freedson et al., 1998). Results The mean (SD) age of the participants was 44 (6.6) years. There were no differences in mean fitness and physical activity values between mild ID and moderate ID participants as well as participants from two hostels except participants from Hostel B had significantly ( $p < .05$ ) higher %MVPA (1.5%) and MVPA minutes (10.2 min) per day than their counterparts (0.7% MVPA, 5.4 min). Half of these participants are overweight or obese (53%) and a quarter of them are at high health risk (27%) based on the Asian standard for body mass index and waist circumference, respectively. They were very sedentary engaging 31% in LPA and 1% in MVPA of waking time per day. Discussion The sample of adults with mild and moderate ID residing in hostels have poor flexibility and upper arm muscular strength with half of them being overweight and obese. They are sedentary both during at-work hours and after-work hours. We suggest that exercise intervention programs should be offered to this group of special population for the purpose of improving on their general health as well as health-related fitness. References Freedson PS, Melanson E, Sirard J. (1998). Med Sci Sports Exerc, 30(5), 777-781. Grondhuis SN, Aman MG. (2013). J Intellect Disabil Res, 58(9), 787-799. Heller T, McCubbin JA, Drum C, Peterson J. (2011). Intellect Dev Disabil, 49(1), 26-36. Contact bchow@hkbu.edu.hk

## EFFECTS OF 12-WEEKS NORDIC WALKING AND XCO WALKING TRAINING ON THE ENDURANCE CAPACITY IN OLDER ADULTS

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Introduction With increasing age, endurance capacity declines and can lead to functional problems in everyday life. Several studies already examined the positive effects of various endurance training forms in patient groups and in healthy adults up to 60 years. However, there is a lack of studies that examined the physiological effects of systematic endurance training in healthy older adults, aged 60 years and older. Therefore, the aim of this study was to analyse the effects of Nordic Walking and XCO Walking training on the endurance capacity in older adults. Methods Twenty-three older participants (mean age:  $69.9 \pm 5.4$  years) were randomly assigned to either the Nordic Walking group (NW; n=12, 5 males, 7 females) or the XCO Walking group (XCO, n=11, 4 males, 7 females). Both groups received 8 sessions of technical training before the pre-measurements of physiological parameters. All participants were measured before and after the 12 weeks of endurance training (2 sessions/week, 60 min. per session) with a portable indirect calorimetric device (MetaMax 3B®, Cortex, Germany) to examine oxygen uptake ( $\dot{V}O_2$ ) and energy consumption during an outdoor field test. Every subject performed the assigned training tool, either Nordic Walking or XCO Walking, on a running track in five progressively increasing speeds (1.0m/s, 1.2m/s, 1.4m/s, 1.6m/s, 1.8m/s, 5 min. per speed, 3 min. rest). In addition, heart rate was recorded and lactate samples collected. Results NW demonstrated a statistically significant ( $p < .05$ ) reduction in energy consumption at 1.0m/s, in lactate concentration at 1.0m/s, 1.2m/s and 1.4m/s after 12 weeks of Nordic Walking training. XCO displayed a statistically significant ( $p < .05$ ) decrease in  $\dot{V}O_2$  at 1.0m/s - 1.6m/s, in energy consumption at 1.6m/s and in lactate concentration at 1.0m/s - 1.6m/s after 12 weeks of XCO Walking training. Both groups trained with similar percentages in heart rates and indicated no differences in walking speed and total distance within the training sessions. Discussion Both, NW and XCO showed positive effects on endurance capacity in older adults. NW mainly demonstrated few improvements at lower walking speeds, whereas XCO revealed several improvements at low to higher walking speeds. Depending on the



fitness level, training goal and walking speed, both endurance training forms (NW and XCO) are effective to maintain the endurance capacity in older adults. References Preuss M, Preuss P, Mechling H. (2008). E-Journal Bewegung und Training, 2(2), 1-16. Skórkowska-Telichowska K, Kropielnicka K, Bulinska K, Pilch U, Wozniowski M, Szuba A, Jasinski R. (2016). Aging Clin Exp Res, Jan 23. Contact t.morat@dsks-koeln.de

### RELATIONSHIP BETWEEN NURSES' PERSONAL FACTORS AND PHYSICAL ACTIVITY

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Do not introduction Physical activity is an important component of a healthy lifestyle to reduce a person's risk of developing diseases. Current recommendations for physical activity advocated by the ACSM and also 11th Thai national economic and social development plan are that "all healthy people need moderate to vigorous intensity aerobic or physical activity". To achieve improving levels of physical activity, all sectors including nurses are important factor. The purpose of this research will 1) describe physical activity counseling behaviors of nurses and 2) investigate the relationship between nurses' personal factors and physical activity counseling behaviors toward their patients. Methods This study used a correlational descriptive method. The sample included 170 nurses in outpatient department, Ramathibodi hospital who were selected by using purposive sampling. Data were collected by a self-reported questionnaire on demographic characteristics (gender, age, work experience, exercise frequency and body mass index (BMI)) and physical activity counseling behaviors. Data were analyzed using descriptive and inferential statistics. Result All females with mean age of  $38.15 \pm 11.29$  years. The average of experience 13 years. Half of them (50%) had normal BMI and 51.4% had no underlying disease. Their physical activity behaviors, 46.8% rarely exercised (1-2 times/mo.), 40.5% regularly exercised. Nurses had physical activity counseling behaviors at low level. The correlation analysis with spearman rho method revealed that work experience was positively associated with counseling behavior subscales, respectively. Especially address agenda, assess patient's health and physical activity level, assist patient by provide information for schedule physical activity plan at appropriate level, and arrange follow-up ( $r = .300, p = .009$ ;  $r = .251, p = .031$ ;  $r = .286, p = .013$  and  $r = .258, p = .026$  respectively). Discussion The findings can fundamental data for the administrators to improve and promote nurses' physical activity, and improve nursing's scope of practice in line with the goal of the National Health Development Plan. This will result in increment nurses' counseling behavior about physical activity and realize that physical activity as part of treatment program. References American College of Sports Medicine. (2014). ACSM's guidelines for exercise testing and prescription. (9 th. ed.). Philadelphia: Two commerce square. Grimstedt, M. E., Ananian. C. D., Keller, C., Woolf, K., Sebren, A. and Ainsworth, B. (2012). Nurse practitioner and physician assistant physical activity counseling knowledge, confidence and practices. Preventive Medicine, 5, 306-308 Contact: E-mail: thachamon.sin@mahidol.ac.th sert authors here

### PHYSICIANS' PHYSICAL ACTIVITY COUNSELING BEHAVIORS AND PERSONAL FACTORS

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Introduction Patients would be more interested in physical activity to stay healthy if advised by their physicians. However, not too much physicians advocates their time for counseling physical activity. Therefore, the aimed of this study was to 1) describe physical activity counseling behaviors of physicians and 2) investigate the relationship between physicians' personal factors and physical activity counseling behaviors toward their patients. Methods This correlational research used purposive sampling, the sample included 96 physicians in outpatient department, Ramathibodi hospital. Data were collected by a self-reported questionnaire on demographic characteristics (gender, age, work experience, exercise frequency and body mass index (BMI)) and physical activity counseling behaviors. Data were analyzed using descriptive and inferential statistics. Results Results revealed that participants were 96 physicians. The 50% males and 50% females with mean age of  $29.09 \pm 1.72$  years. The average of experience  $3.80 \pm 1.93$  years. Most of them (79.2%) had no underlying disease. But they (29.2%) rarely exercised (1-2 times/mo.), (28.1%) sometimes exercised (1-2 times/wk.); only 13.5% regularly exercised. Physicians had physical activity counseling behaviors at moderate level. The correlation analysis with spearman rho method revealed that work experience was positively associated with counseling behavior subscales, respectively. Especially address agenda, assess patient's health and physical activity level, assess patient's belief and knowledge about the health and physical activity, and assist patient by provide information for schedule physical activity plan at appropriate level ( $r = .222, p = .031$ ;  $r = .210, p = .046$ ;  $r = .265, p = .01$  and  $r = .219, p = .033$  respectively). Discussions The findings can fundamental data for the administrators to improve and promote physicians' physical activity, especially increasing exercise in order to enhance awareness and knowledge. Physicians have incremental physical activity counseling behaviors so that they will promote their patients to increase levels of physical activity, in a way that will have an impact on healthy behavior on their patients. References Petrella. R. J., Lattanzio C. N., Overend T.J. (2007). Physical activity Counseling and prescription among Canadian primary care physicians. Arch Intern Med, 167(16), 1774-1781. Ribeiro M.A., Martins M.A., Carvalho C.R.F. (2007) The role of physician counseling in improving adherence to physical activity among the general population. Sao Paulo Med J, 125(2), 115-21 Contact wittapong.sin@mahidol.ac.th

### REGULAR NORDIC-WALKING TRAINING ENHANCES THE MUSCLE STRENGTH AND BLOOD LEUCINE CONCENTRATION IN OLDER WOMEN - EFFECT OF VITAMIN D.

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Introduction Age-related muscle wasting is accompanied by inflammation process, in which the autophagy-inducing stress protein HMGB-1 is involved. Among factors, that protect against muscle degradation are amino-acid leucine (Breen and Phillips 2011) and vitamin D3 (25-hydroxyvitamin D (25-OH-D) (Girgis, Baldock et al. 2015). Consequently, the aim of this study was to evaluate the effect of Nordic-walking (NW) training and vitamin D3 supplementations on leucine, HMGB-1 concentrations and muscle strength. Methods 70 senior women (68±8 years old) took part in the experiment. The participants were divided into following sub-groups: two completing the Nordic-walking training, supplemented by vitamin D3 (I, n=23, 800IU/day; and II, n=22, 4000IU/day) and one control (C, n=15). At baseline and one day directly after the 12-week training programme blood measurements took place. Concentrations of HMGB-1 and myokines (irisin and IL-6) were assessed. Additionally, mass spectrometry coupled with high performance liquid chromatography was used to measure leucine level. Isometric and isokinetic knee muscle functions (90o) were determined using Biodex System. Results The applied training

programme resulted in a significant rise of leucine in II group (pre  $81.9 \pm 22.7$  vs post  $105.4 \pm 40.5 \mu\text{mol} \cdot \text{L}^{-1}$ ,  $p < 0.05$ ), yet in the I group the increase was much smaller ( $88.3 \pm 42.2$  vs post  $97.1 \pm 43.0 \mu\text{mol} \cdot \text{L}^{-1}$ ). Values in C-group did not shift significantly. Isokinetic knee muscle functions in both supplemented groups were improved, however the effect was more pronounced in II-group. No changes in myokines and HMGB-1 were recorded. Still, in all groups a significant, inverse correlation between irisin and HMGB-1 was noted. Discussion Obtained data demonstrate that NW training caused an improvement of muscle functions and this adaptation process was modulated by vitamin D3. These results confirm previous observations that muscle function depends on the vitamin D3 concentration. The shift in muscle strength was accompanied by an increase in blood leucine which is known to stimulate muscle protein synthesis (Breen and Phillips 2011) and this effect is amplified by vitamin D. Conversely, the role of vitamin D in regulation of leucine metabolism and its blood level is not known. Breen, L. and S. M. Phillips (2011). *Nutr Metab (Lond)* 8: 68. Girgis, C. M., P. A. Baldock, et al. (2015). *Mol Cell Endocrinol* 410: 3-10. [anna.dzedzej@gmail.com](mailto:anna.dzedzej@gmail.com)

### GENDER DIFFERENCES IN BODY WEIGHT LOSS AFTER A SHORT AND MIXED WEIGHT REDUCING PROGRAM

JOFFROY, S., GARNIER, S., LEMOINE-MOREL, S., RIESCO, E., SANGUIGNOL, F., MAURIÈGE, P.

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Introduction According to the last ObEpi record, 47.3% of French people aged 18 years and over are overweight, and 15% of them are obese (Eschwège et al., 2012). Diet and aerobic exercise are considered the cornerstone of obesity management (Johns et al., 2014). In France, 3-week weight loss programs developed by weight-loss centers and under medical supervision consist in modifying eating and physical activity habits and include psychological counseling. The main objective of this observational and retrospective study was to verify the effect of a mixed weight loss program combining caloric restriction and exercise on body weight and adiposity reflected by body mass index (BMI), in obese sedentary men and women, and to examine the existence of gender differences after weight loss, once the degree of obesity is taken into account. Methods 562 men ( $42.4 \pm 12.2$  years) and 781 women ( $45.2 \pm 11.2$  years) (NS) received a dietary plan of 1400-200 kcal/day and completed 110 min endurance exercise, 6 days/week during 3 weeks (Lemoine et al., 2007; Riesco et al., 2009). Body weight and BMI were determined before and after the mixed weight loss program. An analysis of variance was used to detect changes in response to the weight-reducing program, between genders and according to the obesity degrees defined by the WHO (1998). Results Body weight and BMI decreased in men ( $-5.5 \pm 2.4$  kg;  $-1.8 \pm 0.8$  kg/m<sup>2</sup>) and women ( $-3.9 \pm 1.8$  kg;  $-1.5 \pm 0.7$  kg/m<sup>2</sup>) in response to the intervention ( $p < 0.0001$ ). Men with the highest BMI values before the program were also characterized by the greatest body weight loss ( $-7.2 \pm 2.3$  kg,  $p < 0.0001$ ). Irrespective of the obesity degree, the reduction of BMI was higher in men than in women ( $p < 0.001$ ). Discussion Our study shows that a short and mixed weight reducing program has a positive impact on men and women's adiposity. However, this program is more beneficial in men than in women. A similar analysis taking into account age classes should be interesting. References Eschwège E, et al. (2015) *Diabetes Metab*, 41, 55-61. Johns D, et al. (2014) *J Acad Nutr Diet*, 114, 1557-68. Lemoine S, et al. (2007) *Menopause*, 14, 432-40. Riesco E, et al. (2009) *Obes Facts*, 2, 87-95. World Health Organization. *Obes Res* 1998; 51S-209S. Contact [sandra.joffroy@univ-tlse3.fr](mailto:sandra.joffroy@univ-tlse3.fr)

## Conventional Print Poster

### PO-CPP-09 Health & Fitness 1

#### ASSOCIATIONS OF PUBLIC BICYCLE USE WITH TRANSPORT-RELATED AND LEISURE-TIME PHYSICAL ACTIVITY IN TAIWANESE ADULTS

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Introduction: Although adults have increasingly used public bicycle in urban areas, limited studies have examined the associations between public bicycle use and domain-specific physical activity. Thus, this study examined the associations of public bicycle use with transport-related and leisure-time physical activity in Taiwanese adults. Methods: A random-digit-dialing telephone-based cross-sectional survey was administered to Taiwanese urban adults aged 20-64 years in 2015. Data on public bicycle use (non-public bicycle users, non-regular public bicycle users, public bicycle users) and time spent in transport-related and leisure-time physical activity using long version of the International Physical Activity Questionnaire was obtained from 1068 adults in three urban cities. Adjusted logistic regression was used. Results: The results showed that after adjusting for potential confounders, public bicycle users were more likely to achieve 150 minutes of leisure-time physical activity (odds ratio, OR = 1.67; 95% CI: 1.07-2.60) and transport-related physical activity (OR = 2.00; 95% CI: 1.27-3.16) in comparison with non-public bicycle users. No significant associations were observed between non-regular public bicycle users and physical activity in Taiwanese adults. Discussion: Consistent with previous studies (Molina-Garcia et al. 2013; Rojas-Rueda et al. 2011; Woodcock et al. 2014), public bicycle use is associated with higher levels of physical activity. The results of this study further reveal that the findings that public bicycle use is associated with 150 minutes of domain-specific physical activity. Therefore, encouraging public bicycle use could be a promising way for promoting adults to achieve recommended levels of both transport-related and leisure-time physical activity. References: 1. Molina-Garcia, J., Castillo, I., Queral, A., Sallis, J.F. (2013). "Bicycling to university: evaluation of a bicycle-sharing program in Spain." *Health Promot Int*. 2. Rojas-Rueda, D., de Nazelle, A., Tainio, M., Nieuwenhuijsen, M. (2011). "The health risks and benefits of cycling in urban environments compared with car use: health impact assessment study." *Br Med J*, 343, d4521. 3. Woodcock, J., Tainio, M., Cheshire, J., O'Brien, O., Goodman, A. (2014) "Health effects of the London bicycle sharing system: health impact modelling study." *BMJ*. 348. Contact: [liaojung@ntnu.edu.tw](mailto:liaojung@ntnu.edu.tw)

## WORKPLACE HEALTH PROMOTION IN APPRENTICES – SURVEY OF HEALTH STATUS, SUBJECTIVE STRESS AND PHYSICAL ACTIVITY

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**Background:** The aim of workplace health promotion (WHP) is to promote the health of all employees equally (Conn et al. 2009). This demands an age- and gender-specific targeting. Especially the group of trainees facing many life-phase-specific challenges at the beginning of their career and the requirements of working life encounters their individual resources for the first time. These burdens include stress, a high pressure to perform as well as unaccustomed physical loads. Due to an early and global health promotion a positive influence on health and thus on performance and working capacity of the trainees can be achieved (Reik et al. 2010). Against this background the study sets out the health status of apprentices in Germany and assembles the different design suggestions for integrating holistic WHP in apprenticeship. **Methods:** The resulting data of a survey among trainees from 5 Cologne-based companies (n=447 trainees, aged 16 to 38 years) forms the basis of this study. In this study the information on the perceived health status, subjective stress, the physical activity behavior (GPAQ) and two open questions relating the needs concerning WHP were analyzed. In addition the study compiles challenges faced by trainees and presents successful measures of target-group-specific WHP. **Results:** The perceived health status was evaluated on average as "good" by the majority of the trainees. On average subjective stress was stated as "medium high" ("part-part"), whereby female trainees specify a non-significantly higher stress level than male. No correlation was found between the physical activity level and subjective health status. There was a significant correlation between the activity level and the stress level of the trainees ( $r=.131$ ). The indicated physical activity level was exceptionally high. Values of men are significantly higher than that of women ( $p<.001$ ). Concerning WHP the trainees primarily ask for movement-oriented offers. **Conclusion:** Especially in the period of training companies still have the opportunity to promote healthy behaviors and thus influence health and long-term ability to work of their employees. Gender-specific health promotion activities are necessary. **References** Reik R, Woll A, Gröben F, Berndt ED (2010). *Arbeitsmed Sozialmed Umweltmed*, 45, 640-646. Conn VS, Hafdahl AR, Cooper PS, Brown LM, Lusk SL (2009). *Am J Prev Med*, 37(4), 330-339. Contact Dr. Bianca Biallas (Biallas@dshs-koeln.de)

## BODY IMAGES IN THE MEDIA AND THEIR EFFECT ON OBESITY AND SPORTS RELATED ATTITUDES OF KINDERGARTEN CHILDREN AND TEACHERS

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**Introduction** Media consumption, especially of screen-based media, represents a major leisure activity of children (Kesztyüs et al., 2013), therefore it is to be assumed, that the seen media content influences the attitude and behaviour of media users regarding nutrition and physical activity. This effect was to be determined in the present study with the purpose of enabling kindergarten teachers to modulate the children's media consumption in terms of the two mentioned phenomena. **Methods** With regard to content analysis the Austrian TV programme was screened for formats broadcasted particularly for children in kindergarten age from four to six years. Thereafter the input material got reduced by the criteria episode length ( $> 15$  min) and serial transmission. The remaining broadcasts (n=39) were examined with the use of a system of categories, destined to identify scenes with an inherent reference to sports or nutrition. Of those scenes, nine were chosen to be – solely or in combination with comparable scenes – processed with the transaction approach of Hartmann et al. (2006). **Results** The described procedure culminated in six transaction schemes with different subjects. These included genuine sports categories as team spirit, mental toughness, competition (the latter also featured fairness) and body image related constructs (general body image, stigma and socialization by media). The mentioned schemes were garnished with teaching aids like transcripts or screenshots for the use in praxi. **Discussion** As indicated prefatory, the acquired transaction schemes shall support the media competence of kindergarten teachers by empowering them to cope with inadequate body images in daily educational routines. This could contribute to the prevention of socio-psychological aspects like exclusion or bullying. As these factors account for hypercaloric eating disorders too (Littleton & Ollendick, 2003), their eschewal will also promote a healthy lifestyle. **References** Hartmann, W., Stoll, M., Chisté, N. & Hajszan, M. (2006). *Bildungsqualität im Kindergarten: Transaktionale Prozesse, Methoden, Modelle*. Wien: öbvht. Kesztyüs, D., Kettner, S., Kobel, S., Fischbach, N., Schreiber, A., Kilian, R. & Steinacker, J. (2013). *Lebensqualität und Erkrankungshäufigkeit bei Grundschulkindern in Korrelation mit Bewegung und Medienkonsum*. *Deutsche Zeitschrift für Sportmedizin*, 64(10), 293 – 300. Littleton, H. & Ollendick, T. (2003). Negative body image and disordered eating behavior in children and adolescents: What places youth at risk and how can these problems be prevented? *Clinical child and family psychology review*, 6(1), 51 – 66. Contact minas.dimitriou@sbg.ac.at

## ADIPOSIITY AND MODERATE-TO-VIGOROUS PHYSICAL ACTIVITY AND HEALTH IN FEMALE RURAL COMMUNITIES

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**Background:** Physically active behaviours occur in contexts that differ between urban and rural settings. Indeed, rural areas are characterized by educational and socioeconomic inequities which have impacted on lifestyles and health of youth, and available research dealing with those adolescent behaviours of rural communities is quite limited. Therefore, the purpose of the present study was twofold; i) to analyse the association between MVPA and the central fat mass of those rural female youth and ii) to assess the proportion of rural adolescents that met the guidelines of moderate-to-vigorous physical activity ( $>60$  min/day of MVPA) in a sample of female adolescents. **Methods:** The sample included 140 girls, 13-16 years of age, from rural regions of the Portuguese Midlands. Weight, height, and waist circumference (WC) were measured. An uniaxial GTIM accelerometer was used to obtain five consecutive days of physically activity (PA) and sedentary behaviour. Cardiorespiratory fitness (CRF) was assessed using the 20-m shuttle run test. Logistic regression analyses were used to test the afore-mentioned associations, adjusted for several potential confounders (i.e. age, CRF, and sedentary behaviour). **Results:** Findings revealed low percentages of active female adolescents who met the international PA guideline - about 24% of the rural girls. After controlling for confounders, inactive female rural adolescents ( $< 60$  min/day of MVPA) were more likely to have higher WC than their active counterparts (OR=1.09, 95% CI 1.03 to 1.15,  $p=0.01$ ). Inspection of the final regression model also indicated that girls classified as inactive were more likely to be involved in sedentary activities than their active peers. **Conclusion:** The present study indicates majority of rural females failed to meet the current guideline of 60 continuous MVPA per day. In addition, inactive rural adolescents were more

likely to have higher central adiposity than their active counterparts. Future research should extend similar design to both genders assessment to confirm some of these preliminary findings of the understudied rural communities.

### PHYSIQUE, PERFORMANCE AND IMMUNOLOGICAL STATE OF INACTIVE OR PHYSICALLY ACTIVE ADULTS

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Introduction: Health in any age group strongly correlates with the individual's lifestyle, especially with physical activity (Tremblay et al, 2011). According to WHO data physical inactivity is the 4th risk factor among deaths, especially in more developed countries. In Hungary sedentary lifestyle is common and overweight, obesity, cardiovascular diseases are major problems in the society. As a consequence ageing is faster in Hungary than it would be expected from biological regression. Regression curve is deeper after the age of 40 years. Among the physiological signs of health problems one important factor is the state of the immune system. According to the literature (Gruver et al, 2007) in healthy young adults the hTrec value in the peripheral blood is measurable between wide ranges (approx. 100-2000 hTrec/ug gDNA). Methods: In the present pilot study volunteer adults (males, 23-25 years) participated in anthropological, performance and immunological measurements. Body composition was calculated from skinfold measurements, physical performance was estimated with the aid of 6 minute walking test and handgrip strength test. The immunological age was calculated from T-cell cycle. Short 150ul peripheral blood was taken from fingertips of healthy young inactive control as well as recreational- and professional-sportsmen (n=5 for each group). Human T-cell excision circle (hTrec) copy number was measured using Taqman chemistry on 3D PCR platform and normalized to genomic DNA. Results: Sedentary controls, as it was expected, had a much higher fat percentage, lower physical performance than subjects in any of the active groups. Control individuals showed lower hTrec levels (218 copies/ug gDNA) compared to recreational- (596 copies/ug gDNA) and professional individuals (647 copies/ug gDNA). Discussion: According to our data physical inactivity inhibits or lowers Tcell level. However, regular sport activity significantly increases objective immune parameters (hTrec levels characterize thymus function) irrespective of the degree of sport-activity (recreational or professional). Since there is only about 10% difference between hTrec levels of the active groups in our study, earlier data showing that in elite sportsmen high chronic stress of the immune system caused by the extreme amount of training renders Tcell maturation in the Thymus is not supported. Altogether immunological ageing strongly correlates with the physical activity level of subjects. References: Gruver AL, Hudson LL, Sempowski GD. (2007) Immunosenescence of ageing. *J Pathol.* 211(2):144-56. Tremblay S.M., LeBlanc G.A, Kho E.M., et al (2011): Systematic review of sedentary behaviour and health indicators in school-aged children and youth. *Int J Behav Nutr Phys Act* 2011, 8:98 Do not insert authors here

### PHYSICAL ACTIVITY IN A COLLEGE COMMUNITY: A PILOT STUDY

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Background: Regular physical activity has multiple health benefits, including reduced cardiovascular disease and Type 2 diabetes. Despite this many people fail to meet the WHO recommendation of 150min/wk. Physical activity at work, when feasible, contributes to overall levels, but can be difficult to recall accurately. This pilot study aimed to evaluate levels of physical activity and inactivity in a university community, using self-reported vs. accelerometer-measured physical activity. Methods: Ethical permission was given to recruit staff, students and academics (aged 18-20) in a university college (n=107; 52M, 55F). Pre- and post-study questionnaires were completed on activity, mood, sleep and anthropometrics. Participants undertook usual work and home activities for 7 days, wearing FitBit One accelerometers with displays concealed. Accelerometer data was categorized into bands of varying intensity as activity counts per minute (cpm): sedentary (<100 cpm), light intensity activity (100-1951 cpm), or MVPA (>1952 cpm). Daily summaries were calculated and overall step counts estimated. Metabolic equivalents (METs) were calculated relative to 1 MET being the energy expenditure of sitting quietly at rest. Results: Average time spent walking, in working hours, was 1.49 hrs/day. Daily step counts were not significantly different between students (7939 steps) and staff (8580 steps) and were irrespective of gender. There was poor correlation overall between measured activity and self-reported activity or pre-study activity habits. However, while males more accurately predicted activity levels (M=0.452 P=0.001; F=0.071 P=0.336), females reported more accurately retrospectively (F=0.176 P=0.145); M=0.047 P=0.382) despite similar activity levels; more active participants estimated weekly totals less accurately (-0.599 P=0.001). The two most active age bands were 20-30 and 51-60 yrs. Sleep quality was significantly better in more sedentary individuals (0.274 P=0.007). Obese and underweight participants reported activity levels more accurately. Average daytime sedentary time was 6.47 hrs, although data on lengths of inactivity periods was lacking. Participant acceptability rating for device use was 87%. Discussion and Conclusions: Physical activity levels varied little across all groups and ages, indicating that the work environment influenced activity behaviour. Those participants involved in club, university or national sport (outside work) all reported that their sport had a positive impact on their working life. All groups achieved healthy levels of activity, despite significant time spent sedentary. There were significant differences between self-reported and actual physical activity levels. Future promotion of workplace physical activity may be compromised unless sedentary behaviour is concurrently monitored with objective monitoring techniques. The FitBit One used cost a relatively minimal amount and was acceptable to participants. Similar accelerometers may be appropriate for GPs who monitor patient activity in "at risk" populations.

### THE EFFECTS OF YOGA TRAINING ON BODY COMPOSITION AND BLOOD BIOMARKERS IN WOMEN OFFICE WORKERS

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Yoga, a traditional exercise in India, has been shown that it can benefit fitness and health. Yoga has become a popular alternative of exercise regimes and many therapies to enhance physical well-being. However, the effect of yoga training on blood biomarkers is still unclear. To investigate the effects of 12-weeks yoga training on physical fitness and blood biochemical maker in women workers, ten women office workers (age  $39.80 \pm 8.48$  yrs, height  $160.19 \pm 4.40$  cm, weight  $58.21 \pm 7.84$  kg and BMI  $22.62 \pm 2.13$  kg.m-2) were recruited from Taipei urban area. All subjects completed yoga training of 1 h/wk for 12 weeks including; warm-up 5 min, training 50 min with over 75% heart rate reserve and break 5 min. Physical Before and after 12 weeks training, all subjects were asked to complete measurement of fitness and blood biochemistry. Index of physical fitness included flexibility and body composition (Dual-energy X-ray absorptiometry, DEXA). Blood biochemical parameters included total cholesterol (TC), high-density lipoprotein (HDL), low-density lipoprotein (LDL) and triglyceride (TG). Data differences between before and after training were analyzed by using paired t-test. Statistical significance was accepted at  $p < 0.05$ . This study found that, after 12-weeks yoga training, the whole body bone mass increased significantly ( $p=0.01$ ), both



of body fat mass ( $p<0.05$ ) and glycohemoglobin (HbA1c) decreased significantly ( $p<0.05$ ). The other parameters including total TC decreased by 4%, TG decreased by 18%, and HDL decreased by 9%. LDL and fasting blood glucose only slightly increased, but there were no difference. In conclusion, yoga training could enhance the improvement of body composition and long term control of blood glucose. Regular and consistent Yoga training could get more health benefit for women office workers.

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### PO-CPP-13 Neuromuscular Physiology 1

#### ANALYSIS OF MUSCLE OXYGENATION PARAMETERS DURING CYCLING: INFLUENCE OF SITE AND COMPARISON OF DIFFERENT COMMERCIAL NEAR-INFRARED SYSTEMS

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**Introduction** Near-Infrared Spectroscopy (NIRS) is widely used as a non-invasive tool for the analysis of muscle oxygenation during exercise with the oxygen saturation and haemoglobin content of the microcirculation being the main parameters (1). For the widespread application of NIRS with commercial instruments which differ in e.g. wavelengths, light source – detector distance and algorithm questions of quality control and standardization are of great concern as well as variations of parameters with site on larger muscles. **Methods** Two commercial NIRS instruments (NIRO-200NX, Hamamatsu GmbH, Germany; moorVMS-NIRS, Moor Instruments Ltd., UK) are based on similar technology (light in the wavelength range 750 nm and 850 nm, spatial resolved spectroscopy) were used, each with two probes placed on the site of vastus lateralis of both legs of 12 healthy subjects. Muscle oxygen saturation and total haemoglobin concentrations during cycling (incremental power steps of 30 W and 2 min duration; cadence 80 bpm) were analysed. Adipose thickness was measured by ultra sound. **Results** A decrease in oxygenation was measured in all subjects with both instruments on all sites. The analysis shows that within error margins both commercial instruments deliver the same values of oxygen saturation on contralateral sites. Within subject variability of oxygen saturation with the probe placement (central to distal site of v. lateralis) were larger than between the two instruments. Due to differences in the algorithms, only relative changes in total haemoglobin concentrations can be analysed. With maximal exercise power the oxygen saturation decrease by about 25 %. The correlation coefficient for the oxygen saturation of the two system was  $> 90\%$ , within errors the correlation was the same when comparing the different sites and legs. Correlation of haemoglobin concentrations was somewhat lower. **Discussion** There is no gold standard for the evaluation of haemoglobin oxygenation and concentration of the microcirculation of larger muscles and therefore the evaluation of NIRS parameters can only be achieved by comparison of different measurement systems on tissue during physiological conditions. The main finding is that the oxygenation parameters of both commercial systems agree within error margins which are set mainly by physiological variations within the muscle and different legs. **References** 1. Wolf M, Ferrari M, Quaresima V, (2007) J. Biomed. Opt. 12(6), 062104. Contact kohl-bareis@rheinahr-campus.de

#### HOW COULD THE PINCH FORCE MVC BE INCREASED MORE WITH A TRAINING COUPLED WITH PAIRS OF WEAK TMS PULSES?

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**Introduction** Force MVC can be improved by muscle hypertrophy and by recruitment of volitional drive from motor cortex. We showed that left pinch force MVC increased by 16.5% from 8.8 kg at initial MVC to the last MVC after the 4 alternate days of training coupled with pairs of threshold TMS pulses. Short interval intracortical inhibition (SICI) was significantly less effective, whereas short interval intracortical facilitation (SICF) was more effective after the last training day in the TMS group and it was concluded that brief synchronization of corticospinal output during MVC training was an effective way of improving central drive to pinch muscles (ECCN in Brno, 2015). We examined how the corticospinal output induced by pairs of threshold TMS pulses would increase pinch force MVC and how long it could take to level off the force MVC. **Methods** TMS group of subjects ( $n=7$ ) received training on alternate days with superimposed TMS pulses until level off in right pinch force MVC was observed, followed by measurement of the force MVC without TMS about 2 weeks. They performed 4 brief sets of MVC training separated by 5min rest. Each set consisted of 3 MVCs (2s duration) separated by 1min rest. TMS group received a pair of TMS pulses superimposed on each MVC and control group ( $n=7$ ) did not receive any stimulation. Stimulus intensity of pairs of weak TMS pulses was 100% of resting motor threshold at 1.5ms of interstimulus interval (ISI) (Ziemann et al. 1998). Results Pinch force MVC in TMS group started about 10.1 kg on average and reached the level off by 8-10 alternate days of training. The force MVC increased by about 33% through training with TMS pulses. Force MVC in control group started about 9.4 kg showed about 15% increase during almost same training period as that of TMS group. After training, force MVC kept almost constant the last value of force MVC with TMS until 5-6 alternate days. **Discussion** Addition of the pairs of weak TMS pulses to force MVC training could contribute to the improvement of the recruitment of volitional drive from motor cortex to muscles for pinch tasks. It is likely that the increased SICF provides the indication of the increased excitability of excitatory interneuron and addresses the possibility of the plastic changes to synchronized corticospinal output because of almost same force MVC as the force increased by MVC with TMS. **References** Ziemann U et al. (1998) J Physiol. 511,181–190, Maruyama et al. (2015) the 15th European Congress on Clinical Neurophysiology in Brno, p232 Contact atu-maru@nuhw.ac.jp

#### THE EFFECT OF PREVIOUS STRAIN INJURY ON REGIONAL NEUROMUSCULAR ACTIVATION WITHIN RECTUS FEMORIS

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**Introduction** Rectus femoris (RF) strain injury occurs during actions such as kicks or sprint. The previous study suggested region-specific functional role of the RF, i.e., most part of RF plays as knee extensor and the proximal regions of RF mainly play as hip flexor (Watanabe et al., 2012). The aim of this study is to investigate whether RF strain injury affects the region-specific functional role. **Methods** The subjects

included seven Japanese collegiate soccer players with a history of unilateral RF strain injury. Physical profile and injury data were obtained by questionnaire. Magnetic resonance imaging (MRI) was used to obtain T1-weighted thigh images. Maximal voluntary contractions were measured during bilateral isometric knee extension and hip flexion with 24 multi-channel surface electromyography (SEMG) and Root Mean Square (RMS) was calculated (Watanabe et al., 2012). RMS values of the hip flexion were normalized by RMS values of the knee extension for each electrode pair. In addition, normalized RMS values were divided into proximal, middle, and distal regions. Normalized RMS values compared each channel bilaterally and three regions of each leg using non-parametric tests. The significance level was accepted as  $p < 0.05$ . Results All subjects sustained RF strain injury more than a year ago. Pseudocysts remained in all injured legs. There were significant differences between the most proximal channels in injured and uninjured legs in normalized RMS values ( $1.03 \pm 0.38$  vs  $1.52 \pm 0.32$ ,  $p < 0.05$ ). There were significant differences between proximal and distal channels of injured legs in normalized RMS values ( $1.06 \pm 0.39$  vs  $0.59 \pm 0.20$ ,  $p < 0.05$ ). Moreover, we identified significant difference between not only proximal and distal channels but also proximal and middle channels in uninjured legs ( $1.25 \pm 0.30$  vs  $0.70 \pm 0.19$ ,  $1.25 \pm 0.30$  vs  $0.76 \pm 0.16$ , respectively,  $p < 0.05$ ). Discussion In this study, the region-specific functional role of the injured leg was disordered. Opar et al. reported that SEMG activity in the previously injured biceps femoris (BF) long head was lower than in uninjured BF. Strain injury might reduce the SEMG activity. Additionally, lower levels of SEMG activity might be induced by disorder of the region-specific functional role. In conclusion, previous RF strain injury might affect the region-specific functional role. References Opar DA, Williams MD, Timmins RG, Dear NM, Shield AJ. (2013) J Electromyogr Kinesiol, 23, 696-703. Watanabe K, Kouzaki M, Moritani T. (2012) J Electromyogr Kinesiol, 22, 251-258. Contact kuboy@tau.ac.jp

## THE EFFECTS OF MYOFASCIAL TRIGGER POINT RELEASE ON THE FORCE & POWER PRODUCTION OF THE LOWER LIMB KINETIC CHAIN

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Introduction: Recently, dry needling has become an increasingly popular treatment method for myofascial pain in athletes. However, the majority of studies have investigated its effect on pain and other subjective measures, with very little research considering its impact on function and performance. Previous research has shown that the presence of myofascial trigger points (MTrPs) alters the movement patterns in the shoulder girdle, which can be restored to typical presentation after treatment<sup>1</sup>. Thus, it stands to reason that the lower limb may be similarly affected as jumping, which is a major component of field sports, requires complex and efficient movement patterns to be executed optimally<sup>2</sup>. Several factors can influence jump performance including; tight mobilising or weak stabilising muscles, and the efficiency of the bi-articular muscles to transfer force across the joints during the movement. The aim of this study is to investigate if MTrP release in the lower limb kinetic chain can improve jump performance through alleviating the functional impairments associated with MTrPs. Methodology: Sixty male field sport athletes were subject matched into 4 groups; control (no intervention) (group 1), rectus femoris needling (group 2), gastrocnemius needling (groups 3) and both rectus femoris & gastrocnemius needling (group 4). All subjects performed 5 loaded squat jumps (0%, 10%, 20%, 40%, 60% body weight), which were recorded using the iPhone (Apple Inc., USA) based app 'MyJump' and analysed to develop a force-velocity profile. This served as a baseline measurement. Subsequently, a minimum of two days later, each subject received their respective intervention and repeated the jump test straight away. Subjects then returned at 48h, 72h and 96h to repeat the test. All subjects performed a standard warm up prior to each test. Percentage changes in the force-velocity profile between sessions was calculated for all subjects for comparison purposes. Results: It is hypothesized that myofascial trigger point release will improve squat jump performance compared to control. With the most significant increase being observed in the both rectus femoris and gastrocnemius intervention group. Results are pending and expected in May 2016. Conclusion: The findings of this study will provide a performance based benefit to what has traditionally been a therapeutic based intervention in myofascial trigger point release. <sup>1</sup>Lucas, K.R., Polus, B.I. and Rich, P.A., 2004. Latent myofascial trigger points: their effects on muscle activation and movement efficiency. Journal of Bodywork and Movement Therapies, 8(3), pp.160-166 <sup>2</sup>Bobbett, M.F. and van Ingen Schenau, G.J., 1988. Coordination in vertical jumping. Journal of biomechanics, 21(3), pp.249-262.

## VOLUNTARY ACTIVATION OF THE QUADRICEPS MUSCLE IS IMPAIRED FOLLOWING A 2000-M ROWING TIME-TRIAL IN ELITE ROWERS

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VOLUNTARY ACTIVATION OF THE QUADRICEPS MUSCLE IS IMPAIRED FOLLOWING A 2000-M ROWING TIME-TRIAL IN ELITE ROWERS Introduction The quadriceps muscle is identified as a major contributor to rowing propulsion and performance [1]. Central and peripheral impairments differ according to the fatiguing task being performed [2]. However, little is known about these alterations following a 2000-m rowing time-trial (TT). Therefore, this study investigated the impact of the TT on neuromuscular function of the quadriceps muscle in elite rowers. Methods Seven elite-level rowers (3 men, 4 women, age:  $19 \pm 6$  yrs) performed a 2000-m TT on an indoor rower or a time-matched rest period (control). Neuromuscular function of the quadriceps muscle was assessed prior to and immediately after the TT and control using electrical stimulation of the femoral nerve. Isometric (MVT<sub>iso</sub>) and concentric maximum voluntary torques (MVT<sub>con</sub>) as well as voluntary activation (%VA) during both contraction modes and peak twitch torques (paired stimuli at 100 Hz and 10 Hz) of the quadriceps muscle were analyzed. Furthermore, maximal M-waves (M<sub>max</sub>) and normalized root mean square of the EMG signal were calculated. To test the effect of the TT, two-way (time x condition) repeated-measures ANOVAs were conducted for each variable. Results Significant time x condition interactions were found for MVT<sub>iso</sub> ( $p = 0.006$ ), MVT<sub>con</sub> ( $p = 0.008$ ), %VA<sub>iso</sub> ( $p = 0.013$ ) and %VA<sub>con</sub> ( $p = 0.034$ ). Post-hoc tests revealed significant declines of MVT<sub>iso</sub> (-17.9%,  $p = 0.007$ ) and MVT<sub>con</sub> (-13.3%,  $p = 0.003$ ) following the TT. MVT decrements were accompanied by reductions in %VA<sub>iso</sub> (-16.8%,  $p = 0.013$ ) and %VA<sub>con</sub> (-13.6%,  $p = 0.037$ ). No significant changes were observed in M<sub>max</sub>, paired stimuli peak twitch torques at 100 Hz and 10 Hz and normalized root mean square. Discussion Fatigue-related reductions in MVT<sub>iso</sub> and MVT<sub>con</sub> of the knee extensors were observed which were mainly caused by an impaired %VA. Thus, the results indicate a development of central fatigue following the TT. It has been suggested that the reduced %VA in a fatigued state could protect the muscles from metabolic catastrophe presumably mediated by central projections of group III and IV muscle afferents [3]. Furthermore, the absence of peripheral fatigue might be due to the time lag between the TT and measurement ( $3:45 \pm 0:02$  min). This observation is in accordance with Froyd et al. [4], who reported substantial recovery of peripheral fatigue within this time period. 1. Soper C, Hume PA. (2004). Sports Med, 34, 825-48. 2. Enoka RM, Stuart DG. (1992). J Appl Physiol, 72, 1631-48. 3. Gandevia SC. (2001). Physiol Rev, 81, 1725-89. 4. Froyd C, Millet GY, Noakes TD. (2013). J Physiol, 591, 1339-46. Contact florian.husmann@uni-rostock.de

## COMPRESSION WITH VANTAGE SUPPORTER ON THIGH PREVENTS HAMSTRING MUSCLE CRAMPS AFTER MAXIMUM CONTRACTION

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**Introduction** Vantage supporters that compress muscles are known to have some advantages such as prevention of muscle strain injury, relief from injury pain, and prevention of muscle cramps. These advantages, however, are hard to verify in terms of specific effects. In this study, we discovered a hamstring muscle cramp induction method. We investigate the effect of compression with a vantage supporter in preventing muscle cramps using this muscle cramp induction method. **Method** Ten healthy men performed maximum voluntary isometric knee flex contraction (knee flex MVC) at 70 degree knee angle in a prone position for 5sec., relaxed in this angle for 5sec. and relaxed in full extended angle with and without vantage supporter compression as a muscle cramp induction experiment. The vantage was wrapped around the thigh and compression pressure was regulated at 40-50mmHg. Hamstring muscles (biceps femoris long head (BFL), biceps femoris short head (BFS), semitendinosus muscle (ST), semimembranosus muscle (SM)) activity levels during relax phase after maximum contraction and subjective assessment for hamstring muscle cramp (5: hard, 4: ordinary 3: somewhat, 2: near, 1: none) were used as an evaluation index of muscle cramps. The subjects performed knee flexion isotonic exercise (10-repetition maximum (10RM) × 5 sets) 24 hours prior to this muscle cramp experiment in order to induce hamstring muscle cramps. The muscle cramp experiments with and without compression were executed in a random order. The experiments were separated by intervals of over 30min. **Result** Root-mean-square (RMS) of electromyography (EMG) in average 4 hamstring muscles during relax phase after maximum contraction normalized by MVC without compression was derived as evaluation index. This RMS value with 40-50mmHg compression was significantly lower than that without compression ( $0.10 \pm 0.11$  vs  $0.23 \pm 0.16$ ). Subjective assessment for hamstring muscle cramps with compression was significantly lower than that without compression ( $1.8 \pm 0.8$  vs  $4.6 \pm 0.6$ ). There were no significant differences either in knee flexion force or RMS of EMG in knee flex MVC between with and without compression. There were no significant differences in RMS of EMG either at rest before knee flex MVC or at rest after knee full extend between with and without compression. **Conclusion** 40-50mmHg compression with vantage supporter on thigh prevents hamstring muscle cramps after maximum contraction. **References** Hoffman MD1, Stuempfle KJ2. Sports Med Open. Muscle Cramping During a 161-km Ultramarathon: Comparison of Characteristics of Those With and Without Cramping. 2015;1(1):8. Epub 2015 May 21.

## MOTOR UNIT CONTRACTILE FUNCTION AND MYOSIN HEAVY CHAIN EXPRESSION IN RAT MUSCLE AFTER VOLITIONAL RESISTANCE EXERCISE

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**Introduction** The molecular basis of muscle fiber functional diversity and plasticity is to a large extent encoded by expression of distinct types of myosin heavy chain (MHC) isoforms in skeletal muscle. However, it is uncertain whether change in the MHC profiling is prerequisite for exerting any functional effect on contractility of muscle fibres of motor units (MUs) at the early stage of resistance training. **Methods** In this study we investigated expression of MHC isoforms, and electrically evoked twitch time characteristics, maximum force generation capability, and fatigability of slow, fast resistant to fatigue (FR) and fast fatigable (FF) MUs in rat fast-type medial gastrocnemius muscle after 5 weeks of voluntary progressive resistance exercise (squat type). **Results** After exercise muscle MHC isoform expression did not change significantly. Maximum force increased in slow (49%) and FR MUs (33%) but not FF MUs. Twitch contraction time was shortened in slow and FR MUs while half-relaxation time only in FR MUs. During the standard fatigue test, FF MUs fatigued less during initial 15 seconds. In FR MUs force was potentiated during the first minute of activity. **Conclusions** After 5 weeks of resistance exercise modifications in the contractile regulatory and energy metabolism systems of MU muscle fibers occur before any significant transition in muscle MHC isoforms is detected. Contact lochyński@awf.poznan.pl

## Conventional Print Poster

### PO-CPP-17 Physiology 1

## HEMATOLOGICAL CHANGES INDUCED BY MARATHON RACE IN DIFFERENT THERMAL ENVIRONMENT

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**Introduction** Prolonged exercise in thermally stressful environmental conditions may impair the hematological parameters and promote hemolytic anemia. Therefore, the aim of this study was evaluate hematological parameters after race in different thermal environments. **Methods** Forty male endurance runners participated in this study. Blood samples were collected 24 h before, immediately after, 24 h after, and 72 h after the São Paulo International Marathon 2014 (20 runners, 21-29°C and relative humidity of 53%) and Marathon 2015 (20 runners, 16-18°C and relative humidity of 82%). The following parameters were carried out: iron, ferritin, total and unconjugated bilirubin, total erythrocyte count (TEC), hemoglobin (Hb), hematocrit (Ht), mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH) and corpuscular hemoglobin concentration (CHCM). **Results** Blood iron levels elevated 24 h after the race and iron and ferritin blood levels reduced 72 h after the race in both thermal environment. TEC, Hb and Ht decreased 24 h after race and remained low 72 h after race in both thermal conditions. We not observed changes on MCV and MCH and CHCM increased after race just in hot environment. The total and unconjugated bilirubin increased 24 h after race and returned to basal levels 72 h after race in temperate and hot environment. **Discussion** Long-distance running induces oxidative stress and systemic inflammation followed by hematological changes increasing the risk to hemolytic anemia (Sureda et al., 2015; Reid et al., 2004; Habte et al., 2015). Previous studies also demonstrated that mechanical stress induced hemolysis (Robach et al., 2014). Prolonged exercise in hot environment can induce progressive dehydration, increase blood flow and a reduction of blood volume (Sureda et al., 2014). In our study we observed just an increase on CHCM in hot

environment. In this study, we demonstrated impairment on hematological parameters indicating the high risk to hemolytic anemia in long-distance runners. The physiological adaptation, acclimatization may be contributed to the same hematological response in different environments. References Reid SA, Speedy DB, Thompson JM et al.. Clin J Sport Med. 2004;14(6):344-53. Sureda A, Mestre-Alfaro A, Banquells M, Riera J, Drobnic F, Camps J, Joven J, Tur JA, Pons A. J Therm Biol. 2015 Jan;47:91-8. Habte K, Adish A, Zerfu D, Kebede A, Moges T, Tesfaye B, Challa F, Baye K. Nutr Metab. 2015 30;12:62. Robach P, Boisson RC, Vincent L, Lundby C, Moutereau S, Gergel L, Michel N, Duthil E, Féasson L, Millet GY. Scand J Med Sci Sports. 2014;24(1):18-27. Contact maria.boaventura@cruzeirodosul.edu.br

## THE COMBINED EXPOSURES BETWEEN INTERMITTENT HYPOXIA AND COLD IS ASSOCIATED WITH ENHANCED RESPIRATORY LONG-TERM FACILITATION AND PERIPHERAL CHEMOREFLEX SENSITIVITY WITH AN ELEVATED CO<sub>2</sub> IN HUMAN

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**Introduction:** Long-term facilitation of ventilation (vLTF) following acute intermittent hypoxic (IH) maneuver is only expressed when CO<sub>2</sub> maintained above isocapnic levels in humans (Harris et al. 2005). vLTF might be characterized by promoting the serotonin neural pathways of respiratory plasticity (Gonzalez-Rothni et al., 2015). We investigated effects of cold in ventilatory responses at IH exposure with an elevated CO<sub>2</sub>. **Methods:** Nine healthy males (years: 22.6±3.3yrs) experienced a series of IH breathing the hypoxic air (FIO<sub>2</sub>: 10%) and the room air (FIO<sub>2</sub>: 21%) seven times alternating every four minutes with two temperature conditions: normal temperature (34 deg) and low temperature (11 deg). Subjects wear the perfused suits. The rectal temperature (Tre) and four skin temperatures (chest, upper arm, thigh and calf) were measured to calculate mean skin body temperature (Tb), temperature (Tsk), respectively. Breath-by-breath ventilation (VE) and O<sub>2</sub> saturation (SpO<sub>2</sub>) were monitored by the metabolic chart. End-tidal CO<sub>2</sub> pressure (PETCO<sub>2</sub>) was maintained at basal level (isocapnic) and higher level (+4 mmHg, hypercapnic). **Results:** Low temperature induced the unchanged Tre and the remarkable decreased Tsk and Tb (p<0.01), otherwise normal temperature made unchanged Tre and Tsk throughout the experiment. The VE was fluctuated at low temperature during IH with the occurrence of vLTF independent of CO<sub>2</sub>. Greater VE response at low temperature was also gradually increased at hypercapnia compared with isocapnia. Acute hypoxia ventilatory responsiveness (HVR: ΔVE/ΔSpO<sub>2</sub>) tended to be increased with the repeated hypoxia. A significantly reduction in Tb at low temperature was related to the augmented VE during isocapnic IH (r = 0.88, p<0.05), however, the hypercapnic IH would depress the slopes of this relationship. **Discussion:** At normal temperature, the enhancement in vLTF could appear following IH maneuver at an elevated CO<sub>2</sub> in human. Besides this, further progression HVR by cold exposure could produce the tight linkage between Tb and VE. On the other hand, this relationship was inhibited by hypercapnia associated with the enhanced basal VE. In conclusion, the IH induced the repeated enhancement in the VE response with long-term facilitation associated with cold and an elevated CO<sub>2</sub>. Hypoxic induced VE response could be linearly enhanced by cold exposure. **References:** Harris DPI, Balasubramaniam A, Badr MS, Mateika JH (2006) Am J Physiol 291, R1111-1119. Gonzalez-Rothi EJ, Lee KZ, Dale EA, Reier PJ, Mitchell GS, Fuller DD (2015) J Appl Physiol 119, 1455-1465.

## ENERGY COST DURING WALKING AT SIMULATED HIGH ALTITUDE IN HEALTHY YOUNG MALE LOWLANDERS

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**Introduction:** Oxygen consumption (VO<sub>2</sub>) during walking, per distance unit (Cw; ml kg<sup>-1</sup> m<sup>-1</sup>), has been shown to have a u-shaped relationship, indicating that there is a particular gait speed that minimizes the Cw in each individual, which is known as economical speed (ES) (Horiuchi et al., 2015). However, little information is available regarding an individual's ES at simulated high altitude. **Methods:** Twelve healthy young male subjects, with a mean age of 24±2 years, height of 174±2 cm, and body weight of 70±3 kg (mean±SEM), participated in this study. They walked on a treadmill at six gait speeds, from 40-98.3 m min<sup>-1</sup> (each gait speed lasted for four min), at a level gradient under normoxia (room air), moderate hypoxia (15% O<sub>2</sub>), and severe hypoxia (11% O<sub>2</sub>), respectively. Muscle deoxygenation (HHb) of the vastus lateralis muscle was also measured using near-infrared spectroscopy. **Results:** The ES under severe hypoxia was significantly slower than under either normoxia or moderate hypoxia (P<0.05, respectively), while no differences were observed between normoxia and moderate hypoxia (80.5±1.2 m min<sup>-1</sup> in normoxia, 78.3±1.2 m min<sup>-1</sup> in moderate hypoxia, and 73.4±1.1 m min<sup>-1</sup> in severe hypoxia). In contrast, there were no differences in the Cw at any gait speed among the different oxygen levels. Relative changes in HHb between the standing baseline and the last minute of gathered data at a gait speed of 98.3m min<sup>-1</sup> were significantly related to an individual's ES when the data were pooled (r=0.441, P=0.007, n=36). **Discussion:** It was reported that VO<sub>2</sub> showed a stable phase after 1-2 min at the onset of exercise, with no differences between normoxia and moderate hypoxia, despite a relatively higher exercise intensity under hypoxia (DeLorey et al., 2004). This may suggest that hypoxia per se did not affect the steady state of the whole body VO<sub>2</sub>, which resulted in unchanged Cw in the present study. Moreover, HHb profiles could explain an individual's ES by ~20 % (r<sup>2</sup>=0.194) at high altitude. Thus, muscle O extraction evaluated by HHb (Grassi et al., 2003) can be a potential factor for determining an individual's ES. Taken together, our results suggest that acute severe hypoxia slowed the ES ~ 8 % with unchanged Cw among conditions. Furthermore, these alterations of ES can partly account for local muscle O<sub>2</sub> extraction profiles. **References:** Horiuchi M, Endo J, Horiuchi Y, Abe D (2015) J Exerc Sci Fitness 13, 79-85. DeLorey DS, Shaw CN, Shoemaker JK, Kowalchuk JM & Paterson DH (2004). Exp Physiol 89, 293-302. Grassi B, Pogliaghi S, Rampichini S, Quaresima V, Ferrari M, Marconi C & Cerretelli P (2003) J Appl Physiol 95, 149-158. .

## EFFECT OF ENDURANCE TRAINING ON VENOUS COMPLIANCE IN YOUNG SUBJECTS

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**Introduction** The venous system plays an important role in hemodynamic control because venous vessels have high distensibility and contain 60-70% of whole blood at resting condition. Ageing and/or the lower physical activity is thought to associate with the increased stiffness of veins (Hernandez et al. 2004; Young et al. 2006), which might cause the cardiovascular disease (e.g. hypertension) (Olsen and Lanne 1998; Safar and London 1987). Many studies have reported the effect of exercise training on arterial function, although the information about venous function is a few. Thus, the purpose of this study was to investigate whether endurance training improves the venous compliance in young subjects. **Methods** Nineteen subjects participated in this study (training group (TRA): n = 8, control group (CON): n = 11). Training program consisted of cycling exercise at 60% HR<sub>reserve</sub> for 40-min 3 times a week for 8 weeks. Forearm and calf venous compliance was measured on subjects in the supine position by inflating a venous collecting cuff placed around upper arm and



thigh 60 mmHg for 8 min and then decreasing cuff pressure to 0 mmHg at a rate of 1 mmHg/s. Forearm and calf venous compliance was determined using the first derivation of the cuff pressure-venous volume relation obtained during cuff pressure reduction (compliance =  $\beta_1 + 2\beta_2 \times \text{cuff pressure}$ ). In addition, venous capacitance and maximal venous outflow were also assessed. Results In TRA, cuff pressure-calf venous volume curve shifted to upward significantly after training ( $P < 0.05$ ), although cuff pressure-calf venous compliance did not alter. In addition, calf venous capacitance was 18% greater after training ( $P < 0.05$ ), but maximal venous outflow did not differ before and after training. Venous functions of forearm were not changed by training. In CON, all parameters did not after. Discussion Endurance training for 8wk in our study caused the increase in venous capacitance but did not improve venous compliance. This result is not consistent with previous studies which have reported that venous compliance is greater in chronic endurance exercise-training men than sedentary (Hernandez and Franke 2004; Monahan et al. 2001). Based on these, our training program might be too short and/or too mild for the young to improve venous compliance. Reference Hernandez JP, Franke WD. (2004). *J Appl Physiol* 97: 925–929. Monahan KD, Dinunno FA, Seals DR, Halliwill JR. (2001). *Am J Physiol Heart Circ Physiol* 281: H1267–H1273. Young CN, Stillabower ME, DiSabatino A, Farquhar WB. (2006). *J Appl Physiol* 101: 1362–1367. Olsen H, L  nne T. (1998). *Am J Physiol* 275: H878–H886. Safar ME, London GM. (1987). *Hypertension* 10: 133–139. Contact e-mail : ls39101500122@toyo.jp]

## EXERCISE INCREASES SKIN-GAS NITRIC OXIDE CONCENTRATIONS EMANATING FROM RAT TAIL

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**Introduction** Exercise increases nitric oxide (NO) synthesis in the arterial vessels because increasing blood flow stimulates vascular endothelial cells by increasing shear stress (Ulrich et al, 1997). Previous studies have demonstrated that exercise training increase the plasma nitrite (NO<sub>2</sub>-) and nitrate (NO<sub>3</sub>-) ( D.S. Xiao and Z.M. Qian 2000). On the other hand, no effects of exercise training on plasma NOx (NO<sub>2</sub>- + NO<sub>3</sub>-) concentrations also have reported (Rin et al. 2013). Moreover, there are very little data concerning the changes in skin-gas NO concentrations during exercise and the effects of exercise training. Therefore, the aim of the present study was to investigate skin-gas NO concentrations emanating from rat tails before and after exercise and to confirm differences in plasma NO concentrations between sedentary and trained rats. **Methods** Wister male rats (7 weeks of age) were divided into sedentary and training group. Exercise training was carried out on treadmill (12-15 m/min) for 30min twice a week. The skin-gas samples were obtained by covering the tail for 10 min with a polyethylene bag (Iwatani material, Tokyo, Japan) in which pure nitrogen gas (120mL) was introduced, and collected (100mL) in a sampling bag (Tedlar bag; GLScience, Tokyo, Japan) at rest and after exercise. The skin-gas NO concentration was measured by a chemiluminescence analyzer (Pico-Device Co., Ltd., Nagoya, Japan). At 15-16 weeks of age, rats were anesthetized and blood was taken immediately transferred into a vacuum tube containing heparin. The plasma NO concentration was analyzed with Nitric Oxide Assay Kit (BioAssay Systems, USA) by microplate reader ( $\lambda=540\text{nm}$ ). **Results** Skin-gas NO concentrations increased significantly ( $p<0.05$ ) after exercise compared to the resting values in trained rats through whole experiment periods. Furthermore, significantly higher plasma NO concentrations were observed in trained than sedentary rats. **Discussion** Increased skin-gas NO concentrations after exercise compared to resting values observed in this study has indicated increased NO synthesis produced by endothelial nitric oxide synthase (eNOS) in the arterial vessels and (or) induced NOS in tissues during exercise. Furthermore, significantly higher plasma NO concentrations in trained rats have suggested that repetitive exposure to haemodynamic and shear stress in trained rats might up-regulate NO dilator system by increasing eNOS activity at rest. **References** F  rstermann U et al. (1994). *Hypertension*, 23:1121-31 Zaros et al. (2009.) *BMC Women's Health* 9-17 D.S. Xiao and Z.M. Qian (2000) *Molecular and Cellular Biochemistry*. 208(1) 163-6 Rin et al. (2013). *Redox Rep.* 18(6):233-7 Contact Hiroshi Itoh [Itoh.hiroshi@nitech.ac.jp]

## THE INFLUENCE OF PHYSICAL ACTIVITY DURING PREGNANCY ON MATERNAL, FETAL OR INFANT HEART RATE VARIABILITY: A SYSTEMATIC REVIEW

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1: University of Graz, Austria 2: University of Witwatersrand, South Africa 3: VU University Medical Centre, Amsterdam, the Netherlands **Introduction** Physical activity (PA) during pregnancy has been shown to be associated with several positive effects for mother, fetus, and offspring (Clapp, 2003; Dye et al., 1997). Heart rate variability (HRV) is a noninvasive and surrogate marker to determine fetal overall health and the development of fetal autonomic nervous system. In addition, it has been shown to correlate strongly with maternal HRV and is significantly influenced by maternal behavior (Graca et al., 1991). However, the influence of maternal PA on HRV has not yet been systematically reviewed. Therefore, the aim of this systematic review was to assess the influence of regular maternal PA on maternal, fetal or infant HRV. **Methods** A systematic literature search following a priori formulated criteria of studies that examined the influence of regular maternal PA on maternal, fetal or infant HRV was performed in the databases Pubmed and SPORTDiscus. Quality of each study was assessed using the standardized Quality Assessment Tool for Quantitative Studies, QATQS (Effective Public Health Practice Project, 2008). **Results** In total, 124 articles were screened by title and abstract. Of these, nine articles passed the a priori formulated criteria and were included into the present systematic review: two intervention studies, one prospective longitudinal study, and six post-hoc analysis of subsets of the longitudinal study. Of these articles, four assessed maternal HRV, five fetal HRV, and one infant HRV. Four of five articles regarding the influence of maternal PA on maternal HRV indicated contrary results. Four of five articles regarding the influence of maternal PA on fetal HRV showed increases of fetal HRV on most parameters depending on maternal PA. The overall global rating for the standardized quality assessment of the articles was moderate to weak. **Discussion** Based on the current evidence available, our overall conclusion is that the hypothesis that maternal PA influences maternal and infant HRV cannot be supported, but there is a trend that maternal PA might increase fetal HRV. Therefore, we recommend that further studies on the influence of maternal PA on HRV should be performed. **References** Clapp JF. The effects of maternal exercise on fetal oxygenation and feto-placental growth. *Eur J Obstet Gynecol Reprod Biol.* 2003;110:S80-S85. doi:10.1016/S0301-2115(03)00176-3. Dye TD, Knox KL, Artal R, Aubry RH, Wojtowycz MA. Physical activity, obesity, and diabetes in pregnancy. *Am J Epidemiol.* 1997;146:961–5. Effective Public Health Practice Project. Quality Assessment Tool for Quantitative Studies. 2008. <http://www.ehphp.ca/tools.html>. Gra  a LM, Cardoso CG, Clode N, Calhaz-Jorge C. Acute effects of maternal cigarette smoking on fetal heart rate and fetal body movements felt by the mother. *J Perinat Med.* 1991;19:385–90.

## Conventional Print Poster

## PO-CPP-21 Sport Development &amp; Sociology

## DEVELOPMENT OF ADVANCED POSITION MEASUREMENT SYSTEM FOR SPORTS TEAMS

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Introduction Sports analytics using advanced sensors is introduced actively into competitive sports. In competitive sports' team, formation assessment of the team is essential in order to achieve advantageous situations in games. However, the accuracies of conventional position measurement technologies such as GPS and video analytics are insufficient. Therefore, the aim of this study is to develop a technology that has better position measurement accuracy. Methods To investigate the necessary accuracy for formation assessment of the team, we conducted interviews with experts in professional teams. Followings are the requirements set by the experts. (1) Accuracy of players' position measurement < 10 cm error (2) Accuracy of personal identification > 90% We considered the new position measurement method combining with Laser Radar and acceleration sensor. The advantage of using Laser Radar is that the error in position measurement is less than 10 cm. However, it is not able to identify individuals. Another method for personal identification is necessary. Then, we found out that players' speed measured by the Laser Radar is associated with energy consumption measured by wearable acceleration sensor. The proposed method measures the trajectories of identified individuals by performing the matching based on similarities. Evaluation We performed an experiment to assess the accuracy of the proposed method. Specifically, we calculated the matching rate between the personal trajectories identified by the proposed method and the actual personal trajectories that were assigned visually. The experiment was carried out on a 3-on-3 passing game called 'Ballschule' that has movements that common with major team sports. We measured a total of 130 trajectories in these games. Results The proposed system accurately identified the individuals in 119/130 trajectories, and the accuracy of personal identification is 91.5%. The accuracy of more than 90% was achieved while keeping the error in players' position measurements of less than 10 cm. Conclusion This study shows that a new method to measure personal trajectories with high accuracy by combining with Laser Radar System and acceleration sensors. Acknowledgement This research is partially supported by the Center of Innovation Program from Japan Science and Technology Agency, JST. References Busck, et al. Defense and Security. International Society for Optics and Photonics (2004): 257-263. Abe, et al. Bull. Nara Univ. Educ. 57.1: (2008): 169-179. Contact shimpei.aihara.gt@hitachi.com

## EVALUATION OF A NOVEL NONINVASIVE BLOOD HEMOGLOBIN MONITOR DEVELOPED FOR ATHLETES

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Introduction Ember is a new product, developed at Cercacor for the endurance athlete, which measures the blood hemoglobin concentration, [Hgb], noninvasively. The technology, based on Pulse CO-Oximetry, is meant to help athletes monitor their performance by measuring and tracking the impact training has on [Hgb]. Ember uses a sensor placed at a fingertip. The sensor is connected to a device which processes the sensor's signal and produces a reading that is calibrated to the hemoglobin concentration in venous blood. The aim of this study was to evaluate Ember in terms of accuracy and reproducibility of its readings. Methods The trend accuracy of Ember technology, defined as its ability to detect changes in [Hgb] when compared to changes detected by an invasive method, was tested in a "hemodilution" study involving 266 subjects. During the study, 450-500 mL of blood were drawn and rapidly replaced with isotonic intravenous fluid. The [Hgb] was measured during the hemodilution process by an ABL Radiometer blood gas analyzer and, simultaneously, by sensors using Ember technology. To test the reproducibility of Ember, we performed duplicate successive measures in 119 athletes of both genders and a wide age range. Results The trend accuracy of Ember technology was found to be within 0.7 g/dL at one standard deviation. This finding takes into consideration errors that could be introduced from placement of the sensor and, therefore, should be indicative of real-world performance. The reproducibility of single measures was high, with intraclass correlation coefficients (ICC) of about 0.83, while the reproducibility of average measures was excellent, with ICC of about 0.91. The median difference between duplicate measures was 0.5 g/dL. Discussion Ember displays good trend accuracy in measuring [Hgb] noninvasively when compared to an invasive reference. In addition, Ember produces hemoglobin readings of high reproducibility, which becomes excellent when duplicate measures are taken and averaged. These findings suggest that the Ember system is suitable as a tool for the study of the acute and chronic effects of exercise on [Hgb]. The findings encourage further research to understand the potential use of Ember in evaluating athletic performance. Contact Vassilis Mougios, mougios@auth.gr

## COMPARING THE PRACTICES OF USA ICE HOCKEY AGAINST A GLOBAL MODEL FOR INTEGRATED DEVELOPMENT OF MASS AND HIGH PERFORMANCE SPORT

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This study was designed to help and improve international ice hockey performance as well as increase domestic hockey participation in the United States. Over 200 sources of literature on sport delivery systems from 28 Australasian, North and South American, Western and Eastern European countries were analyzed to construct a globally applicable model of high performance ice hockey integrated with mass participation, comprised of the following seven elements distributed across three levels: Micro level (operations, processes, and methodologies for development of individual athletes): 1. Talent search and development, 2. Advanced athlete support. Meso level (infrastructures, personnel, and services enabling sport programs): 3. Training centers, 4. Competition systems, 5. Intellectual services. Macro level (socio-economic, cultural, legislative, and organizational): 6. Partnerships with supporting agencies, 7. Balanced and integrated funding and structures of mass and elite sport. The above model was used to design a questionnaire of 54 statements reflecting desired practices. The 54 statements were validated by 12 international experts, including executives from sport governing bodies and academics who published on high performance and sport development. The survey samples of 2,000 hockey professionals' email addresses were collected from various sources, including web pages of USA Hockey, regional and state hockey associations, college and university athletics as well as high school and club hockey teams. Completed online questionnaires were returned by 111 coaches from all key



regions of the country for a response rate of 5.5%. Additionally, 15 regional administrators were interviewed to suggest possible hockey system improvements. The study identifies best management practices as part of the American Development Model used by USA Hockey and provides suggestions for improvement, particularly consistent national qualification, education and award systems for athletes and coaches across all participation levels, further education of volunteers, and provision of greater number of competent coaches per participant at the youth level.

### THE EVOLUTION OF SPORT CLUBS IN CATALONIA <2009-2015>

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1: *Observatori Català de l'Esport (OCE)*

**Introduction** The Catalan Sports Observatory (OCE) is an organism dependent of the Government of Catalonia- INEFC that studies the evolution of the sport phenomenon in Catalonia. The Observatory has developed a study of the situation of sport clubs in Catalonia, which studies the situation of sport in 2015 and its evolution since 2009. Its objective is to show the current situation of Catalan sport clubs and associations and see what changes they have undergone since 2009. **Methods** Sample: 474 sport clubs and associations of Catalonia (5.7% of the total) (N=8.285). The level of accuracy is 95% and a margin of error of  $\pm 4.35\%$ . Online survey of 26 closed questions and a final open question. **Results** More than half of the Catalan clubs (68,7%) have up to 100 members and are part of towns of more than 20.000 inhabitants (72,3%), and for this reason the small clubs located in the Barcelona metropolitan area prevail (58,1%), this tendencies have increased compared to 2009. Councils (95.5%) and regional government (Consell Català de l'Esport), (62.3%) are the main stakeholders' clubs. 98,39% of the Catalan clubs offer a federate sport being competition sport an important part of their offer and the participation in international competitions has had a 12.4% increase since 2009. Aside from federate sport the clubs now offer a variety of sport activities. The activities for specific groups have increased considerably, especially those directed to children up to 6 years of age (a 29.4% increase since 2009) and activities for handicapped people (a 15.4% increase). Finally in relation to the staff of the clubs there is a big difference between paid staff and volunteer staff. Paid staff are in the clubs with more than 1000 members (77%) while volunteer staff have an important paper in clubs with less than 1000 members (71.8%). Comparing the tendency, we can see significant changes, in 2009 the volunteers were a minor (38.3%) in clubs with less than 1000 members. **Discussion** The relationship of Catalan clubs with their stakeholders has increased because of the importance that this represents for the development of sports practice. The stakeholders help financially or through the cession of sport facilities for the practice of sport. The strong relationship with the federations since 2009 is a trend that is maintained over the years. No changes are observed in the size (members) of Catalan clubs where 95% of these have up to 1,000 members, so the big clubs are still a minority. There has been a significant increase of sports activities for specific groups and the participation in international competitions. **References** Observatori Català de l'Esport; (Eds) (2015) Informe de l'estudi sobre la situació dels clubs esportius a Catalunya. Situació a 2015 i evolució des de 2009. Barcelona, Unpublished research.

### A STUDY ON PROCESS OF CAREER FORMATION IN JAPANESE FEMALE FOOTBALL PLAYERS

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**Introduction** There are some studies related to the career development of athletes in Japan had been carried out so far, however they are mostly based on sport psychology and sport policy. In the field of sport sociology, accumulated studies include "socialization to/by sports", sociological study of school club activities, history of career development focusing on difficulties that athletes face and a discussion on their second career among others. Iida(2012) had conducted quantitative as well as qualitative researches of J-League academy players and their parents by focusing on their career formation and process. On the other hand, there are not many teams for girls and it is not easy for them to continue playing football after junior high school. Furthermore, there is no option available to become a professional even after they continue their football career up to a high level, so the options to play at a university compared to the male players are not enough either. That means female players have to build their career among unclear and limited options. What kind of impact does this environmental difference bring to the career development process? This study develops from the questions and interests in Iida's discussion and expands the subject to female football players to find out its characteristics and challenges in comparison with male football players in Japan. **Methods** The content of questionnaire includes: when and why they started to play football; factors to carry on this career; background details and reasons for joining their current team; what they think of their current environment that they play football in; what they think of their future as footballers; and any factors or persons that affected their decisions when their environment changed. 212 University female football players provided valid data. **Results and Discussion** Almost subjects in this study started to play when they were in a lower grade of elementary school and belonged to local club rather than junior high-school team. This result reflects an issue of girls' football in Japan, which lacks the system of "club activities" at school after they move on to a junior high school. Furthermore, one of the reasons to choose their high school is because that was a school with a strong football team but only less than 20% of the students talked to their coach about their choice of school and a great number of them consulted their mothers. Similar responses applied to their consultation on their future careers. Considering some preceding studies of male football players, similar research showed that coaches made more of a presence in consulting on the contrary, so it seems to be necessary to further examine the background of this result. **References** Iida Y. (2012) Study on the process of career decision-making of youth players in J-League Academy. Bulletin of Health and Sports Sciences Institute Senshu University, 36, 17-28. Contact: uemukai@cc.musashi.ac.jp (Uemukai, K.)

### THE ANALYSIS OF SPORT CLUBS IN CATALONIA FROM A GENDER PERSPECTIVE

DÍAZ, N.1, ROCHER, M.1, ANDRÉS, A.1, CAMPS, A.1, PUIG, N.1

1: *Observatori Català de l'Esport (OCE)*

**Introduction** The Catalan Sports Observatory (OCE) has developed, in the last few months, a study that aims to describe the current situation of sport clubs and associations in Catalonia (territory with the highest number of clubs in Spain) and analyze the evolution from 2009 to 2015 from a gender perspective. The specific objectives were to analyze the possible differential situation existing between both sexes, from two points of view: from the partners and associates and from the structure of human resources. **Methods** Sample: 474 sport clubs and associations of Catalonia, (5.7% of the total) (N=8.285). The level of accuracy is 95% and a margin of error of  $\pm 4.35\%$ . The data were collected through an online survey of 26 closed questions and a final open question. **Results** The people associated to a club define its characteristics and the activities it offers. In Catalonia, the majority of people associated to a club, in whatever measure, are men. This tendency has been constant since the study done in 2009 even though we have found minor variations. The most significant data is the

10.7% increase in women membership in clubs with 101 to 300 members. When we pay attention to the sport federate licenses in 2015, independently from the size of the club, the majority belong to men (70.5% men, 29.5% women). The figures in 2009 were very similar. If we begin to analyze the structure of the clubs, starting by the boards of directors, we find that men occupy most of the positions. A clear example can be found in presidential positions, where only 11.3% are women. The figures between 2009 and 2015 show the same tendency, the variations are more visible in treasury areas where the presence of women has increased 6% with a total of 31%. Where we find more women is in secretarial positions where there is a total of 32.9% (3.9% more than in 2009). In relation to the staff of the clubs, once again we find that the proportion of men is higher than that of women. Comparing the results of different years we can see that all the figures have increased for women except in management positions, the most important increase being in the area of technical direction. Discussion In this study we can see that men predominate in the 4 indicators studied, being presidential positions where there is a greater gender difference (88.7% men versus 11.3% women). The tendencies remain since 2009 but we can observe that in some areas the presence of women is gradually increasing. The most remarkable increase in all the areas studied is the 12.2% increase in women that are in the area of technical direction of a club. References Observatori Català de l'Esport; (Eds) (2015) Informe de l'estudi sobre la situació dels clubs esportius a Catalunya. Situació a 2015 i evolució des de 2009. Barcelona, "unpublished research".

## THE DEVELOPMENT OF ELITE SWIMMING IN THE PEOPLE'S REPUBLIC OF CHINA – FROM THE PERSPECTIVE OF POLICY TRANSFER

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China's longing to win for Olympic Glory has driven it to put a great deal of effort into the field for the past three decades, including its enormous investment of both human and material resources. China's investment reached a climax in the 2008 Olympic Games in Beijing while earning back only won six medals (1 gold, 3 silver, 2 bronze) in swimming, which has always been the field in which Western countries are predominant (Olympic, 2014). Nevertheless, at the 2012 Olympic Games in London, the China Olympic swimming team broke its Olympic record with ten medals gained in total (5 gold, 2 silver, 3 bronze). This achievement brought China's swimming to the second place in the world rankings, thus helping China surpass Japan and take the first place in Asia. How China improved its performances in elite sports, especially swimming, is said to be relevant to its policy transfer process from other countries predominant in swimming (Houlihan, Tan & Green, 2010; Hsu, 2014). This research aims at elaborating the idea of policy transfer, through which we could analyze the development of the development of elite swimming in China. Adapted from Dolowitz & Marsh (2000), our theoretical framework of policy transfer includes seven key questions: Why policy transfer happens, who are the key actors involved in policy transfer? What is transferred? From where are lessons drawn? What are different degrees of transfer? What restricts or facilitates the process? How is the whole process of policy transfer related to the result of either success or failure? To answer these questions, this research collects official and semi-official documents of China, and further interviews relevant officials, coaches, athletes, sport scientists and scholars. Qualitative content analysis and depth interview are conducted as the approach to data collection, through which we further analyze the development of elite swimming in China. Aspects mainly touched upon are the reasons why, who, effects of policy transfer, and possible conflicts within the process, with which this research hopes to provide the government with substantial suggestions for the development of elite swimming or future sports policy in Taiwan or elsewhere.

## Conventional Print Poster

### PO-CPP-25 Sports Medicine & Orthopaedics 1

#### THE EFFECT OF TWO DIFFERENT WEIGHT LOSSES ONTO ANAEROBIC POWER VARIABLES OF FREE STYLE WRESTLES DURING WINGATE'S PROTOCOL

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Introduction Wrestling is an Olympic sports that has done by weight classes (Kaynar and Dasdag, 2011). The topic of weight management is a challenge for athletics, coaches and researchers. Matches planning is created a situation that athlete has to reduce his weight in a short time. It is may be effected on muscular function of athletes. A wrestler needs to a high level of physical fitness and muscular power during the competition, the power in the wrestling is related to speed and burst activity in the muscles that lead to success (Vardar et al., 2007). Nevertheless, knowing how much of losing weight influences the wrestlers' power is not clear. Therefore the aim of this study was to investigate the effect of two different weight losses onto changes of anaerobic power variables of free style wrestles during Wingate's protocol. Methodology Twenty seven free style wrestlers (mean  $\pm$  SD; age  $20.55 \pm 2.09$  years; mass  $69.91 \pm 7.70$  kg, height  $170 \pm 0.06$  cm) volunteered to participate in this study. The variables of anaerobic power (mean power and pick power) and fatigue index were recorded during leg Wingate protocol (pretest). Then subjects were randomly divided into one control group and tow experience groups (E1 and E2). E1 reduce 2-3% and E2 reduce 3-4% of their body weight by using of exercising in a rubber/plastic warm-up suit and foot restriction (Webster et al., 1990) during a week. At the end, they perform the protocol after weight loss (post-test). A Kruskal-wallis test was applied to analyze the data in groups, Wilcoxon statistic method was applied to analyze the inner changes of the groups ( $p < 0.05$ ) Results There were no significant difference in the anaerobic power parameters (mean power and pick power) and fatigue index between and inner groups. Discussion Considering there were not any difference in the anaerobic power parameters, it seems that weight loss on these ranges of body weight by rubber/plastic warm-up suit and foot restriction during a week has not effect on anaerobic power parameters. However, there are some differences between our results and previous studies. It has been reported that 4.6 % of weight loss (3.3 KG) during 36 hours reduced anaerobic power (Webster et al., 1990). Maybe, the reason of this antithesis relates to duration of weight loss. It seems that losing weight during a week has not effect on anaerobic parameters. Considering the results of this and other studies, it is suggested that wrestlers do weight loss on longer period if they want to prevent the redaction of anaerobic parameters. References Kaynar, O., & Dasdag, S. (2011). Journal of International Dental And Medical Research, 4(3), 155-159. Vardar, S. A., Öztürk, L., Kurt, C., Bulut, E., Sut, N., & Vardar, E. (2007). Back Issues. Journal of Sports Science and Medicine, 6, 34-38. Webster, S., Rutt, R., & Weltman, A. (1990). Medicine and Science in Sport and Exercise, 22(2), 229-234 morteza7717@yahoo.com

**PRE-PARTICIPATION SCREENING EXAMINATION IN CHILDREN AND ADOLESCENTS**

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**Introduction** Physical activity undoubtedly has a beneficial effect on development and prevention of cardiovascular diseases in children and adolescents. Intensive activity can, however, also de-mask previously undetected underlying cardiovascular disease, triggering cardiorespiratory events as well as sudden cardiac death. Therefore, a pre-participation examination is usually recommended in young athletes, taking into account pre-existing risk factors and diseases as well as type of sport. There is no general consensus how this screening examination should be performed and, in consequence, medical guidelines and recommendations differ between societies and countries. European societies currently recommend a pre-participation screening examination which includes medical history, family history, sports history, physical examination and standard ECG. Further diagnostic procedures follow in case of any significant finding.

**Methods** The current study retrospectively analyses the results of pre-participation screening examinations performed within two years at the Institute of Preventive Pediatrics, Technical University of Munich, following the above mentioned recommendations. In 90%, echocardiography and spiroergometry were added to further understand their role in detecting pre-existing pathological conditions. Results 242 pre-participation examinations were performed in 22 female and 220 male athletes (mean age 14.73 yrs). Athletes competitively participated in football, triathlon, ice hockey, field hockey, or swimming. Results frequently showed signs of physiological adaptation to intensive physical activity such as sinus bradycardia or ectopic atrial rhythm, but also findings which required follow-up and further investigation: In 98 athletes (40.5%), echocardiography showed signs of athlete's heart or other structural findings. In one case (male, 16 yrs) myocardial morphology was compatible with non-compaction cardiomyopathy and cardiac magnetic resonance imaging was recommended. Due to the potential impact on his career as a football player, the patient has been lost of follow-up despite a detailed discussion about potential risks.

**Conclusion** The study shows, that in children and adolescents basic pre-participation screening examinations including medical history, family history, sports history, physical examination and standard ECG provide important information about potential risks and apparent contraindications to participate in sports. Some findings which may indicate significant pre-existing disease could, however, only be found when other examinations such as echocardiography and spiroergometry were added. Whether these investigations should complement the routine pre-participation examinations requires further investigation.

**INTERVAL-TRAINING AND APPETITE REGULATION IN PATIENTS WITH TYPE 2 DIABETES**

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**Introduction:** Weight loss is recommended for overweight/obese subjects with type 2 diabetes (T2D), and strategies that induce and sustain a weight loss are warranted. We have recently shown that 4 months of interval training induces weight loss to a greater extent than continuous training. The reason for this is unclear but may be dependent on differential appetite regulation following single exercise sessions. Therefore, the aim of this study was to investigate if an acute bout of interval-walking (IW) results in differential changes in energy-intake and appetite regulation compared to an acute bout of continuous walking (CW) in subjects with T2D.

**Methods:** Fourteen subjects with T2D were included in the study (2530 y). Subjects underwent three trials in a randomised order. Trials were separated by one week and were identical except the following one-hour interventions: 1) Control (CON); 2) Continuous walking (CW); 3) Interval walking (IW – repeated cycles of 3 min of slow and 3 min of fast walking). Interventions were controlled using indirect calorimetry with the aim to match CW and IW for oxygen consumption rates. Following the intervention, subjects consumed a standard liquid mixed meal tolerance test (MMTT – 300 kCal; 15% protein, 30% fat, 55% carbohydrate) with repeated satiety questionnaires (Visual analogue scales) every hour during the following three hours. Three hours after starting the MMTT, subjects were given an ad-libitum meal consisting of either meatballs with curry-sauce and rice or minced meat with mashed potatoes. Following the MMTT, subjects kept diet records until the end of the following day. Preliminary results (n=5): Oxygen consumption was well-matched between CW ( $1648 \pm 253$  mlO<sub>2</sub>/min) and IW ( $1643 \pm 256$  mlO<sub>2</sub>/min,  $P > 0.05$ ). Ad-libitum meal energy intake did not differ significantly between interventions, but was numerically higher in CON ( $798 \pm 69$  kCal) and CW ( $763 \pm 32$  kCal) than in IW ( $683 \pm 55$  kCal,  $P > 0.05$  for all comparisons). Moreover, hunger sensation during the MMTT did not differ significantly between interventions, but was numerically higher in CON ( $47 \pm 14$  a.u.) and CW ( $49 \pm 8$  a.u.) compared to IW ( $36 \pm 10$  a.u.,  $p > 0.05$  for all comparisons). Based on diet records, free-living energy intake did not differ between interventions, neither at the intervention day nor at the day after.

**Conclusions:** While the study is ongoing and the current analyses are under-powered, preliminary data indicate that interval type exercise might acutely suppress appetite and energy intake compared to continuous type exercise and no exercise.

**CHANGE OF THE FLUID COMPONENT IN CALF AND ATHLETIC PERFORMANCE IN A MENSTRUAL CYCLE**

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**Introduction** A discomfort feel of edema during a menstrual cycle are reported in 10% of Japanese female athletes. The purpose of this study was to evaluate fluid change in calf in a menstrual cycle using Magnetic Resonance Imaging (MRI) quantitatively and investigate its association with athletic performance. **Methods** 14 young healthy women ( $23.6 \pm 0.3$  years) with regular menstrual cycle participated in this study. Body composition, serum Estradiol (E2), Progesterone (P4) and Aldosterone (Ald) were measured at 7:00- 8:00 in AM, and the athletic performance were estimated by static balance test, jump test, side steps, muscle strength of plantar flexion/dorsiflexion in ankle at 14:00-16:00 in PM. MRI in lower leg was performed both in AM and in PM. All measurements were performed every phase of a menstrual cycle: Menstrual (MP), Follicular (FP), Ovulatory (OP), Early Luteal (ELP) and Late Luteal (LLP). Results E2 and P4 were the highest in the ELP and Ald was the highest in the LLP. Although there were no changes in body composition during the menstrual cycle, the fluid in PM and the change of fluid between AM and PM increased significantly in the MP. Static balance test increased significantly in the MP and side step decreased significantly in the MP. Also, there was a negative correlation between side step and the fluid in calf from AM to PM.

**Discussion** Fluid in calf marked the most in PM and the difference between AM and PM in the MP. It has been reported P4 might play an important roles in fluid distribution, especially in fluid retention in the body (Olson et al. 1996) as well as activate the Renin-Angiotensin-Aldosterone System (Stachenfeld, 2004) (Stachenfeld, 2008). The highest level in P4 and E2 in the ELP and Ald in LLP suggests that the hormones may act differently to the fluid balance. Side step decreased significantly in the MP. Lebrun et al. reported that the performance ability remarks the worst in the 2-3 days from the menstruation (Lebrun, 1993), which may support our result. Also, there was a negative correlation between the side step and the difference in the fluid from AM to PM in the MP, which the significant increase of fluid in calf in the MP and maybe the one of the factor that decreases the side step.

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125(7). 564-567. 2. Stachenfeld Nina S. (2008). Exercise and sport sciences reviews, 36(3). 152. 3. Stachenfeld Nina S, TAYLOR Hugh S. (2004). Journal of Applied Physiology, 96(3).1011-1018. 4. Lebrun, Constance M. (1993). Sports Medicine, 16(6). 400-430. Contact Akemi Sawai E-mail : swiff01q@gmail.com

### **SARCOPENIA AND HIP STRUCTURE ANALYSIS VARIABLES IN A GROUP OF LEBANESE POSTMENOPAUSAL WOMEN**

NASR, R., BERRO, A.J., ALWAN, A., BADDOURA, R., EL HAGE, R.

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**Introduction:** Muscle mass decreases with age, leading to "sarcopenia" or low muscle mass, in elderly people [1]. The aim of this study was to compare geometric indices of hip bone strength in postmenopausal women with sarcopenia and postmenopausal women with normal skeletal muscle mass index. **Methods:** This study included 8 postmenopausal women (aged between 65 and 84 years) with sarcopenia and 60 age-matched controls (with normal skeletal muscle mass index). Body composition and bone mineral density (BMD) were assessed by dual-energy X-ray absorptiometry (DXA). We used the skeletal muscle mass index (appendicular skeletal mass (ASM)/height<sup>2</sup>) to define sarcopenia as previously described [1]. A skeletal muscle mass index (SMI) < 5.5 kg/m<sup>2</sup> was defined as the cut point for sarcopenia [1]. To evaluate hip bone geometry, DXA scans were analyzed at the femoral neck (FN), the intertrochanteric region (IT), and the femoral shaft (FS) by the Hip Structure Analysis (HSA) program. Cross sectional area (CSA), an index of axial compression strength and section modulus (Z), an index of bending strength were measured from bone mass profiles. **Results:** Weight, lean mass, BMI, FN CSA, FN Z, IT CSA, IT Z, FS CSA and FS Z were significantly higher in women with normal SMI compared to women with sarcopenia. In the whole population, SMI was positively correlated to CSA and Z of the intertrochanteric and the femoral shaft regions. **Conclusion:** This study suggests that sarcopenia negatively affects hip bone strength indices in postmenopausal women. **References:** [1] Baumgartner RN, Koehler KM, Gallagher D, Romero L, Heymsfield SB, Ross RR, Garry PJ, Lindeman RD. Epidemiology of sarcopenia among the elderly in New Mexico. Am J Epidemiol. 1998 Apr 15;147(8):755-63.

### **SKELETAL MUSCLE MASS INDEX AND BONE MINERAL DENSITY IN A GROUP OF LEBANESE POSTMENOPAUSAL WOMEN**

ALWAN, A., BERRO, A.J., NASR, R., BADDOURA, R., EL HAGE, R.

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**Introduction:** Muscle mass decreases with age, leading to "sarcopenia" or low muscle mass, in elderly people [1]. The aim of this study was to compare bone mineral density in postmenopausal women with sarcopenia and postmenopausal women with normal skeletal muscle mass index. **Methods:** This study included 10 postmenopausal women (aged between 65 and 84 years) with sarcopenia and 73 age-matched controls (with normal skeletal muscle mass index). Body composition and bone mineral density (BMD) were assessed by dual-energy X-ray absorptiometry (DXA). We used the skeletal muscle mass index (appendicular skeletal mass (ASM)/height<sup>2</sup>) to define sarcopenia as previously described [1]. A skeletal muscle mass index (SMI) < 5.5 kg/m<sup>2</sup> was defined as the cut point for sarcopenia [1]. Bone mineral content (BMC) and BMD were measured at whole body (WB), lumbar spine (L1-L4), total hip (TH) and femoral neck (FN). **Results:** Weight, lean mass, SMI, body mass index (BMI), WB BMC and TH BMD were significantly higher in women with normal SMI compared to women with sarcopenia. WB BMD, L1-L4 BMD and FN BMD values were not significantly different between the two groups. In the whole population, SMI was positively correlated to WB BMC, TH BMD and FN BMD. **Conclusion:** This study suggests that SMI is a positive determinant of whole body bone mineral content and hip bone mineral density in postmenopausal women. **References:** [1] Baumgartner RN, Koehler KM, Gallagher D, Romero L, Heymsfield SB, Ross RR, Garry PJ, Lindeman RD. Epidemiology of sarcopenia among the elderly in New Mexico. Am J Epidemiol. 1998 Apr 15;147(8):755-63.

### **THE EFFECT OF ELEVATION ON INTRAMUSCULAR TISSUE TEMPERATURE**

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**Introduction** Ice (I), compression (C), and elevation (E), or ICE, is a universally accepted treatment for acute musculoskeletal injuries; however, it has received recent scrutiny regarding its clinical effectiveness (van den Bekerom et al., 2012), with the component of elevation having the least literature regarding its effectiveness. The aim of this study is to examine tissue cooling at several depths with ice, compression, and elevation. **Methods** Fifteen healthy subjects completed eight conditions including: No treatment, ice only (I), compression only (C), elevation only (E), ice and compression (IC), ice and elevation (IE), compression and elevation (CE), or ice, compression and elevation (ICE). All conditions were tested on each subject with a minimum of 48 hours between each condition. Intramuscular temperatures were recorded every 30 seconds during a 1 minute pre-application period, 30 minute treatment period, and 20 minute post-application period. **Results** No treatment (control), C, E, and CE showed significant differences with any treatment that included ice (I, IC, IE, ICE). No significant difference was seen between IC and ICE. Finally, ice alone was significantly different with everything except IE. Skin and intramuscular temperatures increased with C, E, and CE, yet only the changes in skin temperature were significant (.001 and .001, respectively). **Discussion** From these results elevation does not appear to have an effect on tissue temperature that would indicate it is beneficial for reducing secondary injury. For both measurement locations and treatments, we observed changes similar to those reported in the literature (Merrick et al., 1993; Jutte et al., 2001; Dykstra et al., 2009; Merrick et al., 2003). A limitation of this study was that temperature changes were measured in the gastrocnemius in individuals who were not injured nor active. Different results may have occurred if the individuals had been exercising or after acute injury. Evidence for the effects of elevation on musculoskeletal injury in the low limb are lacking (van den Bekerom et al., 2012) and its use remains highly dependent on the expert opinion that elevation decreases hydrostatic pressure in the vasculature and decreases resistance to venous and lymphatic flow (Bleakley et al., 2010). Further studies need to be completed to conclude the effects and potential benefits of elevation. **References** Bleakley CM, Glasgow PD, Phillips N, Hanna L, Callaghan MJ, Davison GW, Hopkins TJ, Delahunt E. (2010) Physios in Sport (ACPSM). Dykstra JH, Hill HM, Miller MG, Cheatham CC, Michael TJ, Baker RJ. (2009) J Athl Train. 44(2), 136-141. Jutte LS, Merrick MA, Ingersoll CD, and Edwards JE. (2001). Arch Phys Med Rehab. 82, 845-850. Merrick MA, Knight KL, Ingersoll CD, and Potteiger JA. (1993). J Athl Train, 28(3), 236-245. Merrick MA, Jutte LS, Smith ME. (2003). J Athl Train. 38(1), 28-33. van den Bekerom MPJ, Struijs PAA, Blankevoort L, Welling L, van Dijk CN and Kerkhoffs GMMJ. (2012). J Athl Train, 47(4), 435-443. Contact cgillette@uwlax.edu



## Conventional Print Poster

## PO-CPP-29 Training &amp; Testing 1

**THE EFFECT OF HIGH- AND LOW-INTENSITY INSPIRATORY MUSCLE TRAINING ON THE PHYSIOLOGICAL RESPONSE TO EXERCISE IN CROSS-COUNTRY SKIERS**

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**Aim** The aim of the study was to evaluate the impact of isolated respiratory muscle training (RMT) on the work capacity and changes in selected spirometric parameters in trained cross-country skiers. **Methods** The study involved 4 female and 12 male skiers. A cross-over model was used: each subject belonged both to the group that completed 7 weeks of RMT training (the RMT group) and the one that completed 7 weeks of simulated RMT (the placebo group). Half of the subjects started by performing RMT and the other half by performing simulated RMT. Both RMT programmes consisted in performing 30 inspiratory manoeuvres twice a day, 6 days a week, using the heavy resistance model of POWERbreathe®. In the RMT group, resistance was gradually increased in subsequent weeks, whereas in the placebo group, resistance was set to 29 cmH<sub>2</sub>O (level 0) in the first week, and in the next six weeks it was set to a constant value of 53 cmH<sub>2</sub>O (level 1). All of the subjects underwent spirometric measurements and a stress test in the following stages of the study: before the experiment, after the change in RMT, and after the experiment. The spirometric measurements were used to determine i.a. maximal inspiratory pressure (P<sub>Imax</sub>). The stress test was conducted on a ski ergometer, with a gradual increase in intensity, and was continued until exhaustion. **Results** A significant increase in P<sub>Imax</sub> and in the work performed in the stress test was observed in both the RMT and placebo group for male cross-country skiers, but only in the RMT group for female skiers. No significant differences in P<sub>Imax</sub> or work were observed between the RMT and placebo group, regardless of the gender of the skiers. **Conclusion** We found that completing a 7-week RMT programme did not cause an increase in the work capacity of trained skiers. The effects of RMT on improving P<sub>Imax</sub>, which is indicative of the strength of the inspiratory muscles, depend on the magnitude of inspiratory resistance. The principle of gradually increasing inspiratory resistance according to a given person's progress in training should be followed in implementing RMT. The study also showed that RMT did not have a considerable impact on breathing efficiency in maximal effort. **References** HajGhanbari B, Yamabayashi C, Buna TR, Coelho JD, Freedman KD, Morton TA, Palmer SA, Toy MA, Walsh C, Sheel AW, Reid WD. Effects of respiratory muscle training on performance in athletes: a systematic review with meta-analysis. *J Strength Cond Res.* 2013;27(6):1643–1663. Klusiewicz A., L. Borkowski, R. Zdanowicz, P. Boros, S. Wesółowski (2008) Inspiratory muscle training in elite rowers. *J. Sports Med. Phys. Fitness* 48: 279-284. Contact Email: andrzej.klusiewicz@insp.waw.pl Do not insert authors here

**PACING PROFILES BETWEEN DIFFERENT LEVELS OF SUB-3H PERFORMERS AT THE CLASSIC MARATHON COURSE**

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**Introduction** The classic Athens marathon course is characterized by special difficulty, mainly due to a progressively ascending segment that extends between the 18th and the 31th km. This prolonged ascending course may add further challenges in the selection of a proper pacing profile (1, 2, 3). Therefore the aim of the study was to describe pacing profiles of sub-3h performers in the classic Athens marathon course. **Methods** Finishing and split times for the 0-5, 5-10, 10-21.1, 21.1-30 and 30-42.2 km segments were collated for 811 men across eight consecutive competitions (2007-2014) and the mean speeds for each segment were calculated. Athletes were categorized in five groups according to the 5th, 25th, 50th and 75th percentile of all sub-3h finishing times. Two-way analysis of variance with Scheffe post-hoc tests was conducted to compare mean segment speeds between groups and to identify changes between successive race segments for each group. Level of significance was set at  $\alpha=0.05$ . **Results** Group 1 athletes were faster than all other groups in all intermediate segments (all  $p<0.001$ ), Group 2 athletes were faster than all other inferior groups in all intermediate segments (all  $p<0.001$ ) and Group 3 athletes were faster than all other inferior groups in all intermediate segments (all  $p<0.002$ ). Group 1 athletes demonstrated no significant change in speed between consecutive pairs of segments. Groups 2 and 3 maintained speed between the 0-5 and 5-10 and between the 5-10 and 10-21.1 km segments, whilst Groups 4 and 5 maintained speed between the 0-5 and 5-10 km segments. **Discussion** The results of the present study confirm the differences in pacing strategies between successful and less successful marathoners (1, 2, 3). Top finishers were able to maintain their average speed between consecutive segments despite a progressively ascending segment at about midway, whilst intermediate and bottom sub-3h performers showed significant speed reductions during the progressively ascending segment or even sooner. Maintaining a consistent marathon pace results in an effective race profile for best performance (1, 2). **References** 1. Renfree A, St Clair Gibson A. *Int J Sports Physiol Perform*, 2013; 8(3):279-285. 2. Santos-Lozano A, et al. *Int J Sports Med*, 2014; 35(11):933-938. 3. Hanley B. *J Sports Sci.* 2016 Jan 6:1-7; [Epub ahead of print].

**EFFECTS OF SIX WEEKS OF DIFFERENT HIGH INTENSITY INTERVAL VERSUS MODERATE CONTINUOUS TRAINING ON AEROBIC AND ANAEROBIC PERFORMANCE**

CAVAR, M.1, MARSIC, T.1, CORLUKA, M.1, CERKEZ, I.1, CULJAK, Z.1, MÜLLER, A.2, TSCHAKERT, G.2, HOFMANN, P.2

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**Introduction** Effects of diverse intensity training including high intensity interval training (HIT) on aerobic capacity are still underexplored. Most HIT studies were single comparisons to continuous moderate intensity exercise in the lab (Tschakert et al. 2015, Gibala et al. 2006). **Aim** was to explore effects of 3 different training programs on aerobic and anaerobic capacity as well as time to exhaustions (TTE). **Methods** 44 male trained subjects assigned in 3 groups according to Beep test (Leger et al. 1988) results, exercised at different % of the maximal shuttle run speed (MASS) and work/rest schedule 2x weekly for 6 weeks. 3 ranges of %MASS were individually defined and intensities progressed weekly. Beep test and 300 yard test were performed to determine aerobic and anaerobic performance. **Programs:** A) 10s work - 10s rest intervals shuttle run at 115% - 120% of MASS (passive rest, N=16), repetitions in each set (3 sets with 2 min of rest between) were set to be 70% of TTE in cited interval regime and were approx. 15; B) 3 x 4 minutes intervals at 90 to 95% MASS (2-3 minutes passive rest) (N=17). Intensities were matched to demonstrate TTE at approx. 5.5 min duration of work; C) continuous shuttle running (CSR) at 70%

of MASS [35 minutes of CSR, N=11]. Results 3x2 ANOVA showed sign. group time effects for Beep and 300 yard tests. Post hoc Fisher LSD test evidenced no sign. post-test changes for C in both tests. Intervals groups A, B advanced in both tests, and B progressed sign. greater than A in Beep (12.94 vs. 7.63 shuttles) and A in 300 yard (2.43s vs. 1.03s). Sign. post-test improvements of TTE were evidenced for both interval programs in TTE working regime at 5% higher intensity than in pre-tests, where A advanced more (but not sign) in TTE than B (28.7% vs. 7.6%). CSR tests applied showed sign. negative changes in the same TTE. Discussion Some specificity of the applied training was found as A was more effective improving anaerobic performance than B, while the opposite was found for aerobic capacity. CSR yielded no sign. changes, although performing the highest volume. Transformation of TTE around MASS seems to be more pronounced in interval schedules than in continuous ones and for the best results in each TTE regime, probably specific interval training strategies should be applied. References Tschakert G, et al. (2015) J Sports Sci Med. 1;14(1),29-36. Leger L A, et al. (1988) J Sports Sci. 6(2):93-101. Gibala MJ, et al. (2006) J Physiol. 575(Pt 3):901-11.

## CHRONIC AND ACUTE HORMONAL RESPONSES AFTER TWO TYPES OF ENDURANCE TRAINING

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Chronic and acute hormonal responses after the strength training are well established but less is known on the effects of endurance training. This study assessed the hormonal responses of blood testosterone (T), cortisol (C) and growth hormone (GH) concentrations after 8-weeks endurance training. Running performance was tested by the Cooper test. Thirty young males were divided into two groups: interval running (INT) (n = 14) and distance running (DIST) (n = 16) group. Training in INT consisted of 50 repetitions of 10-s intervals with 10-s resting period, length of section was either 44 m (Cooper test  $\leq$  2900 m) or 50 m (Cooper test  $>$  2900 m). Three sections were added every week. Training in DIST started with 30-minute running (70 % of the mean velocity during the Cooper test), duration increased by 2-minutes per week. Training was applied 3 times per week. Morning basal serum hormone concentrations were measured before (PRE) and after (POST1) the experiment. Acute hormonal responses were tested after the training period only, 20 minutes after the Cooper test (POST2). We monitored also changes in distance covered in Cooper test. In INT, significant decreases of C concentrations from PRE to POST1 ( $p < 0.05$ ,  $d = 0.82$ ) and from POST1 to POST2 ( $p < 0.01$ ,  $d = 0.75$ ) were found. Testosterone did not changed significantly. GH significantly increased from POST1 to POST2 ( $p < 0.01$ ,  $d = 2.34$ ) but no chronic basal changes were observed. In DIST, statistically significant decrease in C from PRE to POST1 ( $p < 0.01$ ,  $d = 0.58$ ) and from POST1 to POST2 ( $p < 0.01$ ,  $d = 0.9$ ) was found. T increased from PRE to POST1 ( $p < 0.05$ ,  $d = 0.41$ ). Growth hormone was significantly higher after 8-weeks ( $p < 0.01$ ,  $d = 2.07$ ) and also after the acute loading ( $p < 0.01$ ,  $d = 2.15$ ). Both groups improved their running performance measured by distance in the Cooper test ( $p < 0.01$ ,  $d = 0.59$  and  $p < 0.05$ ,  $d = 0.34$  in INT and DIST, respectively) with no significant differences between the groups. In conclusions, both types of endurance training induced significant decreases in resting C and similar acute elevations in GH. Differences in the acute T responses may reflect physiological specificity of the two training protocols.

## THE EFFECT OF THE PROGRAM FOR DISCOVERING AND FOSTERING KOREA SPORTS TALENTS

YOON, J.R., KIM, H.J., LEE, H.C., JO, J.Y., JO, I.H., CHANG, D.K.

*Korea National Sport University*

Introduction In general, olympic athletes found their own performance at 8 to 12 years old through various programs. Furthermore, as it has reported that the program for discovering and fostering Korea Sports Talents has an effective influence on enhancement of athletic performance, the importance of the program development for young athletes at the national level has been emphasized. Therefore, the purpose of this study is to evaluate the effect of the program for discovering and fostering Korea Sports Talents by comparing records of the physical performance test (Basketball throw, Sit-up, Half Squat, Standing long jump, 20m Shuttle run, The 50m run, Sidestep, Seated forward flexion) before and after starting the program. Methods The study subjects are 45 elementary school students (Age : 9.95 years old  $\pm$  1.44, Height : 143.65cm  $\pm$  11.84, Weight : 36.22kg  $\pm$  11.09) who have participated in 2015 Sports Talents Training Program. They were classified into a track and field training group (23 students), a swimming training group (12 students) and a gymnastics training group (10 students) and performed individual training (Track and field, Swimming, Gymnastics) twice a week for 3 hours a day for 6 months. Results Based on analysis of the basic physical performance test records before and after individual training, (I) those participated in a track and field training program showed a significant improvement in Basketball throw ( $t = -5.425$ ,  $p < 0.001$ ), Sit-up ( $t = -2.814$ ,  $p = 0.01$ ), Standing long jump ( $t = -4.595$ ,  $p < 0.001$ ), 50m run ( $t = 3.688$ ,  $p = 0.001$ ) and 20m Shuttle run ( $t = -2.494$ ,  $p = 0.022$ ). Those participated in a swimming program showed a significant improvement in Basketball throw ( $t = -11.238$ ,  $p < 0.001$ ), Sit-up ( $t = -2.748$ ,  $p = 0.019$ ). Those participated in a gymnastic training program showed a significant improvement in Seated forward flexion test ( $t = -2.712$ ,  $p < 0.024$ ). Discussion Consequently, the track and field training program for discovering and fostering Korea Sports Talents is effective at improving muscular power, muscular endurance and cardiovascular endurance. The swimming training program is effective at improving muscular power, muscular endurance. The gymnastic program is effective at improving flexibility. Contact jryoon@knsu.ac.kr

## PHYSIOLOGY OF A FEMALE JUNIOR WORLD CROSS-COUNTRY CYCLING CHAMPION: FROM YOUTH CATEGORIES TO JUNIOR SUCCESS

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*Cerism - University of Verona*

Introduction Cross-country bikers require highly developed aerobic and anaerobic systems to sustain performance demands [1]. Although these physiological characteristics, as well as a specific anthropometry, seem to be a prerequisite to compete successfully in adult age, few data are available about the development of these characteristics. This study shows the evolution of a young female cyclist, from youth categories to her success as junior world champion. Methods Every year during the competition period, from 14 to 16 years old, the athlete underwent an anthropometric evaluation, an incremental test and a 30 s Wingate Test. Throughout this period she competed for the national youth team. This has permitted a comparison with same age female bikers performing equal assessments. Results Height and body mass grew from 159.7 cm; 50.1 kg at 14 years old to 161.2 cm; 53.7 kg at 16 yo.  $\dot{V}O_{2peak}$  was 3.49 L/min at 14 yo, showing the highest relative value:  $\approx 70$  ml/kg/min.  $\dot{V}O_{2peak}$  increased at 3.68 L/min at 16 yo. PPO and PRCP increased from 14 to 16 yo, reaching at 16 yo 362 W (6.7 W/kg) and 282 W (5.3 W/kg) respectively. Peak anaerobic power increased from 710 W (14.2 W/kg) to 844 W (15.7 W/kg). Discussion Anthropometric evolution defined a morphological profile advantageous for cross-country performance, where a weight-optimization is required [1]. In each session  $\dot{V}O_{2peak}$  was the highest seen within the youth national team, +18% ( $\approx 0.5$  L/min) at 14



yo, +10% ( $\approx 0.35$  L/min) at 16 yo, and even exceeded values reported in top level bikers [2]. Also PPO and PRCP were higher than those reported in literature [2]. At 16 yo anaerobic indices showed the highest differences compared with same age national athletes with +19% in Pmax production (W/kg), with values greater than those of 4 female professional cyclists (12°-86° ranking UCI). Conclusion The characteristics required to compete successfully in cross-country cycling [2] are already highly developed in a young female junior world champion. At 16 years old, before entering in junior category, winning a world title, the athlete showed physiological values comparable to top class bikers, producing high power-to-weight ratios and high anaerobic power peaks. References 1. Impellizzeri, F. M. and S. M. Marcora (2007). 'The physiology of mountain biking.' *Sports Medicine* 37(1): 59-71 2. Impellizzeri, F. M., T. Ebert, et al. (2008). 'Level ground and uphill cycling ability in elite female mountain bikers and road cyclists.' *European journal of applied physiology* 102(3): 335-341

## Conventional Print Poster

### PO-CPP-33 Physical Education & Pedagogics 1

#### EFFECTS OF DIFFERENT PHYSICAL EDUCATION PROGRAMMES ON MOTOR PERFORMANCE, PHYSICAL CAPACITY PERCEPTION AND ACTIVITY ENJOYMENT IN HIGH-SCHOOL STUDENTS

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*University of Bologna*

**INTRODUCTION** The aim of the study was to analyze the effects of physical education (PE) activities, characterized by different physical and coordinative demands, on motor performance, self-perception and PE enjoyment. Improvements in PE enjoyment, gross motor skills, coordination, and aerobic performance were hypothesized, respectively, as an effect of team sports, acrobatics, juggling, and fitness-based programs. **METHODS** Four high school classes, including a total of 72 students of both sexes, were involved for a period of two months (two weekly PE hours) into different PE activities: Team Sports (TS), basic Acrobatics (Acr), Juggling (G), and Aerobic Fitness (F). Pre- and post-activity, the following motor tests were performed: Gross Motor Skills (GMS), Standing Long Jump (SLJ), Leger test (LT), Sit & reach (S & R). Furthermore, the Physical Self-Description Questionnaire (PSDQ, Marsh et al. 2010), and the Physical Activity Enjoyment Scale (PACES, Kendzierski and De Carlo, 1991) were administered. **RESULTS** The motor activity enjoyment (PACES score) increased significantly ( $p < 0.05$ ) in boys belonging to the TS and G groups, indicating a higher PE enjoyment, while it decreased in girls of the same groups. The perception of one's coordination, strength, flexibility and sports practice (as measured by the PSDQ), generally tended to show no changes or light decreases in all the groups. Only the ACR group showed a slight improvement in perceived strength, and a consistent significant improvement of perceived flexibility. All groups showed improved perception for the health scale of PSDQ. Concerning physical performance tests, G improved especially in the monopodal static item of the GMS test, while Acr and F improved in dynamic items of the GMS test. Acr and G worsened the performance in SLJ. Finally, aerobic performance resulted respectively increased and decreased in F and Acr. **DISCUSSION** The proposed motor activities showed improvements on coordinative motor performance. Regarding the physical performance, two hours per week of PE activities would not seem sufficient to induce specific improvements in high-school students. Moreover, some activities involved a scaled down perception of the students' own abilities. This outcome, together with the improved perception of health status, can represent a motivation for enhanced involvement of students in future physical activities. **REFERENCES** Kendzierski D, De Carlo KL (1991). *J Sports Exercise Psy*, 13, 50-64 Marsh HW, Martin AJ, Jackson SA (2010). *J Sports Exercise Psy*, 32, 438-482

#### STUDIES ON IMPROVEMENT OF PHYSICAL FITNESS BY MORNING EXERCISE AT ELEMENTARY STUDENTS

TAKEDA, T., OMIYA, T., MASHIYAMA, N., ISHII, Y., YAMAMOTO, K.

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**Introduction** The decrease of physical strength and ability in children are pointed out in Hokkaido, Japan. We conducted practical research about the physical strength improvement in elementary students in Ebetsu city where our university is located (Takeda et al., 2010~2015). The aim of this study is to examine the effect of the program for improvement of physical fitness for elementary students. **Methods** The subjects were 23 students (10 male, 13 female) in the first grade of elementary school. A "morning exercise" program was made for the subjects and the morning exercise program was carried out 33 times from May to December in 2015. The program was taught by the university students who were aiming to become teachers. The morning exercise program was made for the purpose of physical strength improvement and enjoyment for the students. The new fitness test made by the Japanese Ministry of Education, Culture, Sports, Science and Technology had been carried out before (in May) and after (in December) the program. The exercises performed the new fitness test were the standing broad jump, the power of grip, sit ups, flexibility, sidesteps and a 20m shuttle run (ability of endurance). Statistical differences between the values of before the program (in May) and after the program (in December) were determined by the T test (both sides). Differences with  $p < 0.05$  were considered significant. After the program, the questionnaires filled out by the subjects about their feelings for the morning exercise programs were collected. **Results** All values of male's separate exercises had increased in comparison between before and after. However, there were no significant differences between before and after. Values of standing broad jump, the power of grip, sit ups and flexibility in December (after) were above the National averages. Regarding to the values of female subjects, the power of grip, flexibility, side steps, 20m shuttle run had been increased in comparison between before and after. There was a significant difference between before and after in the 20m shuttle run ( $p < 0.05$ ). Values of standing broad jump, the power of grip, sit ups and flexibility and side steps in December (after) were above the National averages. In the results of questionnaires, 20 subjects answered "they were enjoyed the program very much" and 3 subjects answered "enjoyed the program". **Discussion** From results, the morning exercise program for elementary students in the first grade was effective. In questionnaires after the program, subjects answered that they came to like exercise more than before. The future task is to plan the improvement of the program better. **References** Takeda, T et al. (2015). *Bulletin of Hokusho University School of Lifelong Sport*, 6(1),13-27. Contact take@hokusho-u.ac.jp

**'ACTIVDISPENS.CH' - BEWEGUNG TROTZ SPORTDISPENS**

DIRIWAECHTER, C., WECHSLER, CH.

*Schweizerische Arbeitsgruppe für Rehabilitationstraining*

**Introduction** The WHO state that the fourth common cause of death is physical anergia. The increasing akinesia within human society is also observable in children. For many children and young people school sports is their only exercise time. Due to increased use of social media school sports is often the only chance to encourage activity in this age group. Although doctors and sport teachers follow the same aim regarding health promotion, different conditions exist related to school sport dispensation. **Aim** The aim of this project was to develop a new form of sports dispensation which facilitates the integration of students with a partial dispensation into sports class via customized exercise programmes. **Methods** By means of two online questionnaires, both structured similarly with respect to questions and main themes, a needs assessment was carried out. The questionnaires were sent by e-mail to 2.600 members of three Swiss medical associations, to doctors of the University Children's hospital of Basel as well as to approximately 4.000 sports teachers of the Swiss organization for sports at school. The addressees were asked to complete the questionnaire within two weeks. The sample size was n=87 (doctors, return rate of 3%) and n=213 (sports teachers, return rate of 5%). A catalogue of 54 exercises was created based on scientific literature in the field of physiotherapy and school sport. These exercises were videotaped and together with a newly created partial dispensation form published on a specific website ([www.activdispens.ch](http://www.activdispens.ch)). **Results** Based on the survey feedback, the partial dispensation form should include very precise instructions to differentiate between permitted and prohibited exercises. It should also contain specific information regarding body areas that may be trained versus those that may not. The form should allow fast and precise completion by medical staff, and contain all relevant information for sport teachers. Although teachers' and physicians' demonstrated keen interest in this project following a first pilot phase close collaboration between these groups is not yet established and may be essential for wider acceptance and implementation. **Discussion** This project may be an important contributing factor to health promotion and illness prevention in the school age population. Broad implementation requires closer collaboration between physicians and teachers.

**HOW SHOULD ELITE STUDENTS BALANCE DEMANDS OF COMPETITIVE SPORT AND ACADEMIC CAREERS? A CONCEPT FOR THE EVALUATION OF THE EFFECTS OF GRADUAL EXAMINATIONS IN ELITE SPORT SCHOOLS – THE "ADDITIVES ABITUR"**

BORCHERT, T., GERLACH, E., SALLEN, J.

*University of Leipzig, University of Potsdam*

**Introduction** Elite student athletes have to manage demands of school education with high-performance athletic training. To reduce the difficulties of balancing those "dual careers" (Borggreve & Cachay, 2012), the German conference of education introduced a pilot project with the title 'Additives Abitur' at one of the elite sports schools (ESS). The student athletes at this ESS got the opportunity to expand their time at school to obtain a university entrance qualification. Moreover, they can split the final examinations into smaller parts and pass it prematurely to complete a gradual additive examination ("Additives Abitur"; AA). However, there are no empirical findings on this new pilot project. A research project funded by the Federal Institute of Sport Science and the Ministry of Education in the state of Brandenburg will evaluate the effects of this specific institutional solution. **Methods** The evaluation shall be realized with a combined mixed method longitudinal study. Data from three groups of student athletes will be analyzed: (1) Elite student athletes from the pilot project which use the AA; (2) elite student athletes without using the AA and (3) student athletes who attend regular schools (comparison group). **Expected Results** The theoretical frame of reference as well as design, sampling and analysis procedures will be discussed. The evaluation can lead to two different scenarios: (1) The evidence of the efficiency concerning the AA and other support offers fails and the educational policies have to think about other support systems in ESS. (2) Conversely, the possibility to empirically prove the effectiveness of the AA would lead to a legitimization to implement the AA Germany-wide. **References** Borggreve, C. & Cachay, K. (2012). "Dual Careers": The Structural Coupling of Elite Sport and School Exemplified by the German Verbundsysteme. *European Journal for Sport and Society*, 9 (1+2), 57-80.

**LOAD CHARACTERISTICS OF SOCCER GAMES IN PE CLASSES FROM THE VIEWPOINT OF IMPROVEMENT IN PHYSICAL FITNESS**

TSUDA, R.

*Kanazawa Medical University*

**Introduction** The majority of studies on ball games in PE classes have focused on techniques and tactics, factors determining skill levels (Griffin et al., 1997). However, under the current Japanese physical education curriculum, it has been necessary to enhance physical fitness even in sport and dance exercises (Mext, 2008). From this point, it is important to examine the load characteristics of ball games in terms of physical fitness. The purpose of this study was to examine the effect of differences in pitch area and player number, ball, and rule of soccer games on characteristics of the games from the viewpoint of improvement in physical fitness. **Experiment 1 : Pitch area and player number** **Methods and Results** Twenty male junior high school students participated in the present study. They played four types of games with changing the size of pitch area and player number. (Game A : 30m×20m, 5 players per team ; Game B : 45m×30m, 5players per team ; Game C : 45m×30m, 10 players per team, Game D : 60m×40m, 10 players per team). The number of ball contacts, ratio of appearance time each movement speed, and distance covered during the game were measured. As a results, Small-group games might be improve technique, and the games with large pitch area per player might be available for improvement in anaerobic power. **Experiment 2 : Types of ball** **Methods and Results** Sixteen male junior high school students participated in the present study. They played two types of 4vs4 games with changing the ball. (Game A : futsal ball ; Game B : football). The number of ball contacts, distance covered and heart rate during the game were measured. As a results, there was no significant difference in the number of ball contacts, distance covered and heart rate during the game between game A and B. **Experiment 3 : Rule modifications** **Methods and Results** Eighteen male junior high school students participated in the present study. They played three types of 4vs4 games with changing the rule. (Game A : free game ; Game B : pass game ; Game C : man to man game). The number of ball contacts, ratio of appearance time each movement speed, and distance covered during the game were measured. As a results, the pass game would be the most effective in developing techniques, and the man to man game might be available for improvement in anaerobic power and aerobic endurance. **Conclusion** These results suggest that the load characteristics of soccer game from the viewpoint of improvement in physical fitness differ greatly when the pitch area and player number, types of ball and rule modifications of games are changed. **References** Griffin, L.L., Mitchell, S.A., and Oslin, J.L. (1997) Teaching sport concepts and skill ; A tactical games approach. *Human Kinetics : Cham-*

paign. MEXT (2008) The New Course of Study in Secondary school ([http://www.mext.go.jp/a\\_menu/shotou/new-cs/youryou/chukaisetsu/index.htm](http://www.mext.go.jp/a_menu/shotou/new-cs/youryou/chukaisetsu/index.htm)), (2008, 7).

**13:00 - 14:00**

## Mini-Orals

### MO-PM06 Nutrition & Supplementation

#### THE EFFECT OF NATIVE WHEY- VERSUS MILK-PROTEIN SUPPLEMENTATION ON MUSCLE SIGNALLING AND HYPERTROPHY DURING STRENGTH TRAINING

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*Norwegian School of Sport Sciences*

**INTRODUCTION:** Intake of dairy protein can stimulate muscle protein synthesis (MPS) after a bout of resistance exercise. The stimulation of MPS is driven by increased activity in anabolic signalling proteins, like phosphorylation of p70S6K. Leucine is suggested as a trigger for increased MPS. Consequently, protein sources giving a rapid increase in leucine concentration after ingestion might be beneficial for muscular adaptations to strength training. **AIM:** to investigate whether a native whey (100% whey-protein) supplement, known to rapidly increase leucine concentration, augments activity in anabolic signalling pathways more than milk protein (20% whey – 80% casein), and if this translates to increased hypertrophy and strength during 12-weeks of strength training. **METHODS:** 22 men and women (30±6 years) were randomized to either a milk protein or a native whey supplemented group. Both groups performed heavy load strength training for 12 weeks (3 sessions/week). In the first and last exercise session, biopsies were collected 30 minutes before and 2 hours after exercise to investigate acute responses and training adaptations. Protein supplements were given immediately after each session, in addition to morning or afternoon (2 x 20 g/day). Muscle samples were analysed for hypertrophic signalling and fibre area. Muscle strength and thickness of m. vastus lateralis were measured before and after training period. **RESULTS:** P-p70S6K increased significantly pre to post exercise for both groups in the first session and a significant larger response was observed in the native whey group than in the milk-group (9-fold vs 4-fold, respectively). However, in the last training session there was no significant difference between groups in P-p70S6K. There was no change in P-eEF2, whereas P-4E-BP1 increased acutely in the last session for both groups. Both groups significantly increased muscle strength in chest press and leg press (27±9 and 33±15%, respectively), with no differences between groups. Furthermore, similar significant increases were observed in the native whey and milk protein group for type II fibre area (25±30 vs. 25±29%) and m. vastus lateralis thickness (11±7 vs. 12±6%, respectively). **CONCLUSION:** In accordance with our hypothesis, native whey supplementation increased p70S6K phosphorylation more than similar amounts of milk protein in the first training session. This difference was, however, not present at the end of the training period, indicating adaptive mechanisms. Furthermore, the lack of differences between groups in improvements in muscle size and strength, suggests that the initial superior effects of native whey supplementation on muscle signalling not was translated to superior training adaptations.

#### A COMBINATION OF ACUTE DYNAMIC EXERCISE AND FLAVANOL-RICH COCOA CONSUMPTION ADDITIVELY IMPROVE EXECUTIVE FUNCTION IN HUMAN

TSUKAMOTO, H.1,2, SUGA, T.1, ISHIBASHI, A.1,3, TAKENAKA, S.1, GOTO, K.1, EBI, K.1, ISAKA, T.1, HASHIMOTO, T.1

*1 Ritsumeikan University, 2 Japan Society for the Promotion of Science, 3 Japan Institute of Sports Sciences*

**Introduction** Executive function (EF) is acutely improved by dynamic exercise through neural activation in the brain [1]. In addition, memory function (MF) is acutely and chronically improved by dynamic exercise through increased brain-derived neurotrophic factor (BDNF) in serum [2]. On the other hand, neural activity in the brain during cognitive task is acutely enhanced by flavanol-rich cocoa consumption [3]. Moreover, enhanced BDNF signaling in vitro human Alzheimer's disease model is triggered by cocoa polyphenol [4]. Interestingly, habitual intake of cocoa flavanol (CF) can improve various cognitive abilities [5]. Therefore, we hypothesized that a combination of acute dynamic exercise and high CF (HCF) consumption additively improve EF and MF. To address this hypothesis, we aimed to examine the EF and MF following intake of HCF and exercise. **Methods** Ten young healthy male subjects were randomized to receive a HCF beverage (563 mg flavanols per beverage, 250 ml, 80°C) and an energy-matched low CF (LCF) beverage (38 mg flavanols per beverage, 250 ml, 80°C) 1 h before exercise in a single blind counterbalanced manner. Next, the subjects performed cycle ergometer exercise at 60% VO<sub>2</sub>peak for 30 min. Subjects undertook a color-word Stroop task (to evaluate EF) and face-name matching task (to evaluate MF) at each time point (pre-intake, post-intake at 30 min, pre-exercise, post-exercise at 0 min, 30 min, and 1 h). **Results** The HCF significantly improved EF at 30 min post-intake compared with pre-intake ( $P < 0.01$ ), while the LCF did not affect EF. Furthermore, as compared with pre-intake, the combination of the HCF and exercise significantly improved EF throughout the post-exercise recovery (i.e., 1 h). However, as compared with pre-intake, the combination of the LCF and exercise improved EF only for 30 min during post-exercise recovery. In terms of the improved EF, the size of the effect was significantly larger in the HCF than the LCF at each time point during the experiment except for post-exercise at 30 min ( $P < 0.01$ ). On the other hand, the MF was only significantly improved post-exercise at 30 min in the LCF compared with the HCF ( $P < 0.05$ ). **Conclusion** These results suggest that a combination of acute dynamic exercise and the HCF consumption additively improve EF, but not MF. **References** [1] Byun K et al. (2014) *Neuroimage*, 98:336-45. [2] Griffin EW et al. (2011) *Physiol Behav*, 104(5):934-41. [3] Francis ST et al. (2006) *J Cardiovasc Pharmacol*, 47 Suppl2:S215-20. [4] Cimini A et al. (2013) *J Cell Biochem*, 114(10):2209-20. [5] Mas-troiacovo D et al. (2015) *Am J Clin Nutr*, 101(3):538-48. **Contact** Hashimoto, T. [t.hashimo@fc.ritsumei.ac.jp]

**ACUTE COCOA FLAVANOL INTAKE, EXERCISE AND CEREBRAL HEMODYNAMICS IN HEALTHY ATHLETES**

DECROIX, L., TONOLI, C., SOARES, D., HEYMAN, E., TAGOUGUI, S., MEEUSEN, R.

*Vrije Universiteit Brussel*

Purpose: Evidence exists that acute exercise-induced increases in cognitive function are accompanied by increased (cerebral) blood flow and increased BDNF levels. Acute cocoa flavanol (CF) intake may improve cognitive function, peripheral and cerebral blood flow at rest in humans. In animals, chronic CF supplementation induces cognitive enhancements, which are paralleled by elevated hippocampal BDNF levels. Therefore, this study investigated A) the effect of CF intake on cognitive function in combination with exercise and B) two factors, cerebral oxygenation and perfusion and BDNF, which are related to cognitive function. Methods: Twelve healthy, well-trained men ( $\text{VO}_{2\text{max}}$  63 ml/kg/min) participated in this randomized, double-blind, cross-over study. Participants performed a cognitive task (CT) 100 minutes after consumption of a 904 mg CF drink or placebo (PL), which was followed by a 30-min time trial and a post-exercise CT. Prefrontal near-infrared spectroscopy (NIRS) was applied during cognitive tasks and exercise to measure changes in oxygenated ( $\Delta\text{HbO}_2$ ), deoxygenated ( $\Delta\text{HHb}$ ) and total haemoglobin ( $\Delta\text{Hbtot}$ ) and blood samples were drawn and analysed for BDNF. Repeated measures ANOVA (drink (PL/CF)  $\times$  period (pre/post exercise)) was performed to detect changes in cognitive function, BDNF levels and cerebral oxygenation and perfusion during exercise. To estimate the effect of CF intake on cerebral oxygenation and perfusion during a CT before and after exercise, an analysis of Covariance (ANCOVA) was performed to adjust for day-to-day variability. Results: Reaction time was faster post-exercise (effect of period:  $F(2)=36.4$   $p<0.01$ ), but was not influenced by CF intake (no effect of drink/interaction).  $\Delta\text{HbO}_2$  during the CT at rest was increased by CF intake, compared to PL ( $F(1)=7.1$ ;  $p=0.02$ ).  $\Delta\text{HbO}_2$ ,  $\Delta\text{HHb}$  and  $\Delta\text{Hbtot}$  increased in response to exercise (effect of period), but no effect of CF was observed (no effect of drink/interaction). During the post-exercise CT,  $\Delta\text{HbO}_2$ ,  $\Delta\text{HHb}$  and  $\Delta\text{Hbtot}$  did not differ between CF or PL intake. BDNF was higher post-exercise (effect of period:  $F(1)=31.8$ ,  $p<0.01$ ), but was not influenced by CF intake (no effect of drink/interaction). Conclusion: CF intake did not alter cognitive function or BDNF at rest, but cerebral oxygenation was increased during a CT at rest. The beneficial effect of CF intake on cerebral oxygenation at rest was overruled by the strong exercise-induced increases in cerebral perfusion and oxygenation.

**EFFECT OF HIGH VS. MODERATE POST-EXERCISE PROTEIN FEEDINGS ON RECOVERY OF MASTERS ATHLETES**

DOERING, T.M.1, REABURN, P.R.1, BORGES, N.R.1, COX, G.R.2, JENKINS, D.3

*1:CQUUniversity, 2:Australian Institute of Sport, 3:University of Queensland*

Introduction Following exercise induced muscle damage (EIMD), masters athletes appear to take longer than younger athletes to recover. Post-exercise protein feeding is a recognised recovery strategy for endurance athletes to accelerate glycogen synthesis and elevate muscle protein synthesis for muscle repair and remodelling. However, whether doses of protein recommended for younger athletes are appropriate for masters athletes is unclear. The present study investigated the effect of repeated high vs. moderate protein intakes post-exercise on the same-day recovery of peak isometric torque (PIT), cycling performance and perceptions of recovery following EIMD in masters triathletes. Methods Eight trained masters triathletes ( $52\pm 2$  y,  $\text{VO}_{2\text{max}}$ ,  $51.8\pm 4.2$  mL/kg/min) participated in this study. Participants completed two experimental trials separated by seven days in a randomised, double-blind, crossover design. Diet was standardised for 24 h before each trial. Trials consisted of morning PIT testing and a 30 min downhill (-10%) run at an intensity of 70% of  $\text{VO}_{2\text{max}}$ ; an 8 h dietary intervention followed, providing either a moderate protein intake (MPI;  $3 \times 0.3$  g/kg) or isocaloric high protein intake (HPI;  $3 \times 0.6$  g/kg). PIT testing and a 7 kJ/kg cycling time trial (TT) were completed at the end of the 8 h. Perceptions of fatigue and muscle soreness were recorded pre- and post-exercise. Results Magnitude-based inferences suggest a possibly beneficial effect (62%) of the HPI on cycling TT performance (10 s,  $p>0.05$ ). The HPI attenuated the loss of PIT (-3.6%) from pre- to post-intervention, while a significant reduction in PIT (-8.6%) was observed with the MPI ( $p<0.05$ ). The HPI provided a significant reduction in the perception of fatigue from pre- to post-intervention ( $p<0.05$ ), while no effect was observed with the MPI. Discussion This study is the first to show that higher than recommended post-exercise protein intakes may facilitate physiological and perceptual recovery in masters athletes. Despite minimal effects on cycling performance, the recovery of PIT observed following the HPI in the present study suggests accelerated muscle recovery following EIMD; this may be beneficial to subsequent high intensity training (Twist & Eston, 2005). Furthermore, the present findings suggest a HPI post-exercise may reduce perceptions of fatigue, and thus facilitate an acute return to training. In conclusion, doubling the recommended post-exercise protein intake among well-trained masters triathletes provided no detrimental effect to acute cycling performance, and may attenuate loss of muscle force and perceptions of fatigue associated with EIMD. References Twist C, Eston R. (2005). Eur J Appl Physiol, 94(5-6), 652-658. Contact t.doering@cqu.edu.au

**DIETARY NITRATE INTAKE IN WELL-TRAINED ATHLETES**

JONVIK, K.L.1,2, WARDENAAR, F.C.1, NYAKAYIRU, J.2, SENDEN, J.M.G.2, VAN LOON, L.J.C.1,2, VERDIJCK, L.B.2

*1: HAN University of Applied Sciences, 2: Maastricht University*

BACKGROUND Beetroot juice, as a carrier of dietary nitrate, has become a popular ergogenic supplement in athletes. However, we consume nitrate via many other foods and food groups in our diet. PURPOSE To assess dietary nitrate intake and identify the main food sources that contribute to daily nitrate intake in a large group of well-trained athletes. METHODS 553 Dutch well-trained athletes (226 women and 327 men) completed multiple web-based 24-h dietary recalls and questionnaires within a 2-4 week period. We calculated daily nitrate intake following an assessment of the nitrate content of various foods and food groups. Gender differences were analyzed using independent t-tests. Correlations between energy, nitrate and vegetable intakes were analyzed using Pearson correlations. Results are reported as mean $\pm$ SD. RESULTS Habitual nitrate intake was  $132\pm 87$  mg/d (range 19-525 mg/d). Daily nitrate intake tended to be higher in women vs men ( $141\pm 90$  vs  $127\pm 84$  mg/d;  $P=0.061$ ). Despite substantially lower total energy intake in women vs men ( $9.0\pm 2.4$  vs  $11.5\pm 3.2$  MJ/d,  $P<0.001$ ), total vegetable intake was higher in women vs men ( $186\pm 142$  vs  $136\pm 101$  g/d;  $P<0.001$ ). When corrected for energy intake, nitrate intake was substantially higher in women vs men ( $15.7\pm 9.3$  vs  $11.3\pm 7.2$  mg/MJ;  $P<0.001$ ). A positive correlation was observed between daily energy intake and nitrate intake ( $r=0.27$ ,  $P<0.001$ ), and an even stronger correlation between daily vegetable intake and nitrate intake ( $r=0.75$ ,  $P<0.001$ ). In accordance, the majority of habitual nitrate intake was consumed through ingestion of vegetables and fruit (including potatoes), accounting for 77% of total nitrate intake in women and 71% in men. Lettuce and spinach were the products contributing most. Only 2% of the athletes (10 out of 553) reached a daily nitrate intake above the standard supplement dose of 400 mg. CONCLUSIONS Well-trained athletes have an average daily nitrate intake of 132 mg (19-525 mg). Dietary nitrate intake is significantly correlated with total energy intake and largely determined by the amount of vegetables consumed. Supported by a grant from the Dutch Technology Foundation STW



**DIETARY NITRATE SUPPLEMENTATION AND EXERCISE TOLERANCE IN OBESE ADOLESCENTS**

RASICA, L.1,2, SALVADEGO, D.3, PORCELLI, S.2, MARZORATI, M.2, MORETTI, S.2, SARTORIO, A.4, GRASSI, B.3

*1University of Milan, Italy 2IBFM, National Research Council, Italy 3University of Udine, Italy 4IRCSS Istituto Auxologico Italiano, Italy*

**Aim:** Previous study showed a higher O<sub>2</sub> cost of exercise, and therefore a reduced exercise tolerance, in obese patients during constant work-rate exercise compared to healthy subjects (Salvadego et al.). The ergogenic effects of dietary nitrate supplementation in sedentary healthy subjects has been often demonstrated: a) during moderate-intensity exercise, steady-state V'O<sub>2</sub> was reduced; b) during high-intensity exercise there was a significant reduction in the amplitude of V'O<sub>2</sub> "slow component" and time to exhaustion was increased (Jones). Aim of this study was to evaluate the effects of beetroot juice (rich in nitrate) supplementation on the main physiological variables associated with exercise tolerance in obese adolescents. **Methods:** Ten obese adolescents (age 16.2±1.1 yr; BMI 36.1±5.5 kg/m<sup>2</sup>) (Mean±SD) participated in a crossover double blind placebo-controlled study. Subjects were tested after 6 days of supplementation with beetroot juice (NO<sub>3</sub>- 4.2 mM)(BR) or placebo(PLA). Participants performed: i) a cycle-ergometer maximal incremental test; ii) two repetitions of 6-min sub-maximal moderate (80%GET) constant work-rate exercise and iii) one high-intensity (65%ΔV'O<sub>2</sub>peak-GET) constant work-rate exercise until exhaustion. **Results:** Plasma nitrate concentration was significantly higher after BR (108.4±37.2 μM) vs PLA (11.9±3.3 μM). "Peak" values and the O<sub>2</sub> cost of moderate-intensity exercise were not different in BR vs. PLA. During high-intensity exercise, the amplitude of V'O<sub>2</sub> "slow component" expressed as a percentage respect to total V'O<sub>2</sub>, at the same time in the two conditions, was slightly lower in BR(13.07±12.02 %) vs PLA(16.76±11.55 %) (p<0.05) and time to exhaustion was higher in BR(570±235 s) vs PLA(460±138 s) (p<0.005). **Conclusions:** The results of the present study suggest that, in obese adolescents, dietary nitrate supplementation may be effective in improving exercise tolerance only during high-intensity exercises. This is probably due to low oxygen availability and low pH, conditions that facilitate reduction from nitrite to nitric oxide. Reference 1)Salvadego et al.,(2010) Gas exchange kinetics in obese adolescents. Inferences on exercise tolerance and prescription, AJPRICP 299: R1298–R1305 2)Jones A.,(2014) Dietary nitrate supplementation and exercise performance, Sports Med 44 (Suppl 1):S35–S45

**COCOA FLAVANOL SUPPLEMENTATION AND EXERCISE SCIENCE: A SYSTEMATIC REVIEW AND STATE OF THE ART.**

TONOLI, C.1,2, SOARES, D.D.3, DECROIX, L.1,2, MEEUSEN, R.2, HEYMAN, E.1

*1: ULille2 (Lille, France), 2: VUB (Brussels, Belgium), 3: UFMG (Belo Horizonte, Brazil)*

**INTRODUCTION.** The overall goal of the current systematic review was to examine the effects of cocoa flavanol (CF) intake on exercise performance and physiological adaptations to exercise (acute and chronic) including markers of oxidative stress and inflammation, metabolic and (cardio) vascular parameters. **METHODS.** Pubmed and ISI Web of Knowledge were consulted to identify studies on CF intake and exercise. Key terms (and synonyms searched by MeSH database) that were included and combined were: 'exercise', 'polyphenols', 'flavanols', 'epi-lcatechin' and 'cocoa'. Studies in this systematic review needed to fulfill the following inclusion criteria: 1) humans, 2) original data 3) including cocoa flavanol and exercise, 4) no severe methodological deficiencies and 5) published before February 2016, 6) written in English. **RESULTS:** From a total of 522 studies, 8 met the inclusion criteria. Exercise performance (Time trial performance, VO<sub>2</sub>max, HR), and Rate of Perceived Exertion were not affected by the acute intake of CF. However; a 14-day intake of CF increases the gas exchange threshold during a VO<sub>2</sub>max test. Some oxidative stress markers (F<sub>2</sub> isoprostane, oxidized LDL's, MDA) were reduced by the acute or sub-chronic (14days) intake of CF. Markers of inflammation remained unaffected. Additionally, an increase in diastolic blood pressure during acute exercise has shown to be tempered in obese subjects by an acute high dose of CF intake (702 mg) compared to a low dose (22 mg), while flow mediated dilation increased after acute and chronic intake of CF. CF intake did not affect exercise-induced total platelet count or platelet volume. Furthermore, acute CF intake increased free fatty acids during exercise whereas RER, glucose, insulin, glucagon and cortisol levels remained unchanged. **DISCUSSION:** Based on this systematic review we conclude that CF intake is associated with reduced exercise-induced oxidative stress, tempered increments of blood pressure during exercise, increased mobilization of free fatty acids during exercise but without significant implication for exercise performance. Especially the amount of CF and time of intake is of great importance to have a specific action. Although CF does not increase exercise performance in young healthy subjects, one can expect improved performance in patients with vascular disorders. For more info contact ctonoli@vub.ac.be

**PERFORMANCE AND SIDE EFFECTS OF ACUTE SUPPLEMENTATION WITH N-ACETYLCYSTEINE: A META-ANALYSIS**

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*The University of Auckland*

**Background:** N-acetylcysteine (NAC) is a promising antioxidant supplement with potential as an acute strategy to enhance performance in elite sport, but there are concerns about side effects with high doses. **Purpose:** To review current literature and evaluate the effects of NAC supplementation on sport performance and adverse side effects. **Methods:** The literature up to June 2015 was searched on MEDLINE (PubMed), EMBASE, SPORTDiscus, Google Scholar and Scopus databases to identify for all studies investigating the effects of NAC supplementation on exercise performance and/or side effects experienced. Performance outcomes from each study were converted to the percent effect equivalent to mean power output in a time trial. All pooled analyses were based on random effects models generated by Review Manager (version 5.3). **Results:** A total of 5 studies met criteria for inclusion in the sport performance meta-analysis, and 17 for inclusion in the side effects meta-analysis. The typical daily dose of NAC reported was 5.8 g.d<sup>-1</sup>; with a range between 1.2 and 20.0 g.d<sup>-1</sup>. The mean difference in performance was 0.45% (95% CI -0.79-1.69). The odds ratio of the side effects on NAC compared to placebo was 1.11 (95% CI 0.88-1.39). The sub-analysis of NAC dose suggests an increase in side effects as the dosage of NAC increased however this observation requires further investigation. **Conclusions:** Despite initially promising performance effects with NAC, at this stage it is premature to recommend further. The risk of side effects from NAC supplementation also remains unclear, due to significant variation in effects. Suboptimal reporting and documentation from studies make it difficult to meta-analyse current literature and make clear conclusions regarding the effect of NAC.



### DIETARY NITRATE SUPPLEMENTATION ENHANCES RUNNING PERFORMANCE IN MODERATE NORMOBARIC HYPOXIA, INDEPENDENT OF AEROBIC FITNESS

SHANNON, O.1, DUCKWORTH, L.1, BARLOW, M.J.1, WOODS, D.1,2,3, SIERVO, M.2, LARA, J.2, O'HARA, J.P.1

1: Leeds Beckett University (UK), 2: Newcastle University (UK), 3: Royal Centre of Defence Medicine

**Introduction** Nitrate-rich beetroot juice (BR) reduces the oxygen cost of steady-state exercise and may improve exercise performance in sedentary and moderately-trained but rarely in well-trained individuals exercising at sea-level (Porcelli et al., 2015). Exposure to a hypoxic environment potentiates the nitrate-nitrite-nitric oxide pathway, and may extend the benefits of BR to well-trained individuals. The aim of this study was to determine the effect of BR on treadmill running performance in moderate normobaric hypoxia (equivalent to 2500 m altitude) in participants with a range of aerobic fitness. **Methods** Twelve males with a maximal oxygen uptake ranging from 47.1-76.8 ml/kg/min took part in a randomised double blind cross-over investigation. On the morning of the performance trials participants consumed 138 ml concentrated BR (~12.5 mmol nitrate) or a nitrate-deplete placebo (PL) (~0 mmol nitrate). Three hours later, participants completed moderate-intensity running and a 1500 m time-trial (TT) in a normobaric hypoxic chamber (PIO<sub>2</sub>: 107.5 mmHg, FIO<sub>2</sub>: ~15 %). Plasma nitrite concentrations were measured pre-supplementation and immediately pre-exercise. Oxygen uptake (VO<sub>2</sub>) was monitored at rest in hypoxia and during moderate-intensity running. Arterial oxygen saturation (SpO<sub>2</sub>) was assessed pre-hypoxic exposure, pre-exercise, during moderate-intensity running and post-TT. **Results** Plasma nitrite was no different between conditions pre-supplementation (PL: 43.5±43.8 vs. BR: 34±34 nM), but significantly greater in BR immediately pre-exercise (PL: 70.3±59.1 vs. BR: 705.6±266.5 nM; P<0.05). Average VO<sub>2</sub> was ~10 % lower (PL: 20.4±12.6 vs. BR: 18.4±2.0 ml·kg<sup>-1</sup>·min<sup>-1</sup>; P<0.05), whilst SpO<sub>2</sub> was greater (PL: 86.5±3.3 vs. BR: 88.4±2.7 %; P<0.05) following BR. BR improved TT performance by 3.2 % (PL: 341.9±46.1 vs. BR: 331.1±45.3 s; P<0.05). However, there was no apparent relationship between aerobic fitness and the improvement in performance following BR (r<sub>2</sub> = 0.05). **Discussion** BR supplementation increases plasma nitrite, reduces VO<sub>2</sub>, elevates SpO<sub>2</sub> and improves 1500 m TT performance in moderate normobaric hypoxia. There was no relationship between aerobic fitness and the response to BR supplementation. This suggests that well-trained and less well-trained individuals may derive the same performance enhancing benefits of BR when consuming a high nitrate dose, when conducting moderate and high-intensity exercise in a hypoxic environment. **References** Porcelli S, Ramaglia M, Bellisti G, Pavei G, Pugliese L, Montorsi M, Rasica L, Marzorati M. (2015). *Med Sci Sports Exerc*, 247, 1643-1651. Contact O.Shannon@LeedsBeckett.ac.uk

13:00 - 15:00

## Oral presentations

### OP-PM01 GSSI Presentations: Nutrition

#### POST EXERCISE HIGH-FAT FEEDING INCREASES LIPID GENE EXPRESSION BUT SUPPRESSES P70S6K1 ACTIVITY: IMPLICATIONS FOR TRAINING ADAPTATION

HAMMOND, K.M., IMPEY, S.G., JEROMSON, S., HAMILTON, D.L., SHARPLES, A.P., MORTON, J.P.

Liverpool John Moores University

**Introduction** Carbohydrate (CHO) restriction augments training-induced increases in skeletal muscle mitochondrial biogenesis (Bartlett et al. 2015). Additionally, high-fat diets enhance the activities of enzymes involved in fat oxidation and transport (Erlenbusch et al. 2005). We therefore tested the hypothesis that reduced CHO availability but high fat availability provides an additive effect on the exercise-induced cell signalling pathways and gene expression responses associated with the regulation of mitochondrial biogenesis, lipid gene expression and muscle protein synthesis. **Method** Ten males completed a twice per day exercise model (3.5 h between sessions) comprising morning high-intensity interval (HIT) (8 x 5-min at 85% VO<sub>2</sub>max) and afternoon steady-state (SS) running (60 min at 70% VO<sub>2</sub>max). In a repeated measures design, runners exercised under different isoenergetic dietary conditions consisting of high CHO (HCHO: 10 CHO, 2.5 Protein and 0.8 Fat, g.kg<sup>-1</sup> per whole trial period) or reduced CHO but high fat availability in the post-exercise recovery periods (HFAT: 2.5 CHO, 2.5 Protein and 3.5 Fat, g.kg<sup>-1</sup> per whole trial period). Vastus Lateralis biopsies were obtained pre-HIT, post-SS and at 3 and 15 h post-SS exercise to assess muscle glycogen content, signalling activity of metabolic (AMPK-α2) and protein synthesis (p70S6K) transduction networks and expression of genes associated with mitochondrial biogenesis and lipid metabolism. **Results** Muscle glycogen was lower (P<0.05) at 3 h (251 vs 301 mmol.kg<sup>-1</sup>dw) and 15 h (182 vs 312 mmol.kg<sup>-1</sup>dw) post-SS exercise in HFAT compared to HCHO. AMPK-α2 activity was not increased post-SS in either condition (P=0.41) though comparable 2-3-fold mRNA increases (all P<0.05) in those genes associated with mitochondrial biogenesis were observed in both HCHO and HFAT: PGC-1α (3-fold), p53 (2-fold), Tfam (3-fold), PPAR (3-fold) and ERRα (3-fold). In contrast, the mRNA expression of CD36 (P=0.05) and CPT1 (P=0.03) was 1-2-fold greater in HFAT in the recovery period from SS exercise compared with HCHO. p70S6K activity was higher (P=0.08) at 3 h post-SS exercise in HCHO versus HFAT (72.7 ± 51.9 vs 44.7 ± 27 fmol.min<sup>-1</sup> mg<sup>-1</sup>). **Discussion** We conclude that post-exercise high fat feeding does not "regulate the regulators" of mitochondrial biogenesis though it does increase lipid gene expression. However, high fat feeding suppresses p70S6K1 activity thus potentially impairing post-exercise skeletal muscle remodelling. As such high-fat post-exercise feeding offers no significant metabolic advantages for trained athletic populations. **References** Bartlett JD et al. (2015). *Eur J Sport Sci* 15: 3 – 12. Erlenbusch M et al. (2005). *Int J Sport Nutr Exerc Metab* 14: 1-14.

#### PROTEIN INGESTION BEFORE SLEEP PROVIDES PRECURSORS FOR POST-EXERCISE OVERNIGHT DE NOVO MUSCLE PROTEIN SYNTHESIS

TROMMELEN, J., HOLWERDA, A.M., KOUW, I.W.K., HALSON, S.L., VERDIJK, L.B., VAN LOON, L.J.C.

Maastricht University

**Introduction** Previously, we have demonstrated that ingestion of 40 g protein prior to sleep increases mixed muscle protein synthesis rates during post-exercise overnight recovery. It remains to be established whether ingestion of a more moderate amount of protein increases overnight muscle protein synthesis rates and provides precursors for de novo muscle protein synthesis. **Purpose** To determine

the impact of ingesting 30 g casein protein with and without 2 g free leucine prior to sleep on myofibrillar protein synthesis rates during post-exercise overnight recovery. Methods 36 healthy young males performed a single bout of resistance-type exercise in the evening (19:45 h) after a full day of dietary standardization. All subjects were provided with adequate recovery nutrition (20 g protein + 45 g carbohydrate) immediately after exercise (20:45 h). Thirty min prior to sleep (23:30 h), subjects ingested a beverage containing 30 g intrinsically L-[1-13C]-phenylalanine-labeled protein with (PRO+leu, n=12) or without (PRO, n=12) 2 g free leucine or a noncaloric placebo (PLA, n=12). Continuous intravenous L-[ring-2H5]-phenylalanine, L-[1-13C]-leucine and L-[ring-2H2]-tyrosine infusions were applied. Blood and muscle tissue samples were collected to assess whole-body protein balance, myofibrillar protein synthesis rates and overnight incorporation of dietary protein-derived amino acids into de novo muscle protein. One-way ANOVA with treatment as factor was used to determine differences between treatments. Results Protein ingestion prior to sleep improved overnight whole-body net protein balance (PRO:  $53 \pm 7$ , PRO+leu:  $59 \pm 12$ , and PLA:  $-6 \pm 1$  mol·kg<sup>-1</sup> per 7.5 h;  $P < 0.001$ ). Myofibrillar protein synthesis rates did not differ between treatments and averaged  $0.055 \pm 0.002$ ,  $0.055 \pm 0.004$  and  $0.057 \pm 0.003$  %·h<sup>-1</sup>, respectively ( $P = 0.850$ ). Myofibrillar L-[1-13C]-phenylalanine enrichments increased following protein ingestion and did not differ between the PRO and PRO+leu treatments. Conclusions Protein ingestion prior to sleep supports overnight recovery by providing precursors for de novo muscle protein synthesis during sleep. However, the ingestion of 30 g of casein protein with or without additional free leucine does not suffice to increase muscle protein synthesis rates during post-exercise overnight recovery. Funding The project is funded by TI Food and Nutrition, a public-private partnership on precompetitive research in food and nutrition. Contact jorn.trommelen@maastrichtuniversity.nl

### EXERCISE ENHANCES THE OVERNIGHT MUSCLE PROTEIN SYNTHETIC RESPONSE TO PRE-SLEEP PROTEIN FEEDING IN OLDER MALES

HOLWERDA, A.M., KOUW, I.W.K., TROMMELEN, J., HALSON, S.L., VERDIJK, L.B., VAN LOON, L.J.C.

*Maastricht University*

Purpose: The age-related decline in skeletal muscle mass is, at least partly, attributed to anabolic resistance to food intake. To compensate for anabolic resistance, we recently introduced the ingestion of dietary protein prior to sleep as a nutritional strategy to increase overnight muscle protein synthesis rates. Here we aimed to assess whether resistance type exercise performed in the evening can further augment the overnight muscle protein synthetic response to pre-sleep protein ingestion in older males. Methods: In a parallel group design, twenty-three healthy older men ( $71 \pm 1$  y) were randomly assigned to ingest 40 g casein protein before going to sleep with (PRO+EX; n=11) or without (PRO; n=12) performing resistance exercise earlier that evening. Overnight protein digestion and absorption kinetics, whole body protein metabolism and muscle myofibrillar protein synthesis rates were assessed using primed, continuous infusions of L-[ring-2H5]-phenylalanine and L-[ring-2H2]-tyrosine with the ingestion of intrinsically L-[1-13C]-phenylalanine labeled casein protein. Results: Exogenous phenylalanine appearance rates expressed over time did not differ between treatments. A total of  $55 \pm 2$  vs  $53 \pm 2$ % of the ingested protein-derived phenylalanine appeared in the circulation during overnight sleep in the PRO+EX and PRO treatment, respectively ( $P = 0.49$ ). Myofibrillar protein synthesis rates were 31% higher during overnight sleep when exercise was performed earlier that day ( $0.058 \pm 0.002$  vs  $0.044 \pm 0.003$  %·h<sup>-1</sup> in PRO+EX and PRO, respectively;  $P < 0.01$ ; L-[ring-2H5]-phenylalanine). In line, approximately 27% more L-[1-13C]-phenylalanine was incorporated into myofibrillar protein in PRO+EX compared with PRO ( $0.042 \pm 0.002$  vs  $0.033 \pm 0.002$  MPE, respectively;  $P < 0.05$ ; L-[1-13C]-phenylalanine). Conclusions: Resistance-type exercise augments the overnight muscle protein synthetic response to pre-sleep protein ingestion and allows more of the ingested protein to be directed towards de novo muscle protein synthesis during overnight sleep in older males.

### THE RESPONSE OF MUSCLE PROTEIN SYNTHESIS TO WHOLE BODY RESISTANCE EXERCISE IS GREATER FOLLOWING INGESTION OF 40 G COMPARED WITH 20 G OF WHEY PROTEIN

MACNAUGHTON, L.S., WARDLE, S.L., MCGLORY, C., LAWRENCE, C., WALLIS, G.A., WITARD, O.C., TIPTON, K.D.

*University of Stirling*

INTRODUCTION It is currently accepted that ingesting 20 – 25 g of protein is required to achieve maximal stimulation of muscle protein synthesis (MPS) following resistance exercise. However, the influence of the amount of lean body mass (LBM) on the post exercise response of MPS to protein ingestion has never been investigated. Therefore, our aim was to assess the influence of the amount of LBM on the response of MPS to ingestion of either 20 or 40 g of whey protein following a bout of whole body resistance exercise. METHODS In a between and within groups study design, 15 young resistance-trained males of lower LBM (LLBM;  $\leq 65$  kg) and 15 of higher LBM (HLBM;  $\geq 70$  kg) were recruited. Participants consumed either 20 or 40 g of whey protein following a bout of whole body resistance exercise. Myofibrillar MPS was measured by the infusion of labelled phenylalanine tracer and collection of skeletal muscle biopsy samples. RESULTS Myofibrillar MPS was 18% greater following ingestion of 40 g ( $0.059 \pm 0.017$ %·h<sup>-1</sup>) whey protein compared with 20 g ( $0.049 \pm 0.016$ %·h<sup>-1</sup>) ( $p = 0.005$ ) during a 5 h exercise recovery period. No difference in the MPS response was observed between LLBM ( $0.048 \pm 0.018$ %·h<sup>-1</sup> and  $0.059 \pm 0.021$  for 20 g and 40 g respectively) and HLBM ( $0.051 \pm 0.014$ %·h<sup>-1</sup> and  $0.059 \pm 0.012$  for 20 g and 40 g respectively) groups following whole body resistance exercise and protein ingestion. The rate of phenylalanine oxidation area under the curve (AUC) was greater ( $p = 0.001$ ) following ingestion of 40 g ( $15.53 \pm 5.60$   $\mu\text{mol}\cdot\text{min}^{-1}\cdot\text{kg}^{-1} \times 300$  min) compared with 20 g ( $12.83 \pm 3.83$   $\mu\text{mol}\cdot\text{min}^{-1}\cdot\text{kg}^{-1} \times 300$  min) of whey protein. DISCUSSION Our results suggest that more protein is required to maximally stimulate MPS when whole body exercise is performed compared with leg only. The amount of muscle activated during exercise, but not the total amount of LBM, alters the dynamics of protein nutrition. Further study is required to determine the amount of protein necessary to maximally stimulate MPS following whole body resistance exercise. Moreover, total LBM may influence the maximal response of MPS at higher protein doses. The novel finding of this study, i.e. that 40g of protein stimulates MPS more than 20g after whole body resistance exercise, has implications for design and implementation of nutrition strategies to support training and physical activity. We conclude that greater amounts of protein are required following whole body, compared to leg only, resistance exercise to maximally stimulate MPS. Funded by GlaxoSmithKline Consumer Healthcare, Brentford, UK.

## INGESTION OF 40 G PROTEIN PRIOR TO SLEEP STIMULATES OVERNIGHT MYOFIBRILLAR PROTEIN SYNTHESIS IN HEALTHY OLDER MEN

KOUW, I.W.K., HOLWERDA, A.M.H., TROMMELEN, J., KRAMER, I.F., BASTIAANSE, J., HALSON, S.L., WODZIG, W.K.W.H., VERDIJCK, L.B., VAN LOON, L.J.C.

*Maastricht University Medical Centre (MUMC), Maastricht, the Netherlands; Top Institute Food and Nutrition (TIFN), Wageningen, the Netherlands; Australian Institute of Sport (AIS), Belconnen, Australia*

**Introduction:** The loss of skeletal muscle mass with aging has been attributed to the blunted muscle protein synthetic response to protein intake. Protein feeding prior to sleep has been suggested as an effective strategy to compensate for such anabolic resistance. We assessed the impact of ingesting 20 and 40 g protein prior to sleep on protein digestion and absorption kinetics and subsequent overnight myofibrillar protein synthesis rates in older men. **Methods:** 48 older men ( $72 \pm 1$  y) were randomly assigned to ingest 20 g protein (PRO20), 20 g protein plus 1.5 g leucine (PRO20+LEU), 40 g protein (PRO40) or a placebo (PLA) prior to sleep. Ingestion of intrinsically L-[1-13C]-phenylalanine and L-[1-13C]-leucine labeled casein was combined with intravenous infusions of L-[ring-2H5]-phenylalanine and L-[1-13C]-leucine throughout the night. Blood samples were taken frequently to assess dietary protein digestion and absorption kinetics, and muscle biopsies were taken prior to sleep and after 7.5 h of sleep to assess overnight myofibrillar protein synthesis rates. Plasma data were analyzed by two-factor repeated measures ANOVA (time as within-subjects factor, treatment as between-subjects factor) and differences in muscle protein synthesis data were analyzed by one-way ANOVA (treatment as factor), with Tukey post-hoc testing. Results represent means  $\pm$  SEM. **Results:** Exogenous phenylalanine appearance rates increased following protein ingestion, with more amino acids being released following ingestion of 40 as opposed to 20 g protein ( $P < 0.05$ ). Overnight myofibrillar protein synthesis rates were higher in PRO40 when compared with PLA (PLA:  $0.033 \pm 0.002$ ; PRO20:  $0.037 \pm 0.003$ ; PRO20+LEU:  $0.039 \pm 0.002$ ; PRO40:  $0.044 \pm 0.003$  %/h, respectively;  $P < 0.05$ ). The incorporation of dietary protein-derived amino acids into de novo muscle protein was greater in PRO40 when compared with PRO20 ( $0.033 \pm 0.002$  vs  $0.019 \pm 0.002$  MPE, respectively;  $P < 0.001$ ), and tended to be higher compared with PRO20+LEU ( $0.025 \pm 0.002$  MPE;  $P = 0.06$ ). **Conclusions:** Ingestion of 40 g protein prior to sleep increases overnight amino acid availability and stimulates de novo muscle protein synthesis during sleep in older men. These findings provide a novel basis for nutritional strategies by providing additional protein to preserve muscle mass in both health and disease. Email: imre.kouw@maastrichtuniversity.nl

13:00 - 14:00

## Mini-Orals

### MO-PM04 Body Composition 1

#### WHAT IS THE MOST RECOMMENDED ALTERNATIVE METHOD TO DXA TO ASSESS CHANGES IN BODY FAT PERCENTAGE IN ELITE YOUTH SOCCER PLAYERS?

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**Introduction:** Body fat percentage (BF%) has been shown to be an important item for talent identification (Reilly et al., 2000) and injury prevention in elite-standard youth soccer (Kemper et al., 2015). Our aim was to find out what are the most appropriate alternative methods to identify changes in BF% ( $\Delta$ BF%) when dual-energy X-ray absorptiometry (DXA) is used as the reference method in elite youth soccer players. **Methods:** The sample was composed of 20 highly-trained youth soccer players ( $17.1 \pm 0.5$  y). BF% was measured in the preseason and in the middle of season (5 months after) by DXA (Hologic Serie Discovery QDR, USA), 2 bioelectrical impedance analyzers (Tanita BC-418 (TA), JP; and InBody770 (IB), KR), and skinfold thickness measurement using a Holtain caliper and estimating BF% through several formulas proposed in the literature (Slaughter (SLA), Faulkner (FAU), Carter (CAR), Durnin-Wormersley (DW), Brook (BR), Withers (WIT), and Lohman (LOH)). T test for dependent samples, intraclass correlation coefficient (ICC) and Bland-Altman analysis were used. **Results:** BF% measured by DXA was significantly decreased after 5 months of soccer competition ( $11.4 \pm 2.6\%$  vs.  $10.7 \pm 2.2\%$ ;  $p < 0.05$ ). ICCs between  $\Delta$ BF% by DXA and alternative methods were: 0.53 (TA), 0.44 (IB), 0.83 (SLA), 0.70 (FAU), 0.74 (CAR), 0.79 (DW), 0.75 (BR), 0.87 (WIT), and 0.58 (LOH) (all  $p < 0.05$ ). Bland-Altman analysis revealed a significant bias [95%CI] between  $\Delta$ BF% by DXA and  $\Delta$ BF% by IB (1.9% [5.7, -1.9]), FAU (-0.6% [1.1, -2.3]), CAR (-0.8% [1.0, -2.6]), DW (-0.8% [1.0, -2.6]), BR (-1.1% [1.1, -3.3]), WIT (-0.5% [0.9, -2.0]), and LOH (-0.7% [1.3, -2.7]) (all  $p < 0.01$ ), but not for TA (-0.5% [2.3, -3.2]) and SLA (-0.3% [1.8, -2.4]). The difference between DXA and IB, FAU, CAR, and LOH in estimating  $\Delta$ BF% was affected by the amount of  $\Delta$ BF% ( $r^2 = 0.25$ -0.80;  $p < 0.05$ ). **Conclusion:** The equation of Slaughter et al., which includes triceps and medial calf skinfold thicknesses, seems to be the most recommended alternative method to DXA to assess  $\Delta$ BF% in young soccer players due to its moderate-high ICC and lack of significant bias with DXA. References Reilly T, Williams AM, Nevill A, Franks A. (2000). J Sports Sci, 18(9), 695-702. Kemper GLJ, van der Sluis A, Brink MS, Visscher C, Frencken WGP, Elferink-Gemser MT. (2015). Int J Sports Med, 36(13), 1112-1117. Contact julian.alcazar@uclm.es

#### PROFILING MOVEMENT QUALITY CHARACTERISTICS ACCORDING TO BODY-MASS INDEX IN CHILDREN <9-11Y>

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**Introduction** Obese children move less and with greater difficulty than their normal-weight counterparts (Stratton et al, 2007). This is a result of increased joint pressure, decreased mobility and detrimental modification of gait pattern (Nantel et al, 2006; Shultz et al, 2014). Whilst the effect of high BMI on cardiovascular fitness is well-known (Stratton et al, 2007), the effect on movement quality characteristics, in-field, has not been investigated. The aims of this study were first, to apply automated, novel analyses used in Nano-health, to characterise the movement quality of children during the multi-stage fitness test (MSFT), and second, to report how movement quality character-

istics cluster according to BMI. Methods One hundred and three children ( $10.3 \pm 0.6$ y,  $1.42 \pm 0.08$ m,  $37.8 \pm 9.3$ kg, BMI;  $18.5 \pm 3.3$  kg.m<sup>2</sup>) volunteered to take part and performed the MSFT whilst wearing an ankle mounted accelerometer. BMI groups were used to classify children as UW (<5th percentile, n = 7), NW (5th to 85th percentile, n = 73), OW (>85th to <95th percentile, n = 14) or OB ( $\geq$  95th percentile, n = 9). The raw accelerometer signal was uploaded into Matlab and signal processed to derive characteristics of movement. All characteristics were profiled using a hierarchical clustering algorithm, Spearman's rho was used to assess the relationship with BMI group, and a Mann-Whitney U test was used to assess differences between BMI groups for each characteristic Results Children from the OB group had significantly lower stride control than every other group ( $P < 0.05$ ) and significantly lower TTE than UW and NW children ( $P < 0.05$ ). Following application of a clustergram, BMI was clustered with stride profile and TTE was clustered with spectral purity. Further, significant negative correlations ( $P < 0.05$ ) were found between BMI and TTE ( $R = -0.25$ ), spectral purity ( $R = -0.24$ ), maximal radial velocity ( $R = -0.22$ ), stride angle ( $R = -0.23$ ) and stride variability ( $R = -0.22$ ). Discussion This was the first study to report the stride control of children's gait. Moreover gait analysis unveiled key performance characteristics that differed between BMI groups. Significantly, these were also (i) representative of children's performance during the MSFT and, (ii) significantly negatively correlated with BMI. Obese children were not able to alter stride angle or stride profile to meet the running demands of the MSFT. These results demonstrate that novel analytics of ankle accelerometry data identified movement quality characteristics specific to BMI groups whilst performing the MSFT. Additionally, not only does high BMI impact gait and cardiovascular fitness, it also impacts the fundamental frequency and harmonic content of movement. References Nantel J, Brochu M, Prince F. (2011). Obesity, 14, 1789-1794. Shultz S.P, D'Hondt E, Lenoir M, Fink P, Hills A.P. (2014). Hum Mov Sci, 36, 12-19. Stratton G, Ridgers N, Fairclough S.J, Richardson D.J. (2007). Obesity, 15, 1513-1519. Contact: C.CLARK.801344@swansea.ac.uk

## THE INFLUENCE OF MATURITY STATUS ON THE RELATIVE AGE EFFECT IN ELITE YOUTH ALPINE SKI RACING AND SOCCER IN AUSTRIA

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Introduction A relative age effect (RAE), which consists of an over-representation of athletes born early in a selection year, was shown to be present in all age categories of alpine ski racing and soccer. Before strategies in the talent development systems can be changed to minimize the RAE, it is necessary to find the causal mechanisms of it. The aim of the study was to assess the influence of biological maturity status on the RAE. Methods The study included the investigation of 557 Austrian elite youth athletes (11-12 years): 134 (68 males, 66 females) national ski racers (SR) and 423 male soccer players (SP). Anthropometric measurements were performed, the age at peak height velocity (APHV) (Mirwald et al., 2002) was calculated and the birth months (divided into 4 relative age quarters (Q1-4)) were examined. Univariate ANOVA (post hoc: Scheffé) assessed differences in APHV between the athletes born in Q1-4. Chi<sup>2</sup>-tests evaluated differences in the Q-distributions and in the distributions of early (E), normal (N) and late (L) maturing athletes of the single Q. Statistical significance was set at  $p < 0.05$ . Results A RAE was present in SR ( $\chi^2(3, N=134)=12.09$ ;  $p=0.007$ ;  $\omega=0.30$ ) and SP ( $\chi^2(3, N=423)=33.09$ ;  $p < 0.001$ ;  $\omega=0.28$ ). SR of Q1-4 did not significantly differ in APHV from each other ( $p > 0.05$ ). SP of Q1-4 significantly differed in APHV ( $F(3, 419)=10.86$ ;  $p < 0.001$ ); post hoc-tests revealed that SP of Q 3 and 4 had a significantly lower APHV than SP of Q 1 and 2. The distribution of E, N and L maturing SR and SP significantly differed from the expected normal distribution (SR:  $\chi^2(2, N=134)=23.36$ ;  $p < 0.001$ ; SP:  $\chi^2(2, N=423)=67.63$ ;  $p < 0.001$ ). SR of Q4 were N (65.2%; m: 41.7%; f: 90.9%) and E maturing (34.8%; m: 58.3%; f: 9.1%). The distribution of the SP of Q4 was N (56.9%) and E maturing (43.1%). Discussion A highly significant RAE was present among SR and SP. The biological maturity status (APHV) significantly influenced the RAE in soccer; the relatively younger SP (Q3-4) will reach their individual peak growth spurt at a younger age; they are more mature. In both groups the distribution of E, N and L maturing athletes significantly differed from the expected normal distribution with a high percentage of E and hardly any L maturing athletes (L (Q1-4): SR 0.7%; SP 2.4%). The relatively younger athletes of Q4 can counteract the relative age disadvantage and seem to only have a chance for selection for national races (SR) and performance centers (SP), when they are early or normal matured; late maturing relatively younger athletes seem to have no chance for selection. References Mirwald RL, Baxter-Jones ADG, Bailey DA, Beunen GP. (2002). Med Sci Sports Exerc, 34, 689-694. [Lisa.Mueller@uibk.ac.at]

## RAPID WEIGHT LOSS IN OLYMPIC COMBAT SPORTS

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Introduction Olympic combat sports separate athletes into weight divisions. Official weigh-ins are held 3-24h before competition to ensure no athlete is heavier than permitted. Athletes commonly engage in rapid weight loss (RWL), generally via body water manipulation, before weigh-in then attempt to restore losses before competition on the assumption that performance decrements can be reversed. The belief is that a chance/strength/leverage advantage is gained by competing in a division lighter than habitual body mass (BM). Whether RWL improves the chance of success or not is unclear. Thus the aim of these investigations was to examine post weigh-in BM gain (a reflection of RWL) and competitive success. We also collected data on body composition and methods used to achieve and reverse RWL to determine the necessity and suitability of common practices. Methods Olympic combat sport athletes (n=94) within 2w of competition had body composition assessed by dual energy x-ray absorptiometry and compared to weight division. Athletes (n=227) were surveyed on their aggressiveness of RWL and recovery habits via a previously validated questionnaire (Artioli et al. 2009) which quantifies a rapid weight loss score (RWLS). Post weigh-in BM gain was measured in judo (n=86) and boxing (n=100) athletes at competitions and compared among a variety of sub groups. Results All athletes were significantly heavier than their competitive weight division <2w before competition. Athlete calibre had an effect on RWLS ( $p=0.0042$ ) however sport and sex did not. Differences in post weigh-in BM gain between winners and losers, and medallists and non-medallists in judo were significant at  $0.9 \pm 0.3\%$  ( $p=0.0021$ ) and  $1.4 \pm 0.4\%$  ( $p=0.0026$ ) respectively. Increased recovery time resulted in differences in post weigh-in BM gain in boxers of  $0.37\%$  ( $p < 0.0001$ ). Surveys suggest athletes recognise the importance of recovery from RWL yet most do not understand optimal methods of recovery and rehydration. Discussion Many combat sport athletes engage in RWL to make weight, as loss of body fat alone appears inadequate particularly for lighter athletes. Athletes favour combinations of passive/active dehydration and reduced food intake. Higher calibre athletes engage in more aggressive RWL than lower calibre athletes. A strong association between post weigh-in BM gain and success exists in judo which is not found in boxing, possibly due to the shorter recovery time prohibiting meaningful BM fluctuations or the different activity profiles of the sports. Fighters are keenly aware of the importance of recovery and re-hydration post weigh-in but are in need of support to optimise their practices. References Artioli, G. G. et al. (2009). Scand J Med Sci Sports, 20(1), 177-87 Contact Reid.reale@ausport.gov.au



## NUTRITIONAL PRACTICES AND CORPORAL COMPOSITION AS FACTORS THAT COULD DETERMINE THE DEVELOPMENT OF SPORT TALENTS IN ADOLESCENT SOCCER PLAYERS

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**Introduction:** Soccer practice is continually growing worldwide and the discover of new talents is a priority in this sport. It is known that there is a correlation between body composition (BC) and talent detection (TD) and when coaches select players, they tend to choose them with optimum BC. It is also known that when the soccer competition level increases, players become leaner, bigger and taller. Optimum BC depends of genetics but also have a direct correlation with nutritional intake (NI) of players. The aim was to analyze the correlation between NI and BC in two football teams with identical training load but different performance level and to observe the influence of NI and BC in TD. **Methods:** A descriptive study was carried out with 14 players ( $17.5 \pm 0.7$  years old) belonging to the same club: 8 playing in the higher level team (A) and 6 playing in the lower level (B) team, differentiated according to the subjective criterion of coach. NI was assessed with 7-day food diary (household measures, 3 days). BC was assessed by anthropometric (ISAK) and % fat mass and % muscle mass were calculated by formulas. (Poortmans et al., 2005; Slaughter et al., 1988) **Statistics:** for team comparison a Mann-Whitney U was used and Pearson's correlations were calculated between variables. Statistical significance was set at  $p < 0.05$  **Results:** Players did not meet nutritional recommendations with a notably deficiency in carbohydrate intake ( $4.4 \pm 0.5$ g/Kg Weight (W)/day for team A and  $4.5 \pm 0.5$ g/Kg W/day for team B). It has been observed a significant difference in protein consumption between team A and B ( $120 \pm 13.1$ g for team A and  $105.2 \pm 9.8$ g for team B;  $p < 0.05$ ). Moreover, team A had leaner bodies ( $11.1 \pm 1.5$ % fat mass (team A) vs.  $17.8 \pm 6.7$  (team B) ( $p < 0.05$ )) and it was a negative correlation between % fat mass and protein intake ( $p < 0.05$ ) for both groups. **Discussion:** This study shows an important correlation between TD and BC as was described in previous studies with team sports (e.g.: Torres-Unda et al., 2013) and also between NI and some anthropometric parameters. Therefore, it could be assumed that exists an indirect relationship between nutritional intake of this athletes and TD, so that noncompliance with recommendations could be limiting the maximum potential development of this players and therefore cause a loss of potential talents. **References:** Slaughter et al., Hum Biol 1988, 60(5), 709-723 Poortmans J, Boisseau N, Moraine J, Moreno-Reyes R & Goldman S. MSSE 2005, 37 (2), 316-322 Torres-Unda et al.(2013). J Sport Sci, 31(2), 196-203 Contact: nbonfanti@usj.es

## MANIPULATION OF MUSCLE CREATINE AND GLYCOGEN CONTENT CHANGES DXA ESTIMATES OF BODY COMPOSITION

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**Introduction** Reliable measurements of body composition can be achieved by dual x-ray absorptiometry (DXA) if a standardised protocol is followed (1, 2). The aim of this study was to investigate the effects of manipulating muscle glycogen (Gly) and creatine (Cr) content independently and additively on DXA estimates of lean body mass (LBM) and body fat. **Methods** Eighteen well trained male cyclists undertook a protocol involving parallel group application of Cr loading ( $n=9$ ) ( $20$  g/d for 5 d +  $3$ g/d maintenance) or placebo ( $n=9$ ) with crossover application of Gly loading ( $12$  v  $6$  g/kg BM/d for 48 h) as part of a larger study involving a Gly-depleting exercise protocol. Body composition was measured via DXA using a standardised protocol involving rest and overnight fasting under the conditions of normal, depleted or loaded concentrations of muscle Gly, with or without Cr loading. Biopsies were performed on the vastus lateralis to measure muscle Gly and muscle Cr. **Results** Glycogen-depleting exercise on the day prior to DXA resulted in a most likely substantial decrease in total lean body mass ( $-1.3 \pm 0.8\%$ ,  $\pm 0.3\%$ ; mean  $\pm$  SD, 90% confidence limits). Additionally, very likely to most likely substantial increases in total LBM were observed following a Gly loading diet both with ( $3.0\% \pm 0.7\%$ ;  $\pm 0.4\%$ ) and without ( $2.1\% \pm 0.9\%$ ;  $\pm 0.5\%$ ) Cr supplementation, and with Cr supplementation alone ( $1.3\% \pm 0.9\%$ ;  $\pm 0.6\%$ ). Total body fat showed a very likely trivial change following glycogen depletion, but there were possibly substantial increases of 3-5% with Gly loading and/or creatine supplementation. **Discussion** These results confirm recent work that found that acute intake of a high carbohydrate diet to increased DXA estimate of total and appendicular lean mass in untrained men(3). Our study is the first to investigate the interaction between creatine and glycogen in well trained athletes, and show that these interventions may challenge the ability of DXA to determine real changes in muscle mass that might be meaningful to an athlete. **References** 1.Nana A, Slater GJ, Hopkins WG, Burke LM. Effects of exercise sessions on DXA measurements of body composition in active people. Med Sci Sports Exerc. 2013;45(1):178-85 2.Nana A, Slater GJ, Hopkins WG, Burke LM. Effects of daily activities on DXA measurements of body composition in active people. Med Sci Sports Exerc. 2012;44(1):180-9. Epub 2011/06/21 3.Rouillier M-A, David-Riel S, Brazeau A-S, St-Pierre DH, Karelis AD. Effect of an Acute High Carbohydrate Diet on Body Composition Using DXA in Young Men. Ann Nutr Metab. 2015;66(4):233-6

## ASSOCIATION BETWEEN PHYSICAL FUNCTION AND BODY COMPOSITION CHANGES AFTER A WEIGHT LOSS PROGRAM

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**Introduction** Some studies have evaluated physical function as an important contributor to one's quality of life (Macdonald et al., 2012; Branco et al., 2016). However, few have been conducted after a weight loss program (WLP), combining perceived physical function and body composition (BC) changes (Florez et al., 2012; Cugusi et al., 2015). The aim of this study was to analyze the association between the physical function and changes in BC variables after a WLP. **Methods** One hundred and sixty-five (78 males and 87 females) overweight (W) and obese (O) participants (body mass index  $25$ - $34.9$  kg/m<sup>2</sup>), aged 18-50 years, performed a weight loss intervention during 24 weeks. Subjects were randomized into three training groups (strength training, endurance training or a combination of strength and endurance; training frequency 3 times/week) or a physical activity recommendations group. All of them in combination with a 25-30 % caloric restriction diet. BC changes were measured with DXA (Zapico et al., 2012). Physical function was examined with the SF36 questionnaire. A three-way ANOVA with repeated measures and Spearman's correlations were conducted. The percentage of change was defined as (pre-post)/pre\*100. **Results** Physical function improved significantly after the intervention ( $92.4 \pm 8.87$  vs  $96.90 \pm 0.54$ ). There were no interactions among time (pre and post intervention), gender or groups. Interaction between time and BMI classification was found and overweight participants reported greater physical function than obese participants before the intervention (W:  $95.01 \pm 1.00$ ; O:  $90.03 \pm 0.91$ ). Low but significant correlations were found between body composition changes and physical function, pre and post intervention ( $p < 0.05$ ). **Discussion** Recent studies show an association between BC and physical health, related to quality of life (Castres et



al., 2010; Brostow et al., 2016). Our results also indicated a relation between physical function and fat mass, android fat mass and lean body mass percentages. There was an increment in physical function perceived after the WLP, which is accordance to other investigations (Florez et al., 2012; Cugusi et al., 2015), and obese individuals observed a greater improvement than overweight individuals. Obesity had a negative impact on physical function; therefore obese individuals should be motivated to engage in physical activity and diet programs. References Branco, JC. et al. (2016). RMD Open, 2(1):e000166. Brostow, DP. et al. (2016). Ecol Food Nutr, 55(1):87-109. Castres, I. et al. (2010). Int J Sports Med, 31(11):773-8. Cugusi, L. et al. (2015). J Sports Med Phys Fitness, Epub ahead of print. Florez, H. et al. (2012). J Gen Intern Med, 27(12):1594-601. Macdonald, JH. et al. (2012). Arthritis Care Res, 64(1):92-100. Zapico, AG. et al. (2012). BMC Public Health, 12:1100. Funding: DEP2008-06354-C04-01 Contact sandragudloz@gmail.com

## VERIFICATION OF BODY COMPOSITION BALANCE SUITABLE FOR LIFE BEHAVIOR IN FEMALE ART UNIVERSITY STUDENTS

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**Introduction** We can surmise that differences in the living environment greatly influence morphology. This study aimed to investigate the body composition balance of female art university students, who were thought not to have spent much time engaged in exercise or sports, considering not only their BMI but also fat and muscle accumulation rates based on morphological quality differences. **Subjects** The subjects were 102 female general university students (Control group), 59 female students at arts university A, and 68 female students at arts university B, totaling 229 individuals. The general university's female students were designated as the control group. Female art students at university B were taken to be students with strong backgrounds in the arts. **Methods** Estimates of body fat and muscle percentages with respect to BMI were sought for the control group using the least square approximation polynomial, and first- to third-order regression polynomials were derived. The general validity of these orders was then determined from the results of the coefficient of determination and the Akaike information criterion (AIC). We then investigated the differences in the body composition balance in terms of body fat percentage and the body composition balance in terms of muscle percentage by conducting the chi-squared test on the frequency distribution of the fat accumulation rate and muscle accumulation rate in the control and A and B groups. **Results** The validity of the third order fat and muscle percentage regression polynomial for the BMI measured in the control group was determined from the coefficient of determination and the AIC. In addition, after applying the data from the A and B groups in the constructed regression evaluation chart, we compared the fat and muscle accumulation rate frequency distribution with that of the control group and then conducted the chi-squared test on the results. The results show that the body composition balance for female students at the art university B, where there is greater specialization in the arts, included a higher number of cases wherein body fat and muscle accumulation rates for BMI was somewhat underdeveloped and muscle accumulation was somewhat overdeveloped. **Discussion** One may speculate that attaining a body composition balance suitable for one's lifestyle and behavior creates conditions that facilitate adjustment to the environment. From these results it seems that lower fat accumulation and higher muscle accumulation may be a physical characteristic of the female arts university students in the university with the stronger arts emphasis. This allowed us to evaluate body composition balance from the dualistic perspective of fat and muscle percentage with respect to BMI, and understand the physical characteristics of female art university students. k-hayakawa@nagoya-su.ac.jp

## EFFECT OF 12 SESSIONS OF HIGH-INTENSITY INTERVAL TRAINING ON BODY COMPOSITION IN YOUNG ADULTS

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**Introduction.** High intensity interval training programs has shown to be an efficient way to improve body composition via activation of different metabolic and hormonal mechanisms. **Aims.** To examine the effect of four-week training of repeated sprints based on the Wingate test on power and body composition in young adults. **Methods.** Participants (22.4±1.8 years) were randomly assigned to an experimental or a control group. Prior to and at the end of the training period, all subjects underwent a whole body densitometry scan and performed a Wingate test. The experimental group did 12 repeated sprint sessions, which consisted of three and six sprints of 30 seconds with 4 minutes of rest. The control group was instructed to continue with their daily activities without any intervention. **Results.** In the experimental group, the average and maximum power increased by 9.4-16.5% ( $p < 0.001$ ). In addition, total fat mass decreased by 8.1% ( $p < 0.028$ ) and abdominal fat mass decreased by 10.0% ( $p < 0.038$ ). The control group showed no changes in any of the outcome measures. **Conclusions.** A four-week training of repeated sprints based on the Wingate test with a specific volume of ~3 minutes per session and a frequency of three sessions per week showed improvements in average and maximum power. Furthermore, high intensity interval training induced a lowering in total fat mass and abdominal fat.

## Mini-Orals

### MO-PM08 Environment

## PASSIVE HEATING INDUCES SIMILAR BENEFITS IN AEROBIC CAPACITY AND INSULIN SENSITIVITY AS MODERATE-INTENSITY ENDURANCE TRAINING

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**Background:** Evidence suggests adoption of a sedentary lifestyle leads to reductions in aerobic exercise capacity and insulin sensitivity and an increased risk for chronic disease. Public Health Authorities suggest 150 min of endurance training (ET) per week to prevent reductions in fitness and health. However, exercise may be contraindicated in some individuals. In these conditions passive heating (PH) has been suggested to be an alternative intervention to improve fitness and health, but hard evidence is lacking today. **Aims of the study:** To investigate: 1) The effect of PH on aerobic exercise capacity (VO<sub>2</sub>peak) and insulin sensitivity compared to ET, and 2) whether increases in

skeletal muscle mitochondrial density and capillary density are part of the underlying mechanisms. Methods: 17 young sedentary males matched for age and BMI ( $21 \pm 1$  yr, BMI  $24 \pm 5$ ) were randomly allocated to either 6 wk. of PH (n=10; 40-50 min resting at  $40^\circ\text{C}$  in a heat chamber, 3x/wk.) or ET (n=7; 40-50 min of cycling at  $\sim 65\%$   $\text{VO}_{2\text{peak}}$ , 3x/wk.).  $\text{VO}_{2\text{peak}}$  and insulin sensitivity (oral glucose tolerance test) were measured and muscle biopsies were taken from the vastus lateralis pre and post training. Immunofluorescence microscopy was used to assess fibre type (T1 and T2) specific changes in mitochondrial and capillary density. Results:  $\text{VO}_{2\text{peak}}$  (PH 5%, ET 5%; main effect  $P < 0.05$ ) and insulin sensitivity (ISI Cedarholm; PH 14%, ET 30%; main effect  $P < 0.05$ ) were both improved following training with no differences between PH and ET. Mitochondrial density was increased following training, with no difference between groups or within fibre types (PH T1 11%, T2 12%; ET T1 21%, T2 34%; main effect  $P < 0.05$ ). PH and ET increased all measures of skeletal muscle capillarization, with no difference between fibre types (capillary contacts, PH 17%, ET 12%; capillary-to-fibre perimeter exchange index, PH 23%, ET 23%; capillary density, PH 23%, ET 22%; main effect  $P < 0.05$ ). Both Interventions resulted in increased skin temperature during training (main effect  $P < 0.05$ ), with no difference pre and post intervention. However, only ET increased core temperature during training (PH  $P = 0.366$ ; ET  $P < 0.05$ ). Conclusions: PH induced similar increases in aerobic exercise capacity and insulin sensitivity to ET. These physiological adaptations were accompanied by similar increases in mitochondrial and capillary density. This implies that PH increases 2 of the major determinants of aerobic capacity and insulin sensitivity at the skeletal muscle level to a similar extent as ET. In conclusion PH is an effective intervention to improve aerobic capacity and insulin sensitivity, inducing similar skeletal muscle adaptations to ET.

## THE INFLUENCE OF DEHYDRATION ON THE TIME-COURSE OF HEAT ACCLIMATION AND TEMPERATE EXERCISE PERFORMANCE

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Introduction It has been suggested that adaptation to heat might be ergogenic [1] and that dehydration might represent an additional stimulus for plasma volume expansion and adaptation [2]. This study examined the effect of dehydration on the time-course of Heat Acclimation (HA) and temperate exercise performance. Methods A within-participant (n=8), balanced cross-over design with a three-month washout period was employed. Participants completed a control (euhydrated HA [HAEu]) and intervention (HA with permissive dehydration [HADe]) heat acclimation programme; dehydration was achieved by completely restricting fluid intake and a total of 1.75 L of fluid was provided during each session in the control condition. Thermal, thermoregulatory, physiological and perceptual responses to exercise in the heat ( $40^\circ\text{C}$ , 50% rh) were assessed prior to, mid-way through, immediately following and one week after HA (eight daily 90 minute exercise and heat exposures where rectal temperature ( $T_{\text{re}}$ ) was clamped at  $38.5\text{--}38.7^\circ\text{C}$ ). A graded exercise test for determination of mechanical efficiency, blood lactate threshold (LT), maximal oxygen uptake ( $\text{VO}_{2\text{max}}$ ) and peak power output (PPO) was performed in a temperate environment ( $22^\circ\text{C}$ , 50% rh) pre- and post-HA. Results Long-term HA induced adaptation with a reduced  $T_{\text{re}}$ , heart rate, perceptual strain and augmented sweating when exercising in the heat, although there were no differences in the extent of HA or plasma volume expansion between HAEu and HADe. HAEu and HADe also reduced thermal and cardiovascular strain to a similar extent in a temperate environment following long-term HA. Graded exercise tests in a temperate environment suggest that PPO was improved following long-term HA but this did not differ between conditions and other variables such as mechanical efficiency,  $\text{VO}_{2\text{max}}$  and LT were unaltered. Conclusion Dehydration did not influence the HA response and the ergogenic benefits of HA were unclear. However, HA did induced favourable thermal, thermoregulatory, physiological and cardiovascular responses to exercise in hot and temperate environments in trained men. References 1Lorenzo, S., Halliwill, J. R., Sawka, M. N. & Minson, C. T. (2010). Heat acclimation improves exercise performance. *J Appl Physiol.* 109: 1140-1147. 2Garrett, A. T., Goossens, N. G., Rehrer N. J., Patterson, M. J., Harrison, J., Sammut, I. & Cotter, J. D. (2014). Short-term heat acclimation is effective and may be enhanced rather than impaired by dehydration. *Am J Hum Bio.* 26: 311-320.

## THE EFFECT OF NORMOBARIC HYPOXIA ON APPETITE, APPETITE REGULATING HORMONES & ENERGY INTAKE

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Introduction Acute exposure to very high altitude ( $>3500\text{m}$ ) is associated with a significant suppression of appetite and energy intake, which may contribute to losses of lean mass and functional capacity. The reasons for this appetite suppression are unclear and it is unknown whether this will occur during acute exposure to moderate altitudes. This study examined the effects of exercise on appetite, appetite hormones and energy intake at moderate and very high altitudes. Methods Twelve healthy males (mean $\pm$ SD; age  $30 \pm 9$  years, body mass index  $24 \pm 3\text{kg.m}^{-2}$ ) completed three, 305-minute experimental trials at a simulated altitude of 0m (sea level: SL), 2150m ( $\sim 15.8\%$   $\text{O}_2$ ) and 4300m ( $\sim 11.7\%$   $\text{O}_2$ ) in a normobaric chamber. The trials were randomised using a counterbalanced Latin Square design. Participants arrived at the laboratory after a 12h fast, entering the chamber at 8am. A standardised breakfast was consumed inside the chamber at 1h. One hour after breakfast, participants performed a 60-minute treadmill walk at 50% of altitude specific  $\text{VO}_{2\text{max}}$ . An ad-libitum buffet meal was consumed 1.5h after exercise. Composite appetite score (CAS) [(hunger+prospective food consumption+[(100-fullness)+(100-satisfaction)]/4), acylated ghrelin (AG), glucagon like peptide-1 (GLP1) and insulin were measured throughout. Results During the resting period prior to exercise there were no significant differences in any variables between conditions. During exercise, area under the curve (AUC) for CAS was significantly lower at 4,300m ( $33 \pm 5\text{mm.h}^{-1}$ ) compared with 2150m ( $44 \pm 5\text{mm.h}^{-1}$ ;  $p = 0.024$ ) but not compared with SL ( $42 \pm 4\text{mm.h}^{-1}$ ;  $p > 0.05$ ). In the post-exercise period, AUC for CAS was significantly lower at 4300m ( $40 \pm 19\text{mm.h}^{-1}$ ) compared with SL ( $55 \pm 15\text{mm.h}^{-1}$ ;  $p = 0.004$ ) and 2150m ( $60 \pm 14\text{mm.h}^{-1}$ ;  $p < 0.001$ ). During exercise, AUC for AG was significantly lower at 4300m ( $48 \pm 23\text{pg.mL}^{-1}\text{.h}^{-1}$ ) compared with SL ( $69 \pm 27\text{pg.mL}^{-1}\text{.h}^{-1}$ ;  $p = 0.005$ ) and 2150m ( $67 \pm 31\text{pg.mL}^{-1}\text{.h}^{-1}$ ;  $p = 0.01$ ). During the post exercise period AUC for AG was significantly lower at 4,300m ( $49 \pm 31\text{pg.mL}^{-1}\text{.h}^{-1}$ ) compared with SL ( $116 \pm 49\text{pg.mL}^{-1}\text{.h}^{-1}$ ;  $p < 0.001$ ) and 2150m ( $111 \pm 62\text{pg.mL}^{-1}\text{.h}^{-1}$ ;  $p = 0.002$ ). There were no differences in GLP1 or insulin between conditions. Mean energy intake was significantly lower at 4300m ( $3728 \pm 3179\text{kJ}$ ) compared with SL ( $7358 \pm 1789\text{kJ}$ ;  $p = 0.007$ ) and 2150m ( $7390 \pm 1226\text{kJ}$ ;  $p = 0.004$ ). There was no difference in CAS, AG or energy intake between SL and 2150m. Discussion This study suggests that altitude-induced anorexia and a subsequent reduction in energy intake occurs with acute exposure to very high but not moderate altitudes. This effect may be explained by reduced concentrations of AG at very high altitudes. Further research should aim to identify methods of reducing appetite suppression at altitude.

## PLASMA LEUCINE KINETICS UNDER CONDITIONS OF BOLUS AND INTERMITTENT FEEDING OF FREE LEUCINE IN YOUNG, HEALTHY MEN

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The maintenance, growth or loss of muscle mass occurs in response to the dynamic balance between muscle protein synthesis (MPS) and muscle protein breakdown (MPB) (1). Nutrition interventions that maximise the stimulation of MPS have application in recovery and athletic performance (2) and in addressing age-related loss of muscle mass in elderly (3). Leucine has been shown to be the key amino acid (AA) in the activation of signalling cascade of MPS (Morton et al. 2015). However, stimulation of MPS exhibits an upper limit in response to a given concentration of leucinemia (4,5) and a refractory response to sustained levels of high leucinemia (5,6). In contrast, strategic dosing and distribution of AAs with intermittent and pulse feeding can overcome this refractory response via cyclical oscillation of aminoacidaemia and leucinemia (6). However, few studies have observed the leucinemia after ingestion of leucine alone. During this study, the pharmacokinetics after a single bolus of 3g of leucine were compared to that of 1.5g of leucine followed by another 1.5g 2 hour after initial ingestion. The aim of this study was to determine the magnitude of the cyclical oscillation of leucinemia, and compare the area under the curve (AUC) for each condition. Ten healthy active males participated in an RCT with cross-over design of each of the following conditions: one single bolus feeding (BF) of 3 g leucine; intermittent feeding (IF) encompassing initial ingestion of 1.5 g leucine followed by 1.5 g leucine 2 h later; and a 3 g maltodextrin placebo (PLA). For 4 h after ingestion, plasma leucinemia remained unchanged during PLA, and averaged at 112  $\mu\text{M}$ . During BF, plasma leucinemia peaked after 30 min at  $542 \pm 27.9 \mu\text{M}$  ( $p < 0.05$ ). During IF, plasma leucinemia peaked after 30 min at  $325 \pm 27 \mu\text{M}$ , trended towards baseline levels at  $169 \pm 8.6 \mu\text{M}$  at 120 mins, and peaked again at  $273 \pm 30 \mu\text{M}$  30 min after the second leucine ingestion ( $p < 0.05$ ). These results confirm that the oral ingestion of 3g of leucine, causes a steep rise in leucinemia to  $\sim 540 \mu\text{M}$  at 30 minutes. 1.5g of leucine, delivered intermittently at 2 hour intervals, resulted in a cyclical oscillation of leucinemia, in which leucine concentrations had reached as low as  $\sim 170 \mu\text{M}$  before the second ingestion at 2 hours. This dosing strategy may overcome the aforementioned refractory response of muscle, representing a strategy to maximise MPS in athletic and elderly populations. The present data support the aforementioned feeding strategies that will be employed in an upcoming trial in an athletic population examining recovery from intense resistance exercise. 1. Morton RW, McGlory C, Phillips SM (2015) *Front Physiol.* 6, 245. 2. Sousa M, Teixeira VH, Soares J (2014) *Int J Food Sci Nutr.* 65, 151-63. 3. Brook MS, Wilkinson, DJ, Phillips BE et al. (2016). *Acta Physiologica*. 4. Glynn EL, Fry CS, Drummond MJ et al. (2010) *J Nutr.* 140, 1970-1976. 5. Moore, DR, Robinson MJ, Fry JL et al. (2009) *Am J Clin Nutr.* 89, 161-168. 6. Areta JL, Burke LM, Ross ML et al. (2013) *J Physiol.* 591, 2319-2331.

## EFFECTS OF SPRINT INTERVAL TRAINING UNDER HYPOBARIC HYPOXIC CONDITIONS ON METABOLIC CAPACITY AND HIGH-INTENSITY EXERCISE PERFORMANCE

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**Introduction** Recently, many studies have reported that high-intensity or sprint interval training can improve not only anaerobic (glycolytic) metabolism but also aerobic (oxidative) metabolism and that these metabolic adaptations cause improvements in exercise performance. Also, training under hypoxic conditions has been primarily performed for the purpose of improving O<sub>2</sub> transport system, i.e. maximal aerobic power (VO<sub>2</sub>max). However, several studies reported that maximal accumulated O<sub>2</sub> deficit (MAOD) and buffering capacity increased after altitude training (Mizuno et al. 1990, Ogita 2006), and the possibility that the hypoxic training may improve effectively anaerobic energy releasing system was suggested. Therefore, the present study aimed to examine whether very high-intensity, low-volume, sprint interval training (SIT) under hypobaric hypoxic conditions improve more effectively metabolic capacity and high-intensity exercise performance. **Methods** Fourteen healthy male students (22 $\pm$ 1 yrs) were matched for baseline measurements into two groups and then randomized to normobaric normoxic training group (N, n=7) and hypobaric hypoxic training group (H, n=7). The subjects had a SIT using a bicycle ergometer, which consisted of five 5 s bouts at an intensity which cause exhaustion in around 10 s ( $\sim 300\%$  VO<sub>2</sub>max) with a 10 s rest between each bout. SIT was conducted twice/day, 5 days/week, for 4 weeks, and H performed it under hypobaric hypoxic conditions corresponding to 4000 m above sea level. Before and after training, VO<sub>2</sub>max, and MAOD, and intermittent exercise performance (IE; ten 5 s bout with a 20 s rest) were determined. **Results** After the 4 weeks of training, VO<sub>2</sub>max significantly increased in N ( $P < 0.05$ ), but not in H. On the other hand, a significant increase was found in MAOD ( $P < 0.01$ ), total work in IE ( $P < 0.05$ ) in both groups. Furthermore, peak power output in IE increased significantly only in H ( $P < 0.05$ ). **Discussion/Conclusion** These findings suggest that the SIT used in this experiment could induce a large improvement of MAOD and high-intensity exercise performance in both conditions but that the SIT under hypobaric hypoxic conditions might be more beneficial to improve maximal power output. **Reference** Mizuno, M., C.Juel, T. Bro-Rasmussen, E. Mygind, B. Schibye, B. Rasmussen, B. Saltin. (1990) Limb skeletal muscle adaptation in athletes after training at altitude. *J. Appl. Physiol.* 68:496-502. Ogita, F. (2006) Energetics in competitive swimming and application for training. *Portuguese journal of sport sciences* 6, Suppl.2: 117-121. Contact; ogita@nifs-k.ac.jp

## INFLUENCE OF SOLAR RADIATION ON ENDURANCE EXERCISE CAPACITY AND THERMOREGULATION IN A HOT ENVIRONMENT

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**Introduction** It is known that environmental conditions have a large influence on fatigue and performance in exercising individuals and that endurance exercise capacity is impaired progressively as the ambient temperature (Galloway and Maughan 1997) and the relative humidity (Maughan et al. 2012) increases and the air velocity decreases (Saunders et al. 2005). Despite an awareness of the importance of solar radiation for endurance performance, especially in a hot environment, there has been no systematic investigation to confirm and quantify this effect. The present study investigated the effects of variations in solar radiation on endurance exercise capacity and thermoregulatory responses in a hot environment. **Methods** Eight male volunteers performed four cycle exercise trials at 70% maximum oxygen uptake until exhaustion in an environmental chamber maintained at 30 degrees C and 50% relative humidity. Volunteers were tested under four solar radiation conditions: 800, 500, 250 and 0 W/m<sup>2</sup>. Rectal temperature, skin temperature (chest, upper arm, thigh and calf), heart rate, skin blood flow and blood pressure were recorded at rest and during exercise. **Results** Exercise time to exhaustion was less on the 800 W/m<sup>2</sup> trial (23  $\pm$  4 min) than on all the other trials (500 W/m<sup>2</sup> 30  $\pm$  7 min;  $P < 0.05$ , 250 W/m<sup>2</sup> 43  $\pm$  10 min;  $P <$

0.001, 0 W/m<sup>2</sup> 46 ± 10 min;  $P < 0.001$ ), and on the 500 W/m<sup>2</sup> trial than the 250 W/m<sup>2</sup> ( $P < 0.05$ ) and 0 W/m<sup>2</sup> ( $P < 0.01$ ) trials. There were no differences in core (rectal) temperature, total sweat loss, heart rate, skin blood flow, cutaneous vascular conductance and percentage changes in plasma volume between trials ( $P > 0.05$ ). Mean skin temperature was higher on the 800 W/m<sup>2</sup> trial than the 250 W/m<sup>2</sup> and 0 W/m<sup>2</sup> trials ( $P < 0.05$ ), and on the 500 W/m<sup>2</sup> trial than the 0 W/m<sup>2</sup> trial ( $P < 0.05$ ). The core-to-skin temperature gradient was narrower on the 800 W/m<sup>2</sup> trial than the 250 W/m<sup>2</sup> and 0 W/m<sup>2</sup> trials ( $P < 0.05$ ). Conclusion The present study demonstrates that endurance exercise capacity in a hot environment falls progressively as solar radiation increases. This early fatigue in the higher solar heat load trials was associated with a higher skin temperature and a narrower core-to-skin temperature gradient. These observations suggest that solar radiation is a key consideration for individuals exercising in a hot environment. References Galloway, Maughan RJ. (1997). *Med Sci Sports Exerc*, 29, 1240-1249. Maughan RJ, Otani H, Watson P. (2012). *Eur J Appl Physiol*, 112, 2313-2321. Saunders AG, Dugas JP, Tucker R, Lambert MI, Noakes TD. (2005). *Acta Physiol Scand*, 183, 241-255. Contact hotani@himeji-du.ac.jp

## THE EFFECT HIGH-INTENSITY SHORT-TERM HEAT ACCLIMATION ON PHYSIOLOGICAL AND PERCEPTUAL RESPONSE TO EXERCISE IN THE HEAT IN TRAINED CYCLISTS

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Introduction: Short (< 7 days), prolonged (~ 60 min), submaximal heat acclimation regimens have been shown to induce physiological adaptations to heat exposure (Chalmers et al., 2014); however, pre-competition tapering traditionally involves periods of low volume, high-intensity training. The aim of the present study was to establish the effect of a high-intensity short-term heat acclimation (HISTHA) on heat adaptation parameters in trained cyclists. Methods: Thirteen trained male cyclists (37 ± 11 y; 184 ± 8 cm; 84 ± 8 kg; 60 ± 9 ml.kg<sup>-1</sup>.min<sup>-1</sup>; 328 ± 37 Wmax) undertook 5 consecutive days of HISTHA. Each day involved a 6 min warm-up followed by ~12 x 1-min sprints at 100% Wmax separated by 1-min active rest, in the heat (35°C; 50% rh). Rectal temperature (Tr), heart rate (HR), power output (W), weighted-mean skin temperature (Tsk), rating of perceived exertion (RPE), thermal sensation (TS), sweat rate, haematological data, and ad libitum fluid consumption were recorded throughout. Effect sizes (g or r) were calculated from mean and standard deviations, or z scores and sample sizes, as appropriate. Results: There was no difference between day 1 and day 5 for the total work completed (332 ± 45 vs. 334 ± 39 W;  $g = 0.05$ ). Thermal impulse was lower on day 5 (0.06 ± 0.01 vs. 0.05 ± 0.01°C.hr<sup>-1</sup>;  $g = -0.97$ ). When comparing day 1 with day 5, there was a small increase in Tr-rest (36.8 ± 0.5 vs. 37.0 ± 0.3°C;  $g = 0.47$ ), Tr-mean (37.4 ± 0.3 vs. 37.5 ± 0.2°C;  $g = 0.38$ ) and total voluntary fluid consumption (1.4 ± 0.6 vs. 1.6 ± 0.8 l.hr<sup>-1</sup>;  $g = 0.27$ ). There were small reductions in HRmean (149 ± 16 vs. 143 ± 13 b.min<sup>-1</sup>;  $g < -0.40$ ) and RPEmedian (16 (13-19) vs. 16 (13-19);  $r = -0.22$ ), moderate reductions in TSmedian (7 (5-8) vs. 7 (5-8);  $r = 0.65$ ), and large reductions in Tsk-mean and Tsk-peak (mean: 35.4 ± 0.5 vs. 35.1 ± 0.3°C;  $g = -0.70$ ; peak: 36.4 ± 0.6 vs. 35.9 ± 0.4°C;  $g = -0.95$ ). There was no effect on Tr-peak (38.1 ± 0.3 vs. 38.1 ± 0.3°C;  $g < 0.01$ ), HRrest (73 ± 15 vs. 73 ± 14 b.min<sup>-1</sup>;  $g < 0.01$ ), Tsk-rest (33.9 ± 0.8 vs. 33.8 ± 0.6°C;  $g = -0.14$ ), resting plasma volume (64 ± 6 vs. 63 ± 6 %;  $g = -0.15$ ) or sweat rate (2.7 ± 1.1 vs. 2.6 ± 0.7 l.hr<sup>-1</sup>;  $g = -0.11$ ). Conclusion: A 5 day, 30-min HISTHA regimen improved HR, Tsk, and perceptual responses during exercise in the heat, but had no effect on plasma volume. The degree of change in thermoregulatory and cardiovascular variables was less than that typically shown with more prolonged low intensity heat acclimation protocols. References: Chalmers et al. (2014). *Sports Med.*, 44, 971 – 988.

## MILD DECREASE IN SKIN TEMPERATURE INHIBITS HEART RATE ELEVATION DURING MODERATE EXERCISE, BUT DOES NOT AFFECT METABOLISM

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Introduction Climatic terrain therapy can be applied to health promotion and is covered by insurance in Germany. Climatic terrain therapy is defined as 'walking in sloping terrain with mild body cooling (approximately 2°C decrease in skin temperature)'. Although the heart rate during exercise is useful to control exercise intensity, previous studies observed a reduction in the heart rate during exercise in severely cold environments compared to that in a neutral environmental condition (Gagnon et al., 2013). A characteristic of the climatic terrain therapy is a mild decrease in skin temperature during exercise at a neutral temperature (Schuh, 2012). The effects of mild body cooling on heart rate during exercise are not clear. Moreover, cold exposure enhanced fat utilization during exercise (Gagnon et al., 2013). Therefore, we investigated the effects of a mild decrease in skin temperature on heart rate and metabolism during exercise. Methods Ten men participated in this study (age: 27 ± 3 years, body mass index: 22.7 ± 2.5 kg/m<sup>2</sup>). They performed treadmill exercise of approximately 65% of maximal oxygen uptake for 60 min under two conditions: 1) mild body cooling condition and 2) control condition. In the mild body cooling condition, the participants wore half sleeve and shorts, and were sprayed cold water of approximately 10°C on by a sprayer with a breeze (1.5–2.0 m/s) during exercise. In the control condition, the participants wore half sleeve and shorts during exercise, without a spray or breeze. The experiment was conducted in a climatic chamber set at 25°C and 50% relative humidity. Rectal and skin temperatures were recorded during and after exercise. Heart rate and oxygen uptake were monitored during exercise. Blood samples for determining catecholamine, cortisol, free fatty acid, insulin, and glucose concentrations were collected before, immediately after, and 1 h after exercise. Results The skin temperature dropped by 1.7 ± 0.7°C in the last minutes of the exercise compared to that before exercise under the mild body cooling condition. There were no differences in rectal temperature between the two conditions. Although oxygen uptake during exercise or the blood parameters did not differ between the conditions, the heart rate during exercise was lower under the mild body cooling condition than under the control condition. Discussion The present study suggests that mild body cooling inhibits heart rate elevation during moderate exercise, but does not affect metabolism. References Schuh A. (1991). *Phys Rehber Kur Med*, 1, 22-28. Gagnon DD, Rintamäki H, Gagnon SS, Cheung SS, Herzig K-H, Porvari K and Kyröläinen H. (2013). *Front Physiol*, 4, 99. Contact: m.konishi@aoni.waseda.jp

## INDIVIDUAL HEMOGLOBIN MASS RESPONSE TO NORMOBARIC AND HYPOBARIC HYPOXIA

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1: Swiss Federal Institute of Sport Magglingen (Switzerland), 2: University of Lausanne (Switzerland), 3: National Ski-Nordic Centre Prémanon (France), 4: University of Alicante (Spain) Introduction: A wide range of elite athletes use technical devices to simulate altitude



(normobaric hypoxia: NH) for altitude training. However, only little research compared the effect of altitude training in NH or at real altitude (hypobaric hypoxia: HH) on relevant physiological and performance responses (Hauser et al. 2015; Saugy et al. 2014). Therefore, the aim of the present study was to investigate whether hemoglobin mass (Hbmass) responses differ between an 18-days Live-High Train-Low (LHTL) training camp under either NH or HH. Methods: In a same subject crossover design with one-year washout, 15 male triathletes randomly performed two 18-days LHTL training camps either in hypobaric hypoxia (HH) or normobaric hypoxia (NH). All athletes slept at 2250 m and trained at altitudes <1200 m. Hbmass was measured in duplicate with the optimized CO-rebreathing method before (pre-) and immediately after (post-) each 18-day LHTL training camp, as well as at day 13 of the second training camp in HH (hypoxic dose matched to 18-day NH,  $n = 10$ ). Results: Hbmass increased similar in HH (916 to 957 g, +4.5%,  $P < 0.001$ ) and in NH (918 to 953 g, +3.8%,  $P < 0.001$ ) after 18 days LHTL. Hbmass changes did not differ over time between HH and NH, neither after 18 days ( $P = 0.4$ ) nor after the same hypoxic dose ( $P = 0.29$ ). Absolute individual Hbmass responses ranged from -0.1 to +10.6% within HH and from -1.4 to +7.7% within NH. Discussion: We concluded that HH and NH evoked similar mean Hbmass increases for the same hypoxic dose (~230 h) and after 18-days LHTL. Within mean Hbmass changes there was a notable variability in individual Hbmass responses, indicating that individual Hbmass evaluation for altitude training in either NH or HH is relevant. References: Hauser A, Schmitt L, Troesch S, Saugy JJ, Cejuela-Anta R, Faiss R, Robinson N, Wehrli JP, Millet GP. Similar Hemoglobin Mass Response in Hypobaric and Normobaric Hypoxia in Athletes. *Med Sci Sports Exerc.* 2015. Saugy JJ, Schmitt L, Cejuela R, Faiss R, Hauser A, Wehrli JP, Rudaz B, Delessert A, Robinson N, Millet GP. Comparison of 'Live High-Train Low' in Normobaric versus Hypobaric Hypoxia. *PLoS One.* 2014; 9: e114418. Contact: ana.hauser@baspo.admin.ch

## THE RELATIONSHIP BETWEEN CYCLIC LOW-PRESSURE HYPOXIC ENVIRONMENTS AND PHYSIOLOGICAL RESPONSES DURING EXERCISE AND RECOVERY AFTER EXERCISE

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Aim: We developed a cyclic low-pressure hypoxic environment system. The characteristics of this system were varied between decreased pressure at an altitude of 1,000 m for 150 s and increased pressure at an altitude of 0 m for 150 s; the atmospheric pressure was also changed periodically from 967 to 867 hPa (the external pressure was 1,008 hPa). Further, the relative concentration of oxygen was alternated between 20.9% and 18.5%. The present study aimed to determine the relationship between cyclic low-pressure hypoxic environments and physiological responses during exercise and recovery after exercise. Methods: The study included 15 healthy men, and they provided written informed consent before participation. All subjects performed a cycling exercise for 30 min and recovery after exercise for 10 min. The exercise protocol consisted of 20% of maximum oxygen uptake for 5 min (warm-up), 40% for 20 min (main-exercise), and 20% for 5 min (cool-down). We established two experimental conditions: exercise in the cyclic low-pressure hypoxic environment system (CLPH condition) and exercise outside the system (control (C) condition). Each condition was simulated on a different day. Heart rate (HR), blood pressure (BP), arterial blood oxygen saturation (SpO<sub>2</sub>), rating of perceived exertion (RPE), and respiratory responses were measured in both experiments. Each subject participated in the two conditions in a random order 1 week apart. Results and Discussion: The SpO<sub>2</sub> during exercise was significantly lower in the CLPH condition than in the C condition. The HR and RPE at warm-up were significantly higher in the CLPH condition than in the C condition. However, HR and RPE during main-exercise and cool-down did not show a significant difference between the two conditions. There were no significant differences in BP during exercise between the two conditions. With regard to respiratory responses after exercise, the minute volume and ventilatory equivalent were significantly lower in the CLPH condition than in the C condition. No significant differences were observed in other respiratory response parameters during recovery after exercise. Previous studies have reported that the brachial-ankle pulse wave velocity in the cyclic low-pressure hypoxic environments was significantly lower than before the remained. Thus, cyclic low-pressure hypoxic environments may be useful in preventing metabolic syndrome diseases. Our results show that such environments can be considered an effective training method during highland stays. In conclusion, exercise in a cyclic low-pressure hypoxic environment enhances ventilation efficiency.

## Mini-Orals

### MO-BN03 Muscle - Tendon

#### MUSCLE-TENDON DYNAMICS AFFECT VALUES OF IDENTIFIED MUSCLE PROPERTIES

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Introduction Whenever a person performs an intended movement there are interactions between active and passive elements. In simplified terms, activation dynamics recruit fibres of contractile elements (CE) which contract and thus interact with the serial elastic elements (SEE). Finally, the force produced by the muscle-tendon complex moves the bones/segments. As energy can be stored in the SEE, CE-SEE interactions could be important (Alexander and Bennet-Clark, 1977). Especially if the muscle-power at explosive movements is investigated, these interactions must be considered. We present a method to identify movement independent, individual muscle-tendon parameter values non-invasively and in vivo. Methods Non-linear parameter identification methods are applied to two models. The classic model A (Siebert et al., 2007) and its extension model B, adding a SEE and a force-length relationship, are used to show how CE parameter values change if they are allowed to interact with a SEE whose stiffness is identified at the same time. To identify individual parameter values of the knee-extensor muscle-tendon complexes of 14 male subjects ( $24.7 \pm 3.8$  yrs), datasets containing data from concentric dynamic and isometric maximum voluntary leg-extensions are processed at the same time. Results Comparing the identified values of the CE of models A and B showed differences in the curvature (A/FISO) and in the maximum efficiency (ME): A/FISO\_A  $0.3 \pm 0.079$  vs. A/FISO\_B:  $0.18 \pm 0.075$  ( $p \leq 0.01$ , Hedges'  $g^* = 1.5$ ); ME\_A:  $0.27 \pm 0.042$  vs. ME\_B  $0.38 \pm 0.07$  ( $p \leq 0.001$ ,  $g^* = 1.8$ ). The identified SEE stiffness was  $1777 \pm 324$  N/mm (889 N/mm for a single leg). Discussion The identification resulted in a mean SEE stiffness that is lower than literature values for the patellar tendon (e.g., 1837 N/mm (Kubo et al., 2006)). As it is not clear if the tendon and/or the aponeurosis are in series with the CE (Tilp et al., 2012), the stiffness of the aponeurosis could also be relevant (e.g., vastus lateralis 143 N/mm (Kubo et al., 1999)). Applying this value to each muscle of the quadriceps femoris results in 572 N/mm for a merged SEE. Thus our identified value is within the range from 572 N/mm to 1837 N/mm and may suggest that the SEE is a mixture of both structures. With model B the ME



increased towards values reported in literature (Nelson et al., 2011). We conclude that model B identified a more realistic set of parameters and thus is an improvement to model A. References Alexander RMcN, Bennet-Clark HC. (1977) *Nature*, 265(5590), 114-117. Kubo K, Kawakami Y, Fukunaga T. (1999) *J Appl Physiol.*, 87(6), 2090-2096. Kubo K, Yata H, Kanehisa H, Fukunaga T. (2006) *Eur J Appl Physiol.*, 96(3), 305-314. Nelson FE, Ortega JD, Jubrias SA, Conley KE, Kushmerick MJ. (2011). *J Exp Biol.*, 214, 2649-2653. Siebert T, Sust M, Thaller S, Tilp M, Wagner H. (2007). *Hum Mov Sci.*, 26(2), 320-341. Tilp M, Steib S, Herzog W. (2012). *Eur J Appl Physiol.*, 112, 1485-1494. Contact harald.penasso@gmail.com

## COMPARISON OF ULTRASOUND AND MAGNETIC RESONANCE IMAGING ASSESSMENTS OF THE ACHILLES TENDON CROSS-SECTIONAL-AREA

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1: KFU (Graz, Austria), 2: AU (Thes/niki, Greece) Introduction Magnetic resonance imaging (MRI) and ultrasonography (US) are established, non-invasive diagnostic tools to evaluate Achilles tendon (AT) cross-sectional-area (CSA) (Pierre-Jerome et al., 2010). While MRI is the golden standard, US has several advantages when compared to MRI, e.g., cost and time efficiency (Rasmusson, 2000). To the best of our knowledge, previous assessments of AT CSA using MRI and US have not taken into account measurement and joint angle position nor US probe pressure, making direct comparisons challenging. Therefore, the purpose of this study was to compare MRI and US findings of AT CSA by use of a standardized protocol (SP). Methods Achilles tendon CSA of 15 subjects was assessed at 2 positions (distal, proximal) on 2 days using MRI and US. The SP for all investigations included a splint to fixate the ankle, markers to ensure the same measurement position during examinations, and minimal probe pressure for US image capturing. One image was conducted for each position and digitized on 3 consecutive days. The CSA was outlined manually and calculated automatically. CVs were computed to assess measurement accuracy. Method comparison was conducted by ICC, paired t-tests and Bland-Altman analyses (Bias $\pm$ LoA). Results Reliability of image analysis judged by CV was 1.5 $\pm$ 0.5% and 1.6 $\pm$ 0.7% for MRI as well as 1.9 $\pm$ 1.1% and 1.6 $\pm$ 0.9% for US for the distal and proximal position, respectively. Mean values of AT CSA were 62.1 $\pm$ 8.1mm<sup>2</sup> and 57.6 $\pm$ 8.0mm<sup>2</sup> for MRI as well as 60.2 $\pm$ 6.3mm<sup>2</sup> and 54.4 $\pm$ 7.5mm<sup>2</sup> for US measurements. Comparison of the methods showed ICC values of 0.79 and 0.86 for the distal and proximal position. For the proximal position, the mean difference of both methods tested with a one sample t-test provided a significant ( $p < .001$ ) systematic underestimation (3.3mm<sup>2</sup>) of the AT CSA measured with US. Further, the paired t-test also showed a significant difference ( $p < .001$ ) for this position. The Bias $\pm$ LoA for the distal position was 1.9 [-7.1, +10.9]mm<sup>2</sup>. Discussion We attempted to exclude possible sources of error by using a SP, however, differences between MRI and US findings remained. Although ICCs demonstrate good correlations, a systematic bias exists for the proximal position. For the distal position, the MRI results may be 7.1mm<sup>2</sup> below or 10.9mm<sup>2</sup> above the US values representing 12 and 19% of the mean AT CSA. These differences are not acceptable for clinical purposes, and thus, the methods should not be used interchangeably. However, the CVs confirm that the analysing method used is reliable and we conclude that the AT CSA should be investigated with either MRI or US. References Pierre-Jerome C, Moncayo V, Terk MR (2010). *Acta radiol*, 51(4), 438-454. Rasmusson, OS (2000). *Scand J Med Sci Sports*, 10(6), 360-364. Contact: annikakruse1@gmx.de

## HAMSTRING MORPHOLOGY AND STRENGTH REMAIN ALTERED 2 YEARS FOLLOWING A HAMSTRING GRAFT IN ACL RECONSTRUCTION

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INTRODUCTION: Hamstring grafts used in anterior cruciate ligament (ACL) reconstruction have been shown to lead to changes to the semitendinosus and gracilis musculature, possibly impacting on the morphology and strength of other muscle groups of the knee. This study examined the differences in knee muscle morphology and strength between the surgical and contralateral limbs in patients that underwent ACL reconstruction using a hamstring graft at two years post-surgery. We hypothesised that the loss of donor muscle size would significantly correlate with knee muscle strength deficits and that morphological adaptations would also be evident in non-donor knee muscles. METHODS: 20 participants (14 male, 6 female, 29  $\pm$  7 years, 82  $\pm$  15 kg) that had undergone a hamstring graft in ACL reconstruction at least two years previously, underwent MRI and subsequent strength testing. Using digitised three-dimensional mesh models of each respective muscle/tendon, muscle and tendon volumes, peak cross sectional area (CSA) and lengths were determined for 12 muscles and 6 functional muscle groups of the surgical and contralateral limbs. Peak isokinetic concentric torque was measured at 60°/s in knee flexion/extension and internal/external tibial rotation. RESULTS: Only 50% of the patients regenerated both the semitendinosus and gracilis tendons, which were longer with larger volume and CSA compared to the contralateral side. The semitendinosus and gracilis muscles of the surgical limb both respectively demonstrated a 47% ( $p < 0.001$ ) and 36% ( $p = 0.002$ ) smaller volume, and a 24% ( $p = 0.014$ ) and 31% ( $p = 0.002$ ) smaller peak cross sectional area than the contralateral limb, as well as being 10.2 cm ( $p < 0.001$ ) and 5 cm ( $p < 0.001$ ) shorter. A 7% ( $p < 0.001$ ) larger volume was observed in the surgical leg for the biceps femoris and corresponded with a smaller internal/external tibial rotation torque ratio. The difference in volume, peak CSA and length of the semitendinosus and gracilis correlated significantly with the deficit in knee flexion torque with Pearson correlations of 0.51, 0.57 and 0.61 respectively. DISCUSSION: The muscle and tendon morphological properties of the semitendinosus and gracilis are substantially altered following harvest and these alterations underpin knee flexor weakness in the surgical limb. These deficits are only partially compensated by hypertrophy of other hamstring muscles, possibly affecting joint stabilisation and loading, and risk of re-injury and/or joint degeneration.

## CHRONIC MECHANICAL OVERLOADING THROUGH WALKING, MARCHING AND JOGGING DOES NOT INDUCE CHANGES IN MUSCLE-TENDON MORPHOLOGY

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Introduction Muscle-tendon morphological properties have been extensively examined in a wide range of populations (e.g. Stenroth et al., 2012). Also, adaptations to chronic mechanical loading have been studied but the focus has been mainly on resistance training effects (e.g. Arampatzis et al., 2007). This study examined the morphology of key biological structures in a special population group, who were exposed for a period of 3 years to a chronic constant overload of mechanical stress in the form of combined walking-marching-jogging under military conditions. Methods Eleven 4th year military cadets (age: 21.3  $\pm$  0.5 years; height: 177.3  $\pm$  4.5cm; mass: 72.2  $\pm$

9.4kg) and eleven well-trained males (age:  $21.6 \pm 0.7$  years; height:  $176.8 \pm 4.3$ cm; mass:  $74.6 \pm 5.6$ kg) were recruited to the study. Ultrasonographic measurements (ACUSON P300, Siemens) of muscle and tendon architectural characteristics were made by a linear probe (5.0 – 18.0 MHz) at 19 sites including Achilles tendon (AT) length, 4-site AT thickness (TN), AT cross-sectional area (CSA) and soleus (SOL) thickness. Statistical comparisons between groups and among sites were performed on absolute and normalised - for a range of anatomical lengths- values. Results The grand means for selected variables were: AT length (20.2cm), AT 3-site average TN (4.9mm), AT CSA (53.4mm<sup>2</sup>) and SOL TN (15.5mm). Absolute and normalised values for the above variables were not different between the two groups. In terms of AT thickness both groups exhibited the same pattern of thickness along the distal portion of the tendon, with the 4cm and 5cm sites proximal to the insertion to the calcaneal bone revealing significantly higher values (18% and 16% respectively,  $p < 0.05$ ) than those at the calcaneal notch. Discussion The findings indicate no adjustments in muscle-tendon morphological properties for structures subjected to a particular type of chronic mechanical overloading. Whilst the relevant military cadets undergo a standard annual volume of combined walking-marching-jogging activities in excess of 3,500km, it appears that either the total mechanical stress (over a period of 38 months in this study) or its intensity do not exceed an adaptation threshold sufficient to initiate structural changes. This does not rule out potential changes in intrinsic material and other architectural properties which govern mechanical behaviour and perhaps stimulate movement efficiency. References Stenroth L, Peltonen J, Cronin N.J, Sipilä, S, Finni, T (2012). J Appl Physiol, 113, 1537-1544. Arampatzis A, Karamanidis K, Albracht K (2007). J Exp Biol, 210, 2743-2553. Contact a.bissas@leedsbeckett.ac.uk

## STRUCTURE AND FUNCTION OF HUMAN FASCIA LATA: SITE-DEPENDENCE OF THICKNESS AND FIBER ORIENTATION

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Introduction Thigh muscles are responsible for most of the daily physical activities, and covered with the fascia lata. Connective tissues surrounding a muscle have a mechanical role in lateral force transmission of up to 30% of muscle force (Huijing et al., 2003). However, characteristics of the deep fascia are not fully understood. To infer the functional relevance of the deep fascia, this study compared thickness and fibers' orientation of the fascia lata taken from different regions of the thigh of cadavers. Methods Specimens of the deep fascia of 4cm x 4cm in length and width each were collected from four regions (anterior, lateral, medial, and posterior) of the mid-thigh of 16 legs of 11 cadavers (6 males and 5 females, 75 - 92 years). Thickness of each specimen was measured with a caliper. Each specimen's surface was examined with a stereoscopic microscope and the distribution of fibers' orientation angles was determined. Then the angles were divided into four directions (longitudinal, transverse, positively diagonal, and negatively diagonal). The fractions of the fibers' orientation for each site were compared with one-way ANOVA ( $p < 0.05$ , post-hoc test: Bonferroni). Results The deep fascia of the lateral region ( $0.80 \pm 0.15$  mm) was significantly thicker than those of anterior ( $0.28 \pm 0.10$  mm), medial ( $0.19 \pm 0.04$  mm), and posterior ( $0.24 \pm 0.06$  mm) regions. The fraction of longitudinally directed fibers were larger than other directions for all regions except for the posterior aspect. On the lateral region,  $32.3 \pm 2.6$  % of the fibers were in longitudinal direction which was significantly higher than other directions. The distribution of fibers' orientations showed substantial variability among regions. Discussion The thickest deep fascia on the lateral region includes the iliotibial tract tightly attached to the deep fascia on the lateral side. The deep fascia of the lower limb is composed of interwoven bundles of collagen fibers (Gerlach et al., 1990), and the fibers' orientations reflect their mechanical loading (Stecco C et al., 2010). It was found that the majority of the fibers were in the longitudinal direction, which suggests highest stress occurring in this direction (especially on the lateral side) during daily activities. The variety of fibers' orientations may allow the deep fascia to effectively support or limit various movements of underlying muscles, which presumably makes physical activities more efficient. References Huijing, P. A. et al., (2003) J. Morphol. 256: 306-321. Gerlach, U. J. et al., (1990) Acta. Anat. 139: 11-25. Stecco, C. et al., (2010) Cells Tissues Organs 192: 200-210.

## EFFECTS OF A 10-WEEK PLYOMETRIC TRAINING PROGRAMME ON JUMP PERFORMANCE AND ACHILLES TENDON PROPERTIES

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Introduction Plyometric training using jump exercises that involve both ankle plantar flexor and knee extensor muscles has been shown to increase jump performance and Achilles tendon stiffness (Fouré et al. 2010). However, ankle joint moment, and thereby Achilles tendon loading, is greater during jump exercises performed with knee extended than flexed (Arampatzis et al. 2006). The knee joint angle during jumps may therefore influence Achilles tendon adaptations. This study investigated the influence of knee flexion on the adaptation of Achilles tendon stiffness in response to a plyometric training programme. Methods Twenty young adults participated in a 10-week training programme (two sessions/week) consisting of various plyometric exercises performed either with knees extended (group EXT, 10 subjects) or flexed ( $\sim 90^\circ$ ; group FLEX, 10 subjects), with a progressive increase in the number of jumps per session (from 200 to 400 jumps). A control group (no training) was composed of six subjects. Jump height and contact time for drop jumps performed from 20, 40, 60, and 80 cm were measured before and after the 10-week period. In addition, Achilles tendon cross-sectional area (CSA) was measured and tendon stiffness estimated from the force-elongation relation obtained from the displacement of the muscle-tendon junction assessed by B-mode ultrasonography during plantar flexors contractions of different intensities. Results Performance during drop jump (jump height and contact time) increased ( $p < 0.05$ ) similarly for both groups (EXT:  $21.3 \pm 15.4\%$ ; FLEX:  $24.4 \pm 14.6\%$ ) after training, regardless of drop height. Similarly, tendon stiffness was increased by  $32.7 \pm 27.5\%$  and  $33.2 \pm 37.5\%$  for EXT and FLEX groups, respectively ( $p < 0.05$ ). In contrast, Achilles tendon CSA did not vary after the 10-week period in neither training groups ( $p > 0.05$ ). For all these parameters, there was no significant change in the control group. Discussion As tendon CSA did not change after training, the increase in tendon stiffness should reflect intrinsic changes of the tendon properties (Fouré et al. 2010). However, the degree of knee flexion did not induce specific training adaptations of the Achilles tendon in our experimental conditions. This suggests that part of the observed gain in drop jump performance might reflect an improved elastic energy storage-recoil process independent of the degree of knee flexion during plyometric training. References Arampatzis A et al. (2006). J Biomech, 39, 1891-1902. Fouré A et al. (2010). J Appl Physiol, 109, 849-854. Penzer F. and Laurent C. are supported by a grant of the Sport Ministry of Wallonia-Brussels Federation. Contact fpenzer@ulb.ac.be

### MUSCLE MYONUCLEAR CONTENT CORRELATES WITH INTEGRATED MYOFIBRILAR PROTEIN SYNTHESIS AND WITH MUSCLE FIBRE CROSS SECTIONAL AREA IN THE UNTRAINED AND TRAINED STATE

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Tricoli, V., Parise, G., Ugrinowitsch, C. 1:USP (Brazil), 2:McMaster University (Canada), 3:UFSCar (Brazil) Introduction Resistance training (RT) results in periodic post-exercise increases in myofibrillar protein synthesis (MyoPS) which results in increases in fiber/muscle cross-sectional area (CSA) [1,2]. This process could be regulated by changes in myonuclear content (MNC) and/or MyoPS. The present work aimed to examine the relation between MNC and integrated MyoPS, fiber CSA (fCSA) and vastus lateralis CSA (VLCSA) before and after 10wk of RT. Methods Nine men (age  $27 \pm 3$  years; body mass index  $22.9 \pm 3.0$  kg•m<sup>-2</sup>) performed 10-wks of lower limb RT (2 exercises, 3 sets each x 9-12 RM, twice a week, totaling 19 workouts). VL biopsies collected before and after RT period were evaluated for fCSA and MNC by immunofluorescence microscopy. Integrated MyoPS was evaluated using VL biopsies at pre and 48h post-first and last RT bouts by mass spectrometry coupled with a gas chromatography. VLCSA was assessed by sequential ultrasound images. The Pearson's product moment correlation was performed to assess variables associations. Results In the untrained state, MNC did not correlate with any variable (MyoPS:  $r = -0.01$ ;  $P = 0.98$ , fCSA:  $r = -0.32$ ;  $P = 0.54$ , VLCSA:  $r = -0.36$ ;  $P = 0.34$ ), while in the 10 wk RT-trained state, MNC highly correlated with MyoPS (MyoPS:  $r = 0.89$ ;  $P = 0.001$ ). The MNC's change, at a trained state, highly correlated with the change in fCSA (fCSA:  $r = 0.94$ ;  $P = 0.02$ ), and demonstrated a trend toward correlation with increases in the VLCSA after RT (VLCSA:  $r = 0.64$ ;  $P = 0.06$ ). Discussion In the trained state, there is a specialization of protein synthesis according to stimuli [3], and we recently found that later in RT, there is a good agreement between MyoPS and hypertrophy (unpublished data). Our results here are in line with these observations and indicate that the myonuclear response to RT might also be adaptive with RT, since the MNC in the untrained state did not correlate with any variable evaluated, but in the trained state, there were significant correlations between MNC and MyoPS/hypertrophy. These results suggest, we propose, an increasing role of MNC in MyoPS increase to support accretion of myofibrillar proteins promoting muscle fiber growth with RT. References [1] Bellamy et al. (2014) PLoS One, 9(10), e109739 [2] Mitchell et al. (2014) PLoS One, 9(2), e89431. [3] Wilkinson et al. (2008) J Physiol, 586(Pt15), 3701-17. Contact felipevechin@usp.br

### WEEKLY TIME COURSE OF MUSCLE VOLUME AND STRENGTH PARAMETERS IN RESPONSE TO A MUSCLE HYPERTROPHY TRAINING

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Introduction The examination of strength training methods and the adaptation effects influences the daily work from trainers and athletes for optimizing performance as well as the knowledge of researchers who try to receive a deeper insight in the underlying mechanisms and effects of muscle cellular adaptation. To get knowledge about the adaptive mechanisms it is important to get knowledge about the time course of adaptation. In literature most of the studies only show pre- and post intervention measurement data. As a consequence of this no detailed statements about the chronological processes in adaptation to strength training can be given. Therefore the goal of our study was to give a detailed description of the time course of morphological and functional adaptation effects to a hypertrophy strength training intervention. Methods: The study was designed as a longitudinal case study over eight weeks of hypertrophy training and two weeks of detraining. Two subjects participated at the study and trained three times a week, and underwent a testing procedure once a week. The training consists of a two day split training program for the whole body with ten multi joint exercises within 8-10 RM for three sets. The training exercises for the M. quadriceps femoris were done at an Isomed 2000 using a multi-joint leg press and a single joint knee extension movement. The workload of each training session, set and repetition was documented. Each week before the training session measurements of the CSA of the M. quadriceps femoris (QF) using MRI scans (1.5 T MRI scanner Magnetom Avato Siemens Healthcare), isometric maximum force measurements (iMVT), resting (RTT) and peak twitch torques (PTT) were taken. Results: Both participants increased the mean power performing the isokinetic knee extension movement nearly session by session within the eight weeks of training. Muscle volume of the QF increased by 4,5% to 15,4% during the eight weeks of training and peaked in week six for subject M and in the detraining week 1 for subject D. iMVT decreased over the first four weeks in both athletes and then starts raising over the baseline till the end of the study of about 5,7% for subject D and 0,4% for subject M. PTT showed different results during the training weeks: subject D never couldn't raise the values above the baseline whereas M showed higher values for the first time after 5 weeks of training. Nearly the same behavior was observable at the RTT values. Discussion: The results indicate that adaptations to intensive strength training are complex and nonlinear. The chronological sequence of the different analyzed parameters indicates that the individual reaction to the training stimulus can be totally different and depends on the moment the measurements are made.

## Mini-Orals

### MO-PM01 Health Promotion

#### CARDIORESPIRATORY FITNESS IS INVERSELY ASSOCIATED WITH ABDOMINAL FAT MASS AND LOW-GRADE INFLAMMATION, INDEPENDENTLY OF BMI; A CROSS-SECTIONAL STUDY AMONG 10,973 MEN AND WOMEN.

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Objective: The role of cardiorespiratory fitness (CRF) has to a large extent been ignored in the investigation of the metabolically healthy, but obese phenotype (Primeau et al. 2011). However, recent studies suggest that low physical fitness is an independent cause of accumulation of visceral fat (Olsen et al. 2008) and low-grade inflammation that leads to metabolic deterioration and a whole range of chronic diseases (Pedersen 2009). We hypothesise that abdominal fat mass and low-grade inflammation are inversely associated with cardiorespiratory fitness independently of BMI. Method: Data of 10,973 individuals from the general population, DANHES 2007-2008 (Eriksen et al. 2011), were used when investigating the BMI-independent associations between CRF, abdominal fat mass and low-grade inflammation.

tion. Multiple linear and median quantile regressions were performed. Results: In men, a difference in CRF level by +5 mL/min/kg was associated with a difference in waist circumference by -1.45 cm (95% CI: -1.55 to -1.35 cm;  $p < 0.001$ ) and a difference in high sensitivity C-reactive protein(hsCRP) by -0.22 mg/L (95% CI: -0.255 to 0.185 mg/L;  $p < 0.001$ ), independently of BMI. In women, a difference in CRF level by +5 mL/min/kg was associated with a difference in waist circumference by -1.15 cm (95% CI: -1.25 to -1.0 cm;  $p < 0.001$ ) and a difference in hsCRP by -0.26 mg/L (95% CI: -0.3 to 0.22 mg/L;  $p < 0.001$ ), independently of BMI. Conclusion: Irrespective of BMI, CRF was found inversely associated with the amount of abdominal fat mass and the levels of low-grade inflammation, suggesting that high CRF counteracts some of the detrimental metabolic consequences of obesity without a weight loss. Therefore, CRF may determine the metabolic status and help distinguish the metabolically unhealthy from the metabolically healthy but obese individuals in clinical settings. Reference: Primeau V, Coderre L, Karelis D et al. 2011. Characterizing the Profile of Obese Patients Who Are Metabolically Healthy. *International Journal of Obesity* (2005) 35 (7): 971-81. Olsen RH, Krogh-Madsen R, Thomsen C, Booth FW, and Pedersen BK. 2008. Metabolic Responses to Reduced Daily Steps in Healthy Nonexercising Men. *JAMA* Mar 19 (299(11)): 1261-63. Pedersen BK. 2009. The Diseasome of Physical Inactivity--and the Role of Myokines in Muscle--Fat Cross Talk. *The Journal of Physiology* 587 (Pt 23): 5559-68. Eriksen L, Groenbaek M, Helge JW, Tolstrup JS, and Curtis T. 2011. The Danish Health Examination Survey 2007-2008 (DANHES 2007-2008). *Scandinavian Journal of Public Health* 39 (2): 203-11. Contact: anne-sophie.wedell-neergaard.02@regionh.dk

## THE ESSENTIALS OF TRAINING DIARIES FOR PHYSICAL ACTIVITY QUANTIFICATION IN HEALTH PROMOTION – A WORKPLACE CLUSTER RANDOMISED CONTROLLED TRIAL

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Background: Exercise as medicine has been proven effective for many disorders. In a workplace setting, adherence among participants is a challenge since low adherence compromises effectiveness of exercise. Training diaries provide unique information on participants' adherence and dropout. The aim of this study was to determine drop out and adherence in a strength training intervention using training diaries. The effect on muscle strength/endurance and musculoskeletal pain was investigated. Methods: A total of 763 office workers were cluster-randomised to a training group, TG, or a control group, CG. CG attended health promotion information sessions one hour weekly. TG performed five strength training exercises (forward and backward neck bend, front and side raise, and reverse pull) for 12 weeks, 3x20 min sessions a week -three sets per session- with 1/3 supervised. Training diaries were completed with repetitions and resistances performed. Dropout was defined as missing two sequential weeks of training, and the time point for 25% dropout was determined by Kaplan Meier analysis. Adherence was calculated as number of attended training sessions in the diary out of a maximum of 36 sessions. Adherence  $\geq 70\%$  was used in the dose-response analysis. Intensity of neck/shoulder pain last three months was evaluated by a 10-point numerical scale (0-9, 9=worst possible pain). Muscle strength/endurance was measured for neck flexion/extension and shoulder raise. Intention-to-treat (ITT) analysis and adherence dose-response analysis was performed by Wilcoxon test between groups with  $p < 0.05$  for significance. Results: Time point for the 25% drop out was week 10. Participants had an average adherence of 60%. Out of nine possible training sets each week, on average five training sets were completed (95% CI: 5.04-5.21). TG increased significantly neck flexion strength (mean $\pm$ SD (6.4 $\pm$ 22.0%)) and endurance (28.6 $\pm$ 72.7%), neck extension endurance (30.0 $\pm$ 100.3%), and shoulder raise strength (10.9 $\pm$ 26.4%) and endurance (43.6 $\pm$ 103.5%), compared with CG. Neck and left shoulder pain decreased significantly more (~0.5points) among TG participants with adherence  $\geq 70\%$  compared to those with adherence  $< 70\%$ . Discussion: Specific strength training proved effective in improving muscle strength/endurance and decreasing neck/shoulder pain when adherence was  $\geq 70\%$ . A novel finding is the Kaplan Meier analysis showing 25% of the participants had dropped out at week 10, suggesting reinforcement of motivational initiatives already around week 8-9. Training diaries provide unique opportunities to examine the training volume that will contribute with important knowledge for future implementation of workplace health promotion interventions.

## PERCEIVED INSTRUCTOR BEHAVIOR AND BEHAVIORAL REGULATION FOR EXERCISE. A CROSS-SECTIONAL STUDY IN HEALTH RELATED EXERCISE CLASSES

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Introduction Based on Basic Needs Theory (BNT: Deci & Ryan, 2002), this study examined cross-sectional relationships between perceived instructor behavior, psychological need satisfaction and behavioral regulation for exercise. We proposed that need supportive instructor behavior in terms of care for individuals (CARE), feedback (FB), functional structure (FST), and activation (ACT) relate to need satisfaction and self-determined forms of motivation. Further, we proposed, that the relationship between instructor behavior and behavioral regulation is mediated through psychological need satisfaction. Methods Participants (n=100; 35 male/59 female/6 not specified) from back exercise classes in a local fitness studio completed measures of perceived instructor behaviors, satisfaction of the psychological needs for autonomy, competence and relatedness, and behavioral regulations for exercise (intrinsic, identified, introjected, and extrinsic). Mediation analysis was computed to estimate indirect effects (b) which will be reported with 95% BCA CI in square brackets. Results Need supportive instructor behavior was significantly positively correlated with intrinsic ( $r=.374-.583$ ;  $p=.000$ ) and identified regulation ( $r=.293-.474$ ;  $p=.000$ ) whereas we didn't find significant correlations between need supportive instructor behavior and introjected nor extrinsic regulation. Mediation analyses showed that when instructor behavior promoted autonomy and competence, individuals reported significantly more self-determined forms of motivation (intrinsic and identified). Effect sizes of indirect effects were medium to large in the expected direction:  $b=.08$  [.004; .167] to .38 [.180; .635],  $kappa-sq=.10$  [.010; .208] to .29 [.142; .454]. In addition there were significant medium negative indirect effects of feedback and functional structure on extrinsic motivation through competence satisfaction:  $b=-.10$  [-.304; -.004] to -.26 [-.682; -.028],  $kappa-sq=.09$  [.009; .248] to .013 [.017; .311]. Conclusions Findings indicate that need supportive instructor behavior is an important determinant for behavioral regulation for exercise and that this relationship is mediated by need satisfaction of individuals. Instructors and fitness professionals implementing future health related exercise classes may support physical activity by facilitating need satisfaction and self-determined motivation by providing care, feedback, functional structure and activation. The needs for competence and autonomy seem to be more relevant in the relationship of instructor behavior and intrinsic motivation than the need for relatedness. references Deci, E.L. & Ryan, R.M. (2002). *Handbook of Self-Determination Research*. The University of Rochester Press: Rochester USA.



**INFLUENCE OF A NOVEL TWO DESK SIT-TO-STAND WORKPLACE ON SITTING TIME AND OVERALL PHYSICAL ACTIVITY**

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**Introduction** Prolonged sitting is ubiquitous in modern society and linked to several diseases (Dunstan et al., 2012). To decrease workplace based sitting time (ST) height-adjustable desks are recommended. Common one desk sit-to-stand workplaces exhibit small ST reduction potential and compensational short-term loss of weekly physical activity (PA) (Mansoubi et al., 2016). Thus, the purpose of this study was to investigate the long term efficiency of a novel two desk sit-to-stand workplace on ST and overall PA. **Methods** Eighteen participants (55 % men, mean age = 36 yr., 100% office based) participated in a three-arm, one-year randomized crossover intervention study. Allocation was done via a regional health insurance, with data collection during Jan 2014 – March 2015. Intervention group subjects have been provided with traditional or two-desk sit-to-stand workstations, while control subjects did not experience any changes during the whole study duration. For estimating PA and ST the International Physical Activity Questionnaire (IPAQ-long) was used (Hagströmer et al., 2005). **Results** Pairwise comparisons with Bonferroni adjustments were performed to locate significant differences in ST and PA. At baseline, employees sat  $11:02 \pm 2:02$  h/day and  $74:06 \pm 11:06$  h/week. For sit-to-stand workplace users in comparison to baseline, the proportion of ST significantly decreased for working days ( $-190$  min,  $p < 0.01$ ) and weeks ( $-853$  min,  $p < 0.05$ ). There were no significant changes for control periods and the control group in ST for working days and weeks. Weekly overall and non-working PA (median: 3198 MET-min wk<sup>-1</sup>) did not change within any group or time period. **Discussion** This study examines the effect of a novel two desk sit-to-stand workplace on ST and PA. It has been shown that concerns about a long-term compensational loss of weekly PA are baseless. Reductions in ST differ between individuals and are considerably larger than in comparable studies (Neuhaus et al., 2014). In our view, the main reason for this effect are behaviour change theory techniques (BCTs) indirectly implemented in two desk setups. Our findings are limited due to a small sample size, strong inclusion criteria and the volunteer recruiting process. Although it may be concluded that ST reductions for common employees are noticeably smaller, we assume that our two desk sit-to-stand workplace can be used to fulfil occupational ST recommendations. **References** Dunstan DW, Howard B, Healy GN, Owen N (2012) Diabetes Res Clin Pract 97(3); 368-376 Hagströmer M, Oja P, Sjöström M (2005) Pub Health Nut: 9(6); 755–762 Mansoubi M, Pearson N, Biddle SJH, Clemes SA (in press), Med Sci Sports Exerc Neuhaus M, Eakin EG, Straker L, Owen N, Dunstan DW, Reid N, Healy GN (2014), Obes Rev 15(10); 822-838

**HEALTH PROMOTION AND PHYSICAL ACTIVITY IN THE HUNGARIAN HIGHER EDUCATION – AN EMPIRICAL OUTLINE AND INTENTIONS**

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**Introduction** The issue of health in the broad sense, that is, the well-being of the society as a whole at present and ensuring the same opportunities for the future generations. It is well known in our homeland that the health condition of the Hungarian population is at critical stage and life expectancy is well below those countries of the same development level. The quality of life of our children definitely depends on the country's decision makers, white collars as well as the situations and strategic plans of institutions that educate them. The good news is, that the majority of the factors affecting health can be influenced, are lifestyle-bound therefore are reversible. There are widely approved evidence-based initiatives at international level to explore health promotion-oriented status and elaborate conceptual changes. Most importantly, WHO's 'Health for All' global program states, that health depends much more on community initiatives, inter-sector co-operation and on setting social equality as a goal than merely on the contribution of professionals. **Methods** Researches to reveal the ways of adaptation of the global program of Health Promoting Universities in Hungary were carried out keeping both paradigm sin view. The way public opinion and within it young people relate to knowledge and to the institutions nourishing knowledge, the way these institutions operate and provide services as well as their development initiatives, lifestyle habits of the representative and on-line sample of the students, the content of the whole education portfolio as well as the professions that primarily influence social well-being are the factors forming the current Hungarian state of play. **Results and discussion** The thread running through the literature on health promotion that providing theoretical background is the restructuring of institutional management via a student-centric organizational development. This change will affect the triad of education, research and professional services (third mission) as well as such functions as operation, physical environment and inside services. Continuous restructuring of the Hungarian higher education system can only be executed if the goals set are independent of the changing environment and influencing forces but acceptable by all. The above studies and international examples serve as starting point. On the other hand, beside creating the concept it is a legitimate claim to draw up specific steps, in order to which there are excellent Hungarian cases, good practices. mozes@elte.hu

**LONG-TERM EFFECTS OF THE HEALTH PROMOTION PROJECT "SKIPPING HEARTS" ON MOTOR SKILLS OF CHILDREN: THE "EVASKIP" STUDY**

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Physical activity and motor skills are important aspects in health prevention. In the last years studies showed a decline of motor skills in children. Therefore, the prevention program "Skipping Hearts" was designed (as a school project) to increase physical activity and improve motor skills by using Rope Skipping. Now, after including more than 250000 children, the evaluation "EvaSkip" determines the effectiveness of "Skipping Hearts" to improve motor skills of children in the long run. Motor skills were tested at baseline (t0), after 4 months (t1) and after three years (t2). Flexibility parameters were shoulder flexibility (SF), stand and reach (SR); coordination parameters were one leg stand (OLS), Match-4-Point (M4-P) and lateral back and forth jumps (LBF). Data have been collected of 191 children at t3 (1493 children at t0 and t1). 97 children performed the Basic Workshop (BW, 90 minutes activity in Rope Skipping), 55 children took part in the Champion Program (CH-P, BW + 10 units à 45 minutes in Rope Skipping); 39 children served as the control group (CG). Repeated ANOVA measures were used to calculate changes in parameters over time between groups. In case of significant interactions, group comparisons and analysis of differences between mean values (t1-t0, t2-t0 and t2-t1) were performed with one factorial ANOVA. Significant interactions between time and group occurred in SF ( $p=0.008$ ). From t0 to t2 SF-improvement (right arm up) was lower in BW (21.6%,  $p=0.045$ ) compared to CH-P (43.8%). Time group interactions occurred in OLS ( $p=0.004$ ), from t0 to t2 BW improved (51.3%) more in balance compared to CH-P (35.4%,  $p=0.015$ ) and showed no difference compared to CG. Additionally, in t0 BW showed lower baseline value than CH-



P ( $p=0.010$ ). SR ( $p=0.532$ ), M4-P ( $p=0.220$ ) and LBF ( $p=0.430$ ) showed no differences in development over time between groups. Coordination increased over time in all groups: 33.8% for LBF and 50.2% for MP-4. The main results showed that the intervention program "Skipping Hearts" has little positive long term effects especially for coordination. However, even if there are small-term effects of the project, long term effects can only be achieved by changes in behavior of the children and situations on site. Contact: thorsten.schulz@tum.de

### EFFECTS OF THE HEALTH PROMOTION PROJECT SKIPPING HEARTS ON CARDIOVASCULAR RISK FACTORS IN CHILDHOOD: THE LONG-TERM EVALUATION STUDY EVASKIP

THOMANDL, L.1, ENGL, T.1, MEYER, M.1, OBERHOFFER, R.1, GRAF, C.2, FERRARI, N.2, AL NAJEM, S.3, POSTLER, T.1, SCHULZ, T.1

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The prevalence of obesity, hypertension or elevated body fat is increasing in children and enlarges the risk of following chronic diseases. A reason therefore is the growing number of inactive children. The project Skipping Hearts, a rope skipping intervention in schools (more than 250.000 children included) wants to increase physical activity, improve motor skills and reduce the risk of cardiovascular diseases. Now after 3 years, EvaSkip examines possible long-term effects of Skipping Hearts with regard to cardiovascular parameters. From 1493 children of the short-time evaluation, 191 children (age<sub>2</sub>=12.1y; height<sub>2</sub>=154.7cm; weight<sub>2</sub>=43.7kg) have been included into the study (Oberhoffer et al., 2015). 97 performed a 90 minutes Basic Workshop (SH-B) in rope skipping, 55 received a Champion Program (SH-CH) with additional 10 units à 45 minutes. 39 children served as controls (CG). Body mass index (BMI), body fat, systolic (SBP) and diastolic (DBP) blood pressure, resting heart rate (RHR) and waist-to-height ratio (WHtR) were collected triply (t0, t1 after 4 months, t2 after 3 years). Z-scores were calculated for BMI, SBP and DBP. Changes in parameters over time between groups were analyzed by Two-Way repeated measures ANOVA. Group comparisons and analysis of differences between mean values of t1-t0, t2-t0 and t2-t1 with one-factorial ANOVA were performed. Results are expressed with p-values (p), 95% confidence intervals (CI) and mean±standard deviation. Significant interactions of time and group resulted in DBP ( $p=0.015$ ). From t1 to t2 zDBP of SH-CH increased less compared to CG ( $p=0.020$ ; 95% CI: [-1.58;-0.10]) and SH-B ( $p=0.017$ ; 95% CI: [-0.13;-0.10]). Additionally, in t2 DBP was lower in SH-CH (73.6±9.3mmHg) than CG (79.3±8.6mmHg). Body fat, zBMI, zSBP, RHR and WHtR showed no differences in interaction effects. In t0 the proportion of children with hypertonic values was 59.1% (zSBP) and 50.0% (zDBP), in t2 57.1% (zSBP) and 55.5% (zDBP). With 92.0% (t0), 92.6% (t1) and 90.5% (t2) non overweight children, the study population can be considered as normal weight. SH-CH seems to have a positive long-term effect in DBP compared to SH-B and CG, but not in BMI, body fat, SBP, RHR and WHtR. A 90 minutes Basic Workshop is definitely not enough to cause changes in behavior pattern and thus cardiovascular parameters. However, qualitative studies have to show whether SH-CH achieves behavioral changes in children. References Oberhoffer R, Schulz T, Postler T. (2015). Dtsch Z Sportmed, 66, 175. Contact li-sa.thomandl@tum.de

### MULTIDIMENSIONAL MOTOR SKILL ASSESSMENT IN PRESCHOOL CHILDREN – A CRITICAL ANALYSIS

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Introduction: To address widespread child obesity, movement poverty and increasing numbers of children with cognitive developmental delay as a typical follow up problem of a lack in children's overall daily physical activity, several multidimensional motor skill test batteries are proposed as a valid, reliable, and practical method for monitoring motor development of preschool children. The present study was focused on a critical evaluation of a selection of these published tests. Methods: 23 healthy preschool children (female: n=11; male: n=12; age: 4.6±0.7 yrs; height: 109.2±0.7cm, body mass: 18.4±2.3kg) participated in a total of 13 tests, including physical (10m Sprint (SP), Endurance Running (ER), Sidehopping (SH), Standing Long Jump (SLJ), Shoulder Flexibility (SF), Sit and Reach (SR)) and coordinative tasks (Rolling Ball Trail (RB), One Legged Stance (OLS), Balancing (B), Stringing Beads (SB), Change of Direction (CD), Catch a Bar (CB), Target Throw (TT)). After two preceding baseline measurements for instruction and familiarization reproducibility of the test results had been determined in a pre - posttest design. All items were transferred into a standardized total Fitness Score. Results: 3 items from a total of 13 individual tests were highly reproducible in accordance with the ICC (95% confidence interval). (ICC: SLJ: 0.90, OLS: 0.93, B: 0.98). A mean reliability could be shown for 4 items (ICC: RB: 0.77, SH: 0.84, ER: 0.85, SR: 0.86). No or moderate reliability occurred in 6 individual tests (ICC: TT: 0.38, SB: 0.42, SP: 0.46, CD: 0.51, SF: 0.59, CB: 0.59). The influence of anthropometric data on motor performance was calculated using multiple linear regressions. Age, height and body mass were an important predictor for the total Fitness Score (60.8% explained variation). Based on the results of an One-Way ANOVA, children aged 5 yrs (-0.60 ± 0.37) scored the highest values and therefore differ significantly from the 4 yrs. (-0.08 ± 0.42;  $p \leq 0.05$ ) and the 3 yrs. (-0.58 ± 0.62;  $p \leq 0.01$ ). No gender differences were found ( $m: 0.05 \pm 0.65$ ;  $w: -0.04 \pm 0.64$ ). Overall, 12 items correlated significantly with the total Fitness Score. A factor analysis yielded only one factor, on which 6 items with an explained variance of 71.21% are loaded. Discussion: Our results show that most of the physical and coordinative tests reached an insufficient reproducibility. A multidimensional testing in that age seems to be dispensable since different physical qualities were pointing in the same direction. Generally the acquisition of motor abilities in preschool children is facing considerable problems in concentration and motivation which interferes with scientific standardization.

### EFFECTS OF PHYSICAL ACTIVITY LEVELS ON THE RESPONSE TO DIFFERENT KINDS OF STRESS

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Daily physical activity enhances stress resistance, and the responses to stress are influenced by physical activity levels. On the other hands, the stress responses differ depending on kinds of stress. It is well known that differential responses are frequently observed after receiving physical and psychological stress. It is thus possible that the effects of physical activity levels on stress responses are altered by different kinds of stress. In the present study, we investigated the effects of physical activity levels on the response to 3 kinds of stress in rats. Male Wistar rats were housed in the cages with or without attached running wheel for 4 weeks as physical active or inactive conditions. Based on the 4weeks running distance, the rats were divide into high and low active runners. Following a 4-weeks running session, the each rats received different kinds of stress, such as severe physical stress (electrical foot shock), mild physical stress (little restraint), or psychological stress (fear conditioning). We analyzed brain corticotrophin-releasing hormone, plasma ACTH, and corticosterone levels as indicators of central and peripheral stress responses. The results indicated that physically active conditions induced

some changes on brain corticotrophin-releasing hormone and corticosterone levels in the all kinds of stress conditions. Especially, physical activity enhanced stress resistance following psychological stress compared to inactive condition. In the comparison of physically high active and low active rats, there is no significant difference between high and low runners in the all measurements following severe stress condition. On the other hands, in the psychological stress condition, freezing time, which is an indicator of psychological stress response following fear conditioning, in the low runners were significantly higher than that in high runners. Furthermore, brain CRH levels in the low runner tended to increase compared to high runners after fear conditioning. Stress responses following to mild physical stress buffered in both high and low runners. The results of present study indicate that daily physical activity can change brain functions related to stress response following to several kinds of stress. Furthermore, physical activity levels can influence stress response to psychological stress, but not physical stress, and that daily physical activity can enhance stress resistance to mild stress independent on physical activity levels. Our results suggest that actually daily physical activity decreases stress response and enhances stress resistance, however these reactions may dependent on the kinds of stress.

## Mini-Orals

### MO-PM47 Mixed Session: Injury & Adapted Physical Activity

#### MUSCULOSKELETAL PAIN IN GERMAN ELITE ROWERS

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**Introduction** Rowing is a popular sport and considered to be among the most physically demanding endurance sports that require outstanding physiological attributes. It is characterized by a continuous repetitive motion stressing various anatomic areas continually depending on the stroke phase. The biomechanical demands of the rowing stroke and the high associated training volume produce repeated forces of high magnitude to the musculoskeletal system. Therefore, the aim of the present investigation was to identify prevalence of musculoskeletal symptoms in German elite rowers. **Methods** Prevalence of musculoskeletal pain was recorded in 86 elite rowers ( $m=43$ ,  $f=42$ ;  $20.9\pm3.7$  yrs;  $183.5\pm8.3$  cm;  $76.8\pm11.3$  kg) by a standardized and validated questionnaire based on the Nordic questionnaire (Kuorinka et al., 1987). Lifetime prevalence (LTP) and point prevalence (PP) of musculoskeletal pain in nine different anatomic regions were determined.  $\chi^2$ -statistics were used to determine differences in musculoskeletal pain between gender. The Pearson correlation coefficient was used for analyzing the relation of age. **Results** The most frequently localization of pain was in the lower back. LTP for lower back was 87.2%, followed by neck (66.3%), knee (65.1%), shoulder (61.7%) thoracic spine (58.1%), wrist (53.5%), ankle (33.7%), hip (32.6%) and elbow (17.5%). The PP of musculoskeletal pain showed a similar distribution. Highest PP was found in lower back (47.7%) followed by neck (30.2%), wrist (24.5%), shoulder (23.2%), knee (22.1%), thoracic spine (19.8%), hip (15.1%), ankle (7%) and elbow (3.5%). Comparison of gender showed no significant differences instead of LTP of the wrist ( $p=.022$ ). Analyzing the effect of the rowers age on prevalence of musculoskeletal pain no significant correlation were found. **Discussion** The investigation showed that most common regions of pain were in the lower back and neck. These findings are in line to other studies which reported predominantly low back pain in rowers. Bahr et al. (2004) reported LTP of lower back pain of 63.3%. Ng et al. (2013) actually found LTP of 93.8% in male and 77.9% in female rowers. High physical loads, repetitive mechanical strain, intermittent or continuous hyperflexion of the lumbar spine, high training volume and the sports-related physical requirement profile might be associated with the development of musculoskeletal pain and especially low back pain in elite rowers. The results of the present study indicate the necessity of specific prevention programs in rowers. **Acknowledgement** The study was supported by the Federal Institute for Sport Science, Germany (ZMVI1-080102A/11-18). **References** Bahr R. et al. (2004). Spine, 29(4), 449; Kuorinka I. et al. (1987). Appl Ergon, 18(3), 233; Ng L. et al. (2013). J Sci Med Sport, 17, 266. Contact: lukas.beule@rub.de

#### THE AGGRAVATION OF FUNCTIONAL ANKLE INSTABILITY REDUCED THE JUMP PERFORMANCE.

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**Introduction** An ankle sprain is the most frequent injury in the field of sports. Functional ankle instability (FAI) often results from ankle sprains. FAI is reduced the sports performance, especially, jump performance. Subjects with FAI exhibit altered patterns of movement during single leg landing and took longer time to stabilize compared to healthy subjects. Rebound drop jump (RDJ) is one of the ballistic stretch shortening cycle (SSC) movement. SSC movement is important to sports movement. Subjects with FAI were longer contact time than control subjects. However, the changes of the RDJ performance to become severe of FAI were not clear. **Methods** Ninety-two male college football players participated in this study. They went through the medical check (MC) at 2014(pre-MC) and 2015(post-MC). FAI and RDJ were measured at the MC. Self-reported FAI was evaluated with the Cumberland ankle instability tool Japanese version (CAIT-J) (Kunugi et al. 2016). The leg were defined as "better leg" if the post-MC CAIT-J score was lower than pre-MC CAIT-J score, while the leg were defined as "worse leg" if the post-MC CAIT-J score was higher than pre-MC CAIT-J score. The subject performed RDJ from a height of 15cm for one leg (RDJ15) and 30cm for both legs (RDJ30). RDJ15 were performed by a dominant leg and a non-dominant leg (dominant leg; RDJD15, non-dominant leg; RDJN-D15). The flight time (FT), ground contact time (CT) and peak force (PF) were measured by Multi Jump Tester (DKH). The rate of post-MC/pre-MC were calculated and analyzed to compare to difference between better legs and wore legs using independent two sided t-test. **Results** In RDJD15, there was a significant difference for flight time between "better leg" group ( $n=33$ ,  $98.3\pm8.0\%$ ) and "worse leg" group ( $n=25$ ,  $94.0\pm8.0\%$ ). In RDJN-D15, there was a significant difference for flight time between "better leg" group ( $n=35$ ,  $98.1\pm8.1\%$ ) and "worse leg" group ( $n=19$ ,  $93.0\pm9.4\%$ ). In RDJ30, there was a significant difference for flight time between "better legs" group ( $n=24$ ,  $101.4\pm7.3\%$ ) and "worse legs" group ( $n=14$ ,  $94.4\pm7.7\%$ ). **Discussion** In the "worse leg group", the flight time were shorten compared to one year ago. For shorter contact times and higher jumps, the ankle workload needs to be increased (Zushi et al. 1995), and FAI decreases the SSC ability (Yoshida et al. 2012). Therefore the aggravation of functional ankle instability reduced the jump performance. **References** Kunugi S, Masunari A, Noh B, Mori T, Yoshida N, Miyakawa S. (2016). Disabil Rehabil, 1-9. Zushi K, Takamatsu K. (1995). Japan J Phys Educ, 40, 29-39. Yoshida N, Miyakawa S, Miyamoto T, Masunari A, Kobayashi N, Yamada E, Shiraki H, Ishii T. (2012). J Phys Fitness Sports Med, 1(4), 679-684. contact d\_a\_masu0606@hotmail.com

**SPORTS INJURIES IN GERMAN TOP LEVEL YOUTH ICE-HOCKEY – EPIDEMIOLOGY AND PREVENTION**

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**Introduction:** Ice-hockey differs in dynamic, allowed body contact and equipment from other team sports. That's why players are exposed to a high risk of injury and particularly young players should be protected against avoidable injuries. Aim of the study was to analyse the epidemiology of injuries in German top level youth ice-hockey and to provide information about typical injuries, injury risk and the cause of injuries. **Methods:** All teams (298 players and 10 coaches) of the German ice-hockey junior league (DNL) take part in the study during season 2013/2014. The survey was carried out by means of questionnaires, which were filled in in presence of the interviewer. The questions covered - training and competition exposition (hours), - age, height, weight, playing position and - most recent injuries of the last 18 months (diagnosis, treatment and time-loss, injury situation, protective equipment, position on the field at the time of injury). **Results:** 173 players (age:  $16.92 \pm 1.0$  years; height:  $180.8 \pm 5.9$  cm; body mass  $77.34 \pm 7.6$  kg) announced 141 injuries in the queried period (18 months) which were suffered to 64% in the competition and to 36% in the training. The most frequent injuries were concussions (13.5%), injuries of the acromioclavicular joint (11.3%) or the adductors (9.2%). Injuries of the shoulder had to be treated often inpatient (mean 2.8 days). In five of 31 cases it was necessary to operate. In the first half of the season 2013/2014 (3 months) the incidence for injuries in competition amounts to 0.38 injuries per game or 31.8 injuries per 1000 player-game hours. In the same period 15 players injured themselves in the training, it turns out an injury risk of 10.6 per 1000 training hours. Injuries of the adductors occurred to 75% in training sessions, mainly with the beginning of motion and/or while skating forward. According to the players 67% of the competition injuries were connected to irregular conduct of the opponent, though 73% of the breach of the rules wasn't penalized by the referees. **Discussion:** On the basis of the findings, prevention measures should be age-related and adduced to the proficiency level of the player. 65% of the competition injuries were provoked by body contact, in literature values are between 45 -84 %. Irregular conduct must be penalized by the referees more strictly, referee's performance should be standardised in youth ice-hockey. Injuries of the adductors can be reduced by specific prevention measures. Fairness and the respect for the opponent should be accepted and considered by all players equally, players should be sensitised for it already in their early stage of ice-hockey education. Besides education campaigns can cause a change in thinking.

**SHOULDER TIGHTNESS OF INTERNAL ROTATION ASSOCIATES WITH CLINICAL DOUBLE-CHECK: BOTH OF ULTRASOUND FINDINGS AND ELBOW PAIN CHECK**

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**Introduction** Among youth baseball players, elbow injuries commonly appear, and early detection and prevention of elbow injuries are important. Recently, ultrasound imaging has been used to detect elbow injuries with confirmed reliability (Harada et al., 2006). In epidemiologic researches, however, previous studies mostly have been used only a pain or rest period by pain as indication of injuries, not used precise check. The purpose of this study was to investigate the association between abnormal ultrasound findings besides elbow pain and physical tightness. **Methods** A total of 295 youth baseball players participated in this study. The demographic data was obtained by questionnaire. The passive range of motion of the shoulder (abduction, 90° abducted horizontal adduction, external and internal rotation), straight leg raising (SLR), 90° flexed hip internal rotation (HIR), and finger-floor distance (FFD) were measured. All participants were divided into two groups (injury and normal). Injury group included participants with abnormal ultrasound findings in lateral or medial elbow subchondral bone by using ultrasound equipment besides appearance elbow pain when passive stress test for elbow. The differences of two groups were compared by unpaired t-tests and Chi-square analyses. In addition, logistic regression analysis was conducted. **Results** 41 players were into injury group and 254 players were into normal group. In range of motion, 90° abducted internal rotation of the dominant shoulder and HIR of the step forward side in pitching were significantly less than those in the normal group ( $p = 0.022, 0.045$ ). The result of logistic regression analysis, 90° abducted internal rotation of the dominant shoulder was significantly associated with injury even after adjusted for other factors ( $p = 0.035$ , OR: 0.983, 95%CI: 0.967-0.999). **Discussion** This study indicated that the deficit of 90° abducted internal rotation was independently risk factor for abnormal ultrasound findings besides appearance of elbow pain in stress test. It is reported that the deficit of internal rotation is caused by thickening and contracture of the posteroinferior capsule. And these occur in response to loads that act on it during the follow through in the throwing motion (Burkhart SS et al., 2003). In conclusion, preventing the deficit of 90° abducted internal rotation by stretching may prevent the abnormal ultrasound findings, elbow pain and following elbow injuries. **References** Harada M, Takahara M, Sasaki J, Mura N, Ito T, Ogino T. (2006). *AJR Am J Roentgenol*, 187, 1436-1441. Burkhart SS, Morgan CD, Kibler WB. (2003). *Pathoanatomy and biomechanics. Arthroscopy*, 19, 404-420.

**THE RELATIONSHIP BETWEEN GLENOHUMERAL INTERNAL ROTATION DEFICIT AND INJURY RISK OF THE UPPER EXTREMITY IN BASEBALL PLAYERS**

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**Introduction** Glenohumeral internal rotation deficit (GIRD) has been identified as a significant contributing factor to shoulder injuries (Cools et al., 2015). Relatively few epidemiological studies have examined the relationship between GIRD and injury risk of the upper extremity in Taiwanese baseball players. This study aimed to investigate whether the risk of injury correlate with GIRD in Taiwanese baseball players. **Methods** A total of 406 players with an average age of 16 years, an average height of 171 cm, and an average weight of 68 kg, participated in this investigation. All players were divided into 3 age groups: junior high school (12 to 14 y/o), high school (15 to 17 y/o), and university (18 to 25 y/o). GIRD was defined as a loss of 20° or more of IR angle of the throwing shoulder compared with the non-throwing shoulder. We investigated the following variables include age, player's position, and characteristics of injury (location, mechanism, and treatment). Data from the groups with and without GIRD were analyzed using Chi-square test to detect the relationship between GIRD and variables. **Results** The results showed that there were no significant differences between the incidence of GIRD and player's position ( $p = 0.859$ ), and mechanism of injury ( $p = 0.433$ ). Nonetheless, the incidence of injury was significantly higher in the university group, with the injury rate of 56.9%, 61.8% and 81.0% in junior high school, senior high and university, respectively ( $p = 0.008$ ). The incidence of shoulder injury was also significantly higher in the university group, with the shoulder injury rate of 28.1%, 31.8% and 50.8% in junior high school, senior high and university, respectively ( $p = 0.005$ ). The incidence of elbow and wrist injury did not show significant differences among the three age groups. **Discussion** The results of this study showed that the incidence of injury were significantly higher in the university players who had GIRD. The incidence of shoulder injury was also significantly higher in the university players. Therefore, special

training and stretching program may be necessary to reduce the risk of injury in baseball players. References Cools AM, Johansson FR, Borms D. Prevention of shoulder injuries in overhead athletes: a science-based approach. *Braz J Phys Ther.* 2015 Sep-ct;19(5):331-9. Contact Paul Pei-Hsi Chou, M.D., Ph.D. Professor and Director Division of Sports Medicine Department of Orthopedic Surgery Kaohsiung Medical University Hospital e-mail: arthroscopy.pc@gmail.com

### AN UNAPPROPRIATED EXERCISE TRAINING PROGRAM

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Exercise training is a key component of pulmonary rehabilitation and should be prescribed by an exercise specialist competent in respiratory disease. We report a case of a 72 years COPD male (mild obstruction) with cardiovascular morbidity (myocardial infarction in 2004) referred to our outpatient clinic for excessive exertion dyspnea during exercise in the gym. In 2013, the patient performed a moderate-walking training program for 8 weeks, 2 one-hour sessions a week. At the end of the program, a home-based training was prescribed (speed 4.5 km/h, 30 min, 3/week). Later, he decided to attend the gym, following a non-supervised cardio-fitness program. He was in beta-blocker but the speed was adjusted by the trainer according to the heart rate (HR). Currently, he is training at 6 km/h, slope of 6%, complaining a worsening dyspnoea. At the moment of the visit, spirometry and EKG were unchanged. A cardio-pulmonary exercise test (CPET) was made, mimicking the training session at the gym. Protocol started at 3 km/h progressively increased until 4.4 km/h at a slope of 0%. After 8 minutes the test was stopped for oxygen desaturation (SpO<sub>2</sub> 89%). At that point, HR was 82 bpm (55% of HR<sub>max</sub>); the anaerobic threshold was reached; CO<sub>2</sub> equivalent: 40; ventilatory reserve: 17 L; inspiratory capacity reduced from 2.58 L at rest to 1.55 L. The results of CPET can explain the causes of dyspnoea. Conclusion: An expert staff should supervise patients during the training session at the gym. In fact, this case emphasizes the inadequacy of monitoring only the heart rate during exercise in chronic patients and the importance of evaluating other data (i.e. SpO<sub>2</sub> and previous maximal exercise test) to plan and follow an exercise training program.

### THE EFFECT OF SKIN SCUBA DIVING NITROX EAN 50 PROGRAM ON COGNITIVE DEVELOPMENT AND SOCIAL DEVELOPMENT IN PEOPLE WITH AUTISM

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Introduction There are various studies showing that positive effects of participating in a skin scuba diving program for healthy participants however, to date it is difficult to find studies investigating the use of scuba diving program for people with autism. The primary aim of this study was to analyze the effect of the skin scuba diving nitrox EAN 50 program on cognitive and social development in people with autism. Additional aims were to provide preliminary data on the usefulness of such a program as a form of rehabilitative treatment to provide more opportunities for social participation and an improved quality of life for people with autism. Methods In order to achieve these research goals, measurement factors for standard values and standard deviation values were calculated for 10 people with autism. All the autistic participants were diagnosed in their local hospital and all lived in the Busan Metropolitan City in 2015. Matching sample T verification data analysis was used to verify the difference in standard values for each item before and after the program was conducted. IBM SPSS Statistics 21 was used to analyze the collected data. Results First, there was a positive correlation between the skin scuba diving program and an increase in motor skill abilities for the autistic participants. Second, the program had no effect on the language skills. Third, the skin scuba diving program showed a positive effect on the overall cognitive abilities of the autistic participants. Fourth, there was an improvement in the interpersonal relations. Fifth, the autistic participants were able to follow directions better after taking part in the skin scuba diving program. Sixth, there was a positive correlation between participation and their behavior. Seventh, participation in the skin scuba diving program had a positive effect on their ability to adapt to groups. Discussion These results show that participating in the skin scuba diving nitrox EAN50 program had an effect on a variety of sub-factors related to the cognitive and social development of people with autism. The results provide evidence for the idea that the EAN 50 program is useful as a rehabilitation program for people with autistic disabilities. Additionally, this program gives people with autistic disabilities the chance to stand shoulder to shoulder with their non-disabled peers by increasing their chances for social participation and furthermore will provide preliminary data that will be helpful for the creation of rehabilitation and treatment problems for people with autistic disabilities. Contact [yshwang@pusan.ac.kr]

### MONITORING TRAINING LOADS IN HANDCYCLING – PREPARING FOR RIO 2016

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Aim Scientific literature containing training load monitoring in Paralympic sports is lacking. The aim of the present study was to analyze training loads in handcycling for the first time during a full competitive season of a multiple Paralympic medalist. Methods At the beginning of this observation in 11/2014 the featured handcyclist was 54 years old (classification: WH5, height: 1.78 m, body mass: 68.0 kg, body fat: 12.8 %). As a member of the German paracycling national team she won four medals in the 2008 and 2012 Paralympic Games. Aiming towards the 2016 Paralympic Games this study is focusing on the preparation and the competitive period of the 2015 season. Using a SRM-Powermeter every training session was recorded from 11/2014 to 09/2015. At the beginning of the observation and in May 2015 laboratory testing were conducted to determine training intensities. Training intensity was analyzed according to the five-zone intensity scale (Seiler, 2010) like shown in table 1. In addition to this scale the model of three intensity zones (1: below the individual lactate threshold (ILT), 2: between the ILT and the onset of blood lactate accumulation (OBLA), and 3: above the OBLA) was used to compare the present results with general results in the literature (Seiler, 2010). Results The athlete completed 186 handcycling training sessions in 382:28 hours, covered a distance of 8640.96 km, climbed 35611.0 m and burned around 145000 kJ during the investigation. The intensity distribution according to the five- and three-zone intensity scale is shown. Conclusions Maintaining a high fitness level throughout the season was important to collect points for the qualification of the 2016 Paralympic Games. This aim was reached by winning every world-cup time-trial of the 2015 season. The analysis of the training intensity distribution shows a tendency to a greater volume in zone 2 than recommended in the literature (Esteve-Lanao et al., 2005; Seiler, 2010; Stöggl & Sperlich, 2015). Therefore, a room for improvement for the upcoming Paralympic season was found. References Esteve-Lanao, J., Juan, A. F. S., Earnest, C. P., Foster, C., & Lucia, A. (2005). How Do Endurance Runners Actually Train? Relationship with Competition Performance. *Medicine & Science in Sports & Exercise*, 37(3), 496–504. Seiler, S. (2010). What is best practice for training intensity and duration distribution in endurance athletes? *International Journal of Sports*



Physiology and Performance, 5(3), 276–291. Stöggl, T. L., & Sperlich, B. (2015). The training intensity distribution among well-trained and elite endurance athletes. *Frontiers in Physiology*, 6(October).

### THE EFFECTS OF VIRTUAL AND TRADITIONAL GOLF PROGRAMS ON STRENGTH, FLEXIBILITY AND REACTION TIME IN CHILDREN WITH CEREBRAL PALSY

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**Introduction** A regular lifelong physical therapy and rehabilitation program is required for reducing motor control problems in cerebral palsy (CP). Sports and virtual reality can be used as alternative enjoyable exercise methods. The aim of this study is to compare the effects of virtual golf training (VGT) and traditional golf training (TGT) on strength, flexibility and reaction time in children with CP. **Methods** 19 with CP (hemiplegia) ages 6-12 participated in this study. Subjects divided into two matching groups according to Gross Motor Function Measure: VGT (n:9) and TGT (n:10). For the assesment of muscle strength: hand grip, lateral step up and curl up tests; flexibility: sit and reach, modified appley and modified thomas tests and reaction time: anticipation time tests were used. These tests were done at baseline and after 12 weeks intervention. In this study, similar full swing training program used on both groups. Children attended to the training program for 60 minutes a day, 3 days a week during the 12 week. **Results** Within group comparison analyses, significant differences were found in hand grip strength test on the favor of TGT group ( $p < 0.05$ ). After 12 weeks training program both groups' sit and reach values, lower body and abdominal muscle strengths increased similarly ( $p < 0.05$ ). No significant increases were found on modified appley and thomas tests for each group ( $p > 0.05$ ). **Discussion** Higher positive changes on hand grip strength in TGT group than VGT group shows the importance of using heavy materials which increases the muscle strength on bimanual exercises. Lower extremity strength increased significantly in effected and unaffected extremities on both groups. This shows that functional training methods like golf training may cause positive effect on neuromuscular system. Abdominal muscle strength was increased for each training group, because of the need to contract trunk muscles (Lim ve ark., 2002) during the golf swing. Short training period only increased trunk flexibility in both VGT and TGT group. Significant positive changes on anticipation reaction time in VGT group than TGT group shows the effects of necessity to follow concurrent visual feedback in virtual games. Our study shows that VGT and TGT programs which can be used as alternative therapy methods have positive effects on motor performance in children with cerebral palsy. **References** Lim YT, Shin IS, Woo SY. Electromyographical Analysis of Trunk Muscle Activities During a Golf Swing. InISBS-Conference Proceedings Archive (Vol. 1, No. 1), 2002.

## Mini-Orals

### MO-SH11 Psychology: Ageing & Risk Groups

#### POSSIBLE SELVES, PHYSICAL ACTIVITY, AND WELL-BEING IN OLDER ADULTS – A ONE YEAR LONGITUDINAL STUDY

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**Abstract** Model Possible selves, physical activity, and well-being in older adults – A one year longitudinal study Hsu, YW1, Lu, JH2 1: National Chiayi University (Chiayi, Taiwan), 2: Chinese Culture University (Taipei, Taiwan) **Introduction** “Possible selves” is an individual's self-knowledge about how he/she thinks of their own potential images in the future (Markus & Nurius, 1986). Literature suggests that possible selves is an important self-related construct for older adults' health behaviors and mental well-beings (Whaley & Schrider, 2005). However, literature recommended the vital need for empirical research in physical activity and exercise settings. The purpose of the present study was to examine the relationship among current self-views, future possible selves, physical activity participation, and well-being in older adults. **Methods** Longitudinal data was collected to construct a model illustrating the relationship among physical self-concept, possible selves, physical activity participation, and well-being. The potential moderators were also taken into account while examining the model. One hundred and eighty-seven community-dwelling older adults in Taiwan completed the survey packet three times every six months. Furthermore, semi-structured interviews were conducted to supplement the nature of older adults' possible selves on physical activity and exercise. **Results** In Time 1, 302 older adults finished the questionnaire. After one year, longitudinal data ( $n = 187$ ) showed that older adults' future possible selves were influenced not only by their current self-views in baseline, but also by their health status, the disposition of hope, future time perspective, and the discrepancy of hoped-for and feared future selves. The interview indicated that: those older adults with regular exercise have more positive thought for the future, less worry over independence and live style in the future. **Discussion** The aim of this research was to extend the self-concept research in Taiwan through investigating older adults' possible selves in physical activity. The findings of one year longitudinal study illustrated the significance of using the construct of possible selves to understand older adults' physical activity exercise behaviors and psychological well-being. Furthermore, given that one's images of the future represent the most vulnerable and mutable component of the self (Whaley & Schroyer, 2010), the model in the present study and the moderators could serve as an effective roadmap to promote older adults' participation in exercise and physical activity. Finally, the supplemental interview showed that volunteering could be a protective factor while facing identity loss as ageing and is worthy of future investigation. **References** Hsu, Y.W., Lu, F.J.H., & Lin, L.L. (2014). *Educational Gerontology*, 40(9), 666-675. Markus, H., & Nurius, P. (1986). *American Psychologist*, 41, 954-969. Whaley, D. E., & Schrider, A. (2005). *The Sport Psychologist*, 19, 148-164. Whaley, D. E., & Schroyer, R. (2010). *Journal of Sport Psychology in Action*, 1(1), 25-32.

#### THE ASSOCIATIONS BETWEEN EXECUTIVE FUNCTIONS OF PLANNING AND PROBLEM SOLVING AND BALANCE IN OLDER ADULTS

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**The associations between executive functions of planning and problem solving and balance in older adults** **Introduction** Executive functions were shown to decline with age and seem to influence balance in older adults (van Iersel et al., 2008). The ability of planning and problem solving may play a role in this mechanism. Yet, the associations between these executive functions and balance in older adults



were unclear. Thus, the purpose of this study was to examine the relationships between executive functions of planning and problem solving and balance in older adults. Methods A total of 27 older adults (mean age  $64.85 \pm 2.71$  yrs) were recruited for this study. Participants' dynamic balance was assessed using the "Timed Up and Go" test. Proprioception, a mechanism needed for balance, was measured using an ankle proprioception measuring instrument designed by professor Lan-Yuen Guo. The executive functions of planning and problem solving were assessed using a Tower of London Task. Pearson correlation analysis was used to examine the relationships between the recorded time (seconds) of the Timed Up and Go test and the angles (degrees) of the ankle proprioception test and the performance of the Tower of London Task. Results The results showed that there were no significant correlations between the recorded time of the Timed Up and Go test and total initial time ( $r = 0.058$ ,  $p = 0.779$ ), total executive time ( $r = 0.069$ ,  $p = 0.733$ ), and total time ( $r = 0.123$ ,  $p = 0.520$ ) of the Tower of London Task. There were also no significant correlations between the Timed Up and Go test and total move score ( $r = 0.205$ ,  $p = 0.315$ ) and total correct score ( $r = -0.061$ ,  $p = 0.767$ ). As for proprioception, there were no significant correlations between both active and passive proprioception of ankle dorsi flexion, plantar flexion, inversion and eversion and all measures of the Tower of London Task. Discussion The results of this preliminary study suggested that the executive functions of planning and problem solving were not associated with dynamic balance and ankle proprioception in older adults. Future studies with larger sample sizes are needed to further examine the relationships between these executive functions and balance in this population. References Van Iersel, M.B., Kessels, R.P., Bloem, B.R., Verbeek, A.L., and Olde Rikkert, M.G. 2008. Executive functions are associated with gait and balance in community-living elderly people. *The journals of gerontology. Series A, Biological sciences and medical sciences*, 63(12), 1344-1349. Contact [ihchu@kmu.edu.tw](mailto:ihchu@kmu.edu.tw)

### ASSESSING STEREOTYPES ABOUT EXERCISE AMONG PEOPLE LIVING WITH HIV: DEVELOPMENT AND PSYCHOMETRIC EVALUATION OF THE HIV EXERCISE STEREOTYPES SCALE

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Introduction Despite the extensive literature related to the benefits of exercise in people living with HIV (PLHIV), a large proportion of this population is not sufficiently active according to current recommendations (O'Brien et al., 2010). Exercise stereotypes have been shown to be psychological barriers to exercise in specific populations (Emile et al., 2014; Falzon et al., 2014). The main objective of the current study was to validate a French-language scale measuring exercise stereotypes in PLHIV, in order to gain visibility to the possible barriers and facilitators for exercise. Methods A series of four complementary studies was carried out with a total sample of 524 participants (107 healthy individuals; 417 PLHIV) to: (a) develop a preliminary version of the HIV Exercise Stereotype Scale (HIVESS), (b) confirm the factorial structure, (c) evaluate the temporal stability, and (d) examine the construct validity of the instrument. Results Factorial analyses provided support for a 14-item scale with three subscales related to (a) stereotypes related to exercise benefits (e.g., "Physical activity improves the morale of HIV-infected people"), (b) stereotypes related to exercise risks (e.g., "Practicing a physical activity should be avoided by HIV-infected people because it causes injuries") and, (c) stereotypes related to the lack of capacity for exercise (e.g., "HIV-infected people do not have enough physical resources to practice a physical activity"). The scale indicated good internal consistency and stable test-retest reliability. Negative stereotypes related to exercise risks and the lack of capacity for exercise were inversely related to exercise self-efficacy and level of physical activity. Lastly, healthy individuals scored higher for both negative exercise stereotypes subscales. Discussion Although several scales have been developed to measure psychological constructs in PLHIV (Barroso & Lynn, 2002), the HIVESS is the first scale to record exercise stereotypes in this population. This scale presented satisfactory psychometric properties and constitutes a reliable and valid instrument for future research and clinical practice among French PLHIV. The procedure reported in this paper is however limited by the sociodemographic characteristics of the sample. Furthermore, the HIVESS, which was first developed in French, would need to be translated and validated in other languages in order to be used internationally. References Barroso J, & Lynn MR. *Journal of the Association of Nurses in AIDS Care*. 2002; 13(1):66-75. Emile M, Chalabaev A, Stephan Y, Corrier K, & d'Arripe-Longueville F. *Psychology of Sport and Exercise*. 2014; 15:198-204. Falzon C, Sabiston C, Bergamaschi A, Corrier K, Chalabaev A, d'Arripe-Longueville F. *Journal of Psychosocial Oncology*. 2014; 32(6):708-726. O'Brien K, Nixon S, Tynan A-M, Glazier RH. *The Cochrane collaboration*. 2010.

### MECHANISMS OF EXERCISE STEREOTYPES IN PEOPLE LIVING WITH HIV: THE MEDIATING ROLE OF PERCEIVED PHYSICAL FATIGUE AND SELF-EFFICACY

GRAY, L., FALZON, C., BERGAMASCHI, A., SCHUFT, L., DURANT, J., ROSENTHAL, E., PRADIER, C., DURACINSKY, M., ROUANET, I., COLSON, S.S., D'ARRIPE-LONGUEVILLE, F.

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Introduction Perceived physical fatigue is one of the most distinctive symptoms in People Living with HIV (PLHIV) (Lee et al., 2005). Exercise benefits for PLHIV are well documented (O'Brien et al., 2010), however a majority of PLHIV remains insufficiently active (Frantz & Murenzi, 2013). According to the stereotype embodiment theory (SET) (Levy, 2009), stereotype internalization influences health behaviors through self-perceptions. In line with this theory, exercise stereotypes have been identified as barriers to physical activity (PA) in specific populations (e.g., Emile et al., 2014). Furthermore, Emile et al. (2015) suggested that stereotypes may affect health-related outcomes through other processes than those related to internalization and notably through ego depletion effects. In this study, we considered the internalization and ego depletion pathways simultaneously by examining the mediating role of exercise self-efficacy and perceived physical fatigue in the relation between exercise stereotypes and PA in PLHIV. Methods A total of 560 PLHIV completed questionnaires measuring HIV exercise stereotypes (d'Arripe-Longueville et al., 2016), PA level (Robert et al., 2004), perceived physical fatigue (Fisk et al., 1994), exercise self-efficacy (Schwarzer et al., 2011), and stages of change for regular exercise (Prochaska et al., 1992). Results Analyses revealed a significant mediating effect of perceived physical fatigue between positive exercise stereotypes (i.e., exercise benefits) and PA level, and a significant mediating effect of exercise self-efficacy between exercise benefits and stage of change. There was no significant mediating effect between negative exercise stereotypes and PA level or stage of change. Exercise benefits were directly related to PA level. No direct effects were observed between negative stereotypes and PA level or stage of change. Discussion Exercise benefits were significantly related to PA level both directly and through the mediating role of perceived physical fatigue. This is in line with previous studies suggesting that positive exercise stereotypes encourage an active lifestyle (Emile et al., 2015) providing support to the ego depletion theoretical position. A significant mediating effect of exercise self-efficacy was observed between exercise benefits and stage of change, consistent with the SET and existing literature about the effects of stereotypes on PA through self-perceptions (Emile et al., 2014). Results provide support for multiple pathways of influence of positive exercise stereotypes in PLHIV and suggest some form of resistance to the internal-

zation of negative exercise stereotypes. Further research is needed to test this hypothesis. References Emile M., d'Arripe-Longueville F., Amato M., Cheval B., & Chalabaev A. *Journal of Gerontology: Psychological Sciences Series B*, 2015;70(6):876–885. Falzon C, Sabiston C, Bergamaschi A, Corrion K, Chalabaev A, d'Arripe-Longueville F. *Journal of Psychosocial Oncology*. 2014;32(6):708–726. Levy B. *Current Directions in Psychological Science*. 2009;18:332–336.

### **SPORTSPECIFIC RISK FACTORS FOR DISORDERED EATING HABITS IN ELITE ENDURANCE SPORTS**

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**SPORTSPECIFIC RISK FACTORS FOR DISORDERED EATING HABITS IN ELITE ENDURANCE SPORTS** Introduction Endurance sports is given as leanness sports and require athletes to have a low body weight to achieve high performance. Therefore elite athletes are at higher risk for disorderd eating or eating disorders (Dasil, 2008). The aim of this study is to identify potential sport-specific risk factors related to eating habits of elite female athletes in triathlon and swimming. Furthermore the current paper addresses the research question if elite swimmers or triathletes are at a different risk of maybe struggling with eating patterns. Methods Regarding methodology section this study follows a qualitative social research including guided interviews. The respondents were asked to answer 39 questions, as for example: "Do you talk with your training-group about your weight?" or "Do you think there is a relationship between performance, weight and success in your sport?" All interviews were acoustically recorded and transcribed. The analysis of the interviews was done based on an analysis of content (Mayring, 2008). The sample of this study includes 12 female elite-athletes, 6 swimmers and 6 triathletes, who competed at the Olympic Games, World or European Championships and therefore are seen as experts in their sport. Results The results indicate that adolescence and the coach are the most named factors for changing eating habits in both sports. The coach is an important factor because coaches are having a big influence on athletes. Swimmers and triathletes describe their eating habits as healthy and important to reach better performances. Furthermore triathletes describe the demands of their sport as a factor for changing eating habits to lose weight. Specially the running part requires a low body weight. The respondent swimmers believe that swimming is a non-leanness sport and swimming is no risk factor for disorderd eating or eating disorders. Discussion The explore risk factors could lead athletes to change their eating habits which could be the beginning of disorderd eating and furthermore eating disorder. Triathletes could have a bigger risk in comparison to swimmers caused by low body weight required for fastest running. Against common literature (Thompson & Sherman, 2010) respondents believe swimmers will become more corpulent in future and swimming should not be called leanness sport. The present thesis suggests that further research about eating habits and risk factors for disorderd eating has to be done in triathlon. Triathlon consists out of three leanness sports and is not enough explored yet how the three sports influence each other. References Dasil, J. (2008). *Eating Disorders in Athletes*. John Wiley & Sons Ltd: England. Mayring, P. (2008). *Qualitative Inhaltsanalyse. Grundlagen und Technik*. Weinheim und Basel: Beltz. Thompson, R. A., & Sherman, R. T. (2010). *Eating Disorders in Sport*. Taylor and Francis Group: New York. Contact tamara.knopf@hotmail.com

### **ATTENUATION OF OSCILLATORY ALPHA ACTIVITY DURING WORKING MEMORY MAINTENANCE IN CHILDREN WITH POOR MOTOR COORDINATION**

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**Introduction** Recent research has indicated that neuropsychological disorders and soft neurological signs might be related to motor proficiency problems in children with motor-related disorders. The neural mechanism underlying such problems in children, however, has thus far remained elusive. **Methods** Here we compared oscillatory EEG activity from 20 children with motor difficulties as defined by the movement Assessment Battery for Children – second edition (MABC-2) (aged 10 – 11 years; female =10; scores < 15th on MABC-2 test) and 20 age- and gender-matched typically developing counterparts (TD) (aged 10 – 11 years; scores > 25th on MABC-2 test) when they performed a visuo-spatial attention and working memory task. **Results** The results revealed that, relative to TD children, those with motor problems showed worse performance selectively in the working memory condition. This coincided with diminished ability in modulating neural oscillations, as evidenced by less posterior parietal alpha (8 – 13 Hz) suppression during late maintenance phase in these children. Importantly, we observed that such oscillatory alpha activity was significantly correlated with visuo-spatial working memory (VSWM) performance. **Discussion** These findings suggest that children with poor motor coordination might have a reduced ability to temporally maintain visuo-spatial information, resulting in poorer behavioral performance. We would thus conclude that changes in oscillatory EEG activity reflect some of the problems leading to cognitive deficits in children with poor motor coordination.

### **THE EFFECT OF MINDFULNESS MEDITATION AS A CLINICAL INTERVENTION TO REDUCE PAIN AND PSYCHOLOGICAL DISORDERS FOR INJURED ATHLETES**

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**Introduction** Reese et al, (2012) and Heaney (2006), mentioned that when athletes become injured there are numerous negative psychological changes including mood, decreased self-esteem, loss of identity and isolation. As a result sport injuries lead to worsening consequences in athletes' health. The aim of this research is to investigate the role of mindfulness meditation in assisting injured athletes in reducing the perception of pain and mood. Mindfulness can be defined as the awareness that emerges through paying attention in a particular way, on purpose, in the present and nonjudgmentally Zinn, (1994). **Methods** Independent variables: Group (Mindfulness-based Stress Reduction (MBSR), control) and Time (pre, post). Dependent variables: pain perception (of the injury) and pain tolerance (time to remove the hand in the cold pressor test). Both groups followed their normal physiotherapy treatment, but in addition the MBSR group practiced meditation for 8 weeks (one 30 minute session/week). Each week additional measures were: Mindfulness Attention Awareness Scale-MAAS, Profile of Mood State-POMS, Depression, Anxiety and Stress scale-DASS. **Results** Changes in mean pain perception scores showed no differences between the two groups ( $p=0.242$ ), however, there was greater variability in pain perception scores after MBSR ( $p=.01$ ). Pain tolerance showed a significant interaction between Group and Time with greater pain tolerance in the MBSR group after meditation ( $F(1,12) = 12.453, p= 0.004$ ). MAAS scores increased over the 8 weeks and in addition increased after MBSR. POMS and DASS scores showed a decrease in all mood scores over the 8 weeks. **Discussion** MBSR has two effects on pain. First, an increase in pain tolerance indicating either less sensitivity/habituation to pain. This supports previous research that indicates the self-regulation benefits of MBSR on pain management and well-being (Nehra et al. 2012; Lykins & Baer, 2009). Second, an increase in the variability of the percep-

tion of pain to their injury. This indicates that MBSR can increase as well as decrease pain perception. Further research is required to determine the cause and could support other research that finds limited evidence for effectiveness of Mindfulness-based interventions for patients with chronic pain (Bawa, 2015). References Bawa FLM, Mercer SW, Bond CM. (2015). Br J Gen Pract 65.635, e387-e400. Heaney C (2006). JSEP, 4:1, 73-86. Lykins, EL, Baer RA (2009). J Cog Psychotherapy, 23(3), 226-241. Nehra DK, Nehra S, Dogra R (2012). Global Vision Publishing House. Reese S, Pittsinger LMR, Yang J (2012). JSHS, 1(2), 71-79. Zinn K (1994). Mindfulness Meditation in Everyday Life. Hyperion. Contact warn2@kent.ac.uk

## Mini-Orals

### MO-SH10 Psychology: Cognition, Performance, Career Transitions

#### PREDICTING MENTAL TOUGHNESS IN TENNIS: THE ROLE OF SELF-AWARENESS

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Introduction Researchers have theoretically proposed (Loehr, 1995) or qualitatively found (Gucciardi, Gordon, & Dimmock, 2009) that self-awareness promotes mental toughness development or outcomes. To provide quantitative support for these suppositions and preliminary findings, this study examined the relationship between dimensions of self-awareness and mental toughness among competitive tennis players. Methods A sample of 333 male (N = 175) and female (N = 158) South African tennis athletes (Mage = 29.24, SD = 13.95) completed the Sport Mental Toughness Questionnaire (Sheard, Golby, & van Wersch, 2009) and Self-Reflection and Insight Scale (Grant, Franklin, & Langford, 2002) to assess mental toughness (i.e., confidence, constancy, control) and self-awareness (i.e., self-reflection, self-insight) dimensions, respectively. Multivariate multiple regression was computed to determine the extent to which the self-reflection and self-insight scales simultaneously predicted the mental toughness components of confidence, constancy, and control. Results Self-reflection,  $F(3, 323) = 11.84, p < .001$ , Wilk's  $\lambda = .90$ , partial  $\eta^2 = .10$ , and self-insight,  $F(3, 323) = 33.36, p < .001$ , Wilk's  $\lambda = .76$ , partial  $\eta^2 = .24$ , were both significant predictors of each mental toughness component. Compared to the mental toughness dimensions predicted by self-reflection [confidence,  $F(1, 325) = 8.11, p = .005$ , partial  $\eta^2 = .02$ , constancy,  $F(1, 325) = 10.86, p = .001$ , partial  $\eta^2 = .03$ , control,  $F(1, 325) = 12.90, p < .001$ , partial  $\eta^2 = .04$ ], however, the effect size estimates were larger for self-insight [confidence,  $F(1, 325) = 37.00, p < .001$ , partial  $\eta^2 = .10$ , constancy,  $F(1, 325) = 39.65, p < .001$ , partial  $\eta^2 = .11$ , control,  $F(1, 325) = 69.44, p < .001$ , partial  $\eta^2 = .18$ ]. Discussion Extending prior qualitative research, the results support the relevance of self-reflection and insight, as indicators of self-awareness, to the mental toughness of competitive tennis athletes. Although self-insight appears to be the most prominent factor to consider in relation to mental toughness, there are a number of prospective self-reflection and insight implications for tennis players' mental toughness, including psychological interventions aimed at reflective practices and cognitive reframing. References Loehr, J. (1995). The new mental toughness training for sport. New York, NY: Penguin. Grant, A., Franklin, J., & Langford, P. (2002). The self-reflection and insight scale: A new measure of private self-consciousness. Social Behavior and Personality, 30, 821-836. doi:10.2224/sbp.2002.30.8.821 Gucciardi, D., Gordon, S., & Dimmock, J. (2009). Evaluation of a mental toughness training program for youth-aged Australian footballers: II. A qualitative analysis. Journal of Applied Sport Psychology, 21, 324-339. doi:10.1080/10413200903026074 Sheard, M., Golby, J., & van Wersch, A. (2009). Progress toward construct validation of the Sports Mental Toughness Questionnaire. European Journal of Psychological Assessment, 25, 186-193. doi:10.1027/1015-5759.25.3.186

#### PHYSICAL EXERCISE PERFORMED IN SIMULATED ALTITUDE CONDITIONS IMPROVES DECISION-MAKING

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Introduction Exposure to high altitude can worsen decision-making, whereas, it is known that physical exercise performed at sea level can improve cognitive functions, including decision-making. Taking this into account, the aim of this study was to evaluate the influence of acute physical exercise in simulated altitude conditions on decision-making performance. Methods Thirty-eight healthy men were included in the study, distributed randomly into four groups: Sea Level n=10, Simulated Altitude n=10, Exercise at Sea Level n=10 and Exercise in Simulated Altitude n=10. The values of mean  $\pm$  (SD) were age:  $23 \pm (8)$  years, weight:  $71 \pm (7)$  kg, height:  $1.76 \pm (1)$  m, BMI:  $22 \pm (9)$  kg/m<sup>2</sup> and Vo<sub>2</sub> peak:  $47 \pm (4)$  ml/kg/min. Decision-making was assessed using the Game of Dice Task (Rzezak et al., 2012), applied on the first day in all groups and reapplied on the second day, immediately after the exercise session of 60 minutes at 50% of Vo<sub>2</sub> peak. The groups that were exposed to simulated altitude conditions equivalent to 4500-m remained in a Colorado Altitude Training™/12 CAT-Air Unit for 29 hours. Two-way ANOVA was used to determine differences between groups. The statistical significance was determined as  $p < 0.05$ . Results There was a significant improvement in decision-making ( $p = 0.001$ ) in the exercise in simulated altitude group when compared with the simulated altitude group. In the simulated altitude group a significant worsening in decision-making ( $p = 0.002$ ) was observed, compared with the sea level group. The exercise at sea level group presented a significant improvement in decision-making ( $p = 0.006$ ) when compared with the sea level group. Discussion Our results show that acute physical exercise performed in simulated altitude conditions improves decision-making performance. This improvement can be explained by an increase in brain metabolism which may have influenced the increase in cerebral blood flow (Querido et al., 2007), improving decision-making (Gligoroska et al., 2012). Thus, we suggest that acute physical exercise may be a strategy for minimizing impairment in decision-making in people travelling to high altitudes. References Gligoroska JP, Manchevska S. (2012). Mater Sociomed, 24(3), 198-202. Querido JS, Sheel AW. (2007). Sports Med, 37(9), 765-82. Rzezak P, Antunes HK, Tufik S, De Mello MT. (2012). Arq Neuropsiquiatr, 70(12), 929-33. Supported by FAPESP n° 2012 / 09236-4 Contact aquino.lemos@terra.com.br

**CAPACITY LIMITS OF TRACKING MULTIPLE MOVING OBJECTS IN ELITE BASEBALL AND SOFTBALL PLAYERS**

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**Introduction:** Playing a ball sport always involves tracking multiple moving targets. Baseball and softball players have to track the moving balls, the running teammates and opponents at the same time in order to have a best defense. An exceptional baseball or softball player might have a better performance of attentively tracking multiple moving targets than non-athletes. The purpose of the study was to examine this hypothesis. **Method:** Forty-nine male baseball, 25 female softball players, and 39 non-athletes (20 females and 19 males) were recruited in this study. The tracking performance for all participants were measured with the typical Multiple Object Tracking (MOT) Task (Pylyshyn & Storm, 1988). In this task, participants were asked to attentively track specific targets wandering around the computer monitor among some distractors for a few seconds, and they reported those targets in the end of trial. The study manipulated the object moving speeds for the Experiment 1 and manipulated the number of tracked targets for the Experiment 2 to measure the capacity limits of attentive tracking for athletes and non-athletes. **Results:** No matter how fast the targets moved in the Experiment 1 or how many targets were tracked in the Experiment 2, baseball players significantly performed better than non-athletes, and the tracking performance of softball players was non-significantly worse than baseball players and better than non-athletes. The capacity limits of attentive tracking were calculated with the speed limit for the Experiment 1 and the number limits for the Experiment 2. Baseball players performed significantly higher speed limits and larger number limits than non-athletes. This study suggested baseball players having significantly larger capacity limits of attentively tracking than non-athletes.

**EXPERT-NOVICE DIFFERENCES IN SPORT-SPECIFIC CUEING ATTENTION: AN EVENT-RELATED POTENTIAL STUDY**

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**Introduction** Athletes have been widely demonstrated to show superiority in sport-specific information processing. The neural mechanism that characterizes such expert behavior, however, has thus far elusive. Accordingly, we examined event-related potentials (ERPs) elicited during a cueing task involving sport-specific contexts to further address this issue. **Methods** We compared ERP measures associated with cueing attention (i.e., contingent negative variation, CNV) from male racket sport players ( $n = 16$ ; aged  $20.56 \pm 1.82$  years) and male novice controls ( $n = 16$ ; aged  $20.73 \pm 1.50$  years) when they performed the sport-specific cueing task in which racket-sports-related body movements were used to indicate the possible locations of a forthcoming target. **Results** The behavioral findings primarily showed that racket sport players responded faster to targets as compared to novice controls, regardless of cue types. Specifically, we observed that, relative to controls, players exhibited smaller CNV amplitudes at Fz and Cz electrodes, indicating that less attention resources were required for cueing attention in players. **Discussion** These findings suggest that cueing attention may be enhanced via long-term participation in racket sports training. In addition, the ERP results may point to optimal performance with minimal cortical resource consumption when processing sport-specific cues in the players, further supporting the neural efficiency hypothesis in athletes. We thus conclude that the training-induced enhancement in perceptual-cognitive processes (e.g., cueing attention) may contribute to greater efficiency in neural processing.

**ON THE EFFECTIVENESS OF COUNSELING APPROACHES FOR ENHANCING ATHLETIC PERFORMANCE**

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**Introduction** Standard mental training for athletes mainly involves teaching psychological skills without directly dealing with the athlete's personality development. The present author, however, believes that counseling and or psychotherapeutic techniques can be effective not only for personality development but also for enhancing athletic performance. The author has been applying these techniques in his daily practice of psychological support for athletes. In mental training seminars, the author uses a mental training program in which psychotherapeutic techniques are applied together with a few standard psychological skill exercises (Nakagomi, et al., 2006). The present study examines the effectiveness of the counseling techniques for enhancing athletic performance. **Methods** With reference to the author's own consultation cases in which counseling approaches resulted in performance enhancement, the author attempts to elucidate the factors leading to effective counseling. **Results and discussion** The author could identify five characteristics of effective counseling. (1) "Free and protective spaces" in counseling rooms promote self-expression and stimulate the flow of psychological energy in client athletes. (2) Talking about their athletic behavior in front of their counselor helps clarify their problems in relation to competition, and helps create their understandings of and meanings regarding their athletic behavior. (3) Athletes who talk frequently about their bodies and body movements experience a type of image training. (4) The increase in their awareness and intention through counseling will change their athletic attitude and the quality of their training. (5) Psychological problems are recognized in the background of their many performance problems, and thus those problems are treated and resolved through counseling. All five characteristics do not necessarily appear in each successful case, though at least one is always involved. Successive sessions for athletes will change the relative importance of psychological support from teaching psychological skills to counseling, and from then on almost all the sessions will exclusively consist of counseling (Hiraki T. & Nakagomi S., 2009). **References** Hiraki T. and Nakagomi S. (2009) Cooperation between mental training and counseling: A case study of one psychological support involving a shift from mental training to counseling. *Japanese J. of Sport Psychology*, 36-1:23-36. Nakagomi S. et al. (2006) Examining the effectiveness of a mental training program oriented toward the exploration of the athlete's inner world. *Japanese J. of Sport Psychology*, 33-2:19-33. [email address: nakagomi@taiiku.tsukuba.ac.jp]

**PERCEPTION-ACTION COUPLING AND EXPERTISE IN A TRACKING TASK**

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**Introduction** Interceptive actions in sports requires prodigiously and accurate visuomotor coordination (Le Runigo et al., 2010). Consequently, it can be assumed that expertise in such sports can be identify in the ability to couple with accuracy perception and action. In this context, the purpose of this study was to show that expert perception-action coupling can be revealed in an experimental visual-motor tracking (VMT) task if the constraints of this later are high enough for sensory-motor control. **Methods** Three study groups were tested corresponding to their expertise in tennis. The Super-Experts (SE; International level;  $n=13$ ); Experts (E; National-Regional level;  $n=14$ ) and



Non-Experts (NE;  $n=13$ ). Subjects were asked to track a moving ball on a screen with a stylus. The ball could bounce on the side of a square and could have two different accelerations ( $A0: 0 \text{ m/s}^2$ ;  $A1: 0.05 \text{ m/s}^2$ ). We divided each trial in two periods: bounce tracking (BT: tracking at the vicinity of the bounce) and free tracking (FT: tracking without bouncing effect). Then for each period, we analysed temporal variables: reaction time (RT); duration of BT period and kinematic variables: distance to target (DT), Alpha Mean (AM: mean angle between to the ball direction and the cursor direction), average occurrence of DT reducing gaps (DTRG: number of times where participants reduced the distance cursor-target) and average occurrence of AM reducing gaps (AMRG: number of times where participants reduced the angle cursor-target). All data were assessed using an Expertise (SE vs. E vs. NE)  $\times$  Acceleration ( $A0$  vs.  $A1$ )  $\times$  Tracking period (BT vs. FT) analysis ANOVA with mixed-design. A forward stepwise regression with duration of BT period and AMRG as predictors were calculated to evaluate the origin of performance of AM and DT. Results Analysis of DT and AM variables showed a significant main effect for Expertise, Acceleration, and Tracking period. NE demonstrated a greater AM and a longer DT than E and SE ( $p < .05$ ). For temporal variables (RT and BT period), a significant main effect was showed for Expertise and Acceleration. For both indicators of regulation (DTRG and AMRG) a significant effect of Expertise and Tracking period was revealed. NS had a smaller DTRG and AMRG than and SE ( $p < 0.05$ ). The analysis of regression with BT period and AMRG as predictors and AM as dependent variable revealed a significant correlation with  $r = 0.78$ . Discussion As expected, the VMT task discriminate expertise, particularly in the most constraining conditions (BT period and  $A1$  condition). BT duration and AMRG variables differentiate expertise and predict performance in VMT task. This suggests transferable information-movement coupling capacities in this task and that perception-action adaptations can be determinant factors of expertise (Le Runigo et al., 2010). References Le Runigo, C., Benguigui, N., & Bardy, B. G. (2010). Visuo-Motor Delay, Information-Movement Coupling and Expertise in Ball Sport. *Journal of Sports Sciences*, 28, 327-337. Contact maroua.mallek@unicaen.fr

### TRAINING OF ATTENTION IN SPORTS USING HEMOENCEPHALOGRAPHY

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Introduction Attention is a key factor in optimal athletic peak performance and necessary when action control is required. According to Norman and Shallice (1986), the supervisory attentional system (SAS) controls non-routine procedures. Under specific conditions concentration may inhibit peak performance. In such cases automated routines regulated by contention scheduling mechanism are essential to success. This leads to diverse attention patterns depending on movement phases. Our goal is to investigate if near-infrared based HEG (Toomim, 2002) might be an effective method to analyze and train particular attention pattern during various movements. Methods The non-invasive HEG monitors hemodynamic activities in the prefrontal cortex (PFC) by detecting changes of blood oxygenation. Hence describes neuronal activity in PFC (Serra-Sala et al., 2012), which is a particularly important part of the brain to control executive functions such as attention. We used an HEG-system provided by MediTECH company to examine following: (1) Evaluation of reliability of HEG-plots during 7 different movements and conditions (91 athletes) and (2) development of individual HEG-feedback-program with sport specific video sequences. Results The results of our researches have shown individual task-related HEG-plots. During acyclic movements we detected individual differences in the plots. These are reproducible under similar conditions ( $rtt = .804-.893$ ). Attention patterns depend on movement phases, training conditions and situations. Our prototype to demonstrate HEG-feedback program is based on typical pattern of a high performance level in trapshooting. In 14 HEG-feedback-sessions the athlete practiced a movement-related attentional behavior. During feedback session HEG-plots have been optimized and resulted in significant improvement of shooting scores. Additional, we found individual differences during cyclic movement in the HEG-plots, especially in the higher loading increments during ergometry. The reproducibility of the plots was possible ( $rtt = .97$ ) but patterns were depending on mental strategies. Discussion HEG is an analytical measure and feedback option which can be easily applied. The results indicate that athletes can practice a movement-related attention behavior effectively by using HEG-feedback. It helps to toggle between non-routine procedure and subconscious processes. HEG feedback allows analyzing and shaping individual performance to optimize competition results. Further improvements of the program may be attained by simultaneous measurement of HEG and physiological / biomechanical parameters. References Norman D, Shallice T (1986). *Plenum*, 4, 1-18. Serra-Sala M, Timoneda-Gallert C, Pérez-Álvarez F (2012). *J of Neurotherapy*, 16, 183-195. Toomim H (2002). *For the Professional*, 11 (2), 19-21. Contact christine.stucke@ovgu.de

### CAREER PATHS AND POSTRETIREMENT ADJUSTMENT AMONG SPANISH ELITE-ATHLETES

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The study presented by Pallarés, Azocar, Torregrosa, Selva, and Ramis (2011) proposed three types of sport career paths: i) linear: where the athlete gives exclusive dedication to sport; ii) convergent: in which the athlete prioritises the sport career but he/she maintains another activity (i.e., study or work); and iii) parallel: where the athlete places equal importance on the sport career and the alternative activity. Particularly, the available research has been focused on how athletes who follow a "dual career" (DC) are less likely to suffer difficulties regarding their social and labor market integration after their sport career (Tekav, Wylleman, & Cecir Erpic, 2015). Thus, the aims of the present study were to analyze whether the type of career path chosen is related to: i) their academic level, ii) the labor market integration; and iii) the difficulties experienced after the retirement. Methods An adaptation of the Athlete's Retirement Questionnaire (Alfermann, Stambulova & Zemaityte, 2004) was fulfilled by 178 retired athletes ( $n = 109$  male and  $n = 69$  female;  $39 \pm 7$  years). Results Most of the athletes combined the studies and sport while they were at the mastery stage of their sport career, in the convergent (40.1%) or in the parallel (30.5%) way. Only 15.3% of the athletes were focused solely on the sport. The career path was not independent of the gender. More female than male combined studies and sport in a parallel way (39.1% vs. 25.0%) while more male than female followed a DC combined with their work (18.5% vs. 7.2%) or were focused solely on the sport (20.4% vs. 7.2%). Significant differences were found regarding the academic level reached according to the model chosen for male but not for female. The male athletes who followed a career path combining the studies and the sport in a convergent or in a parallel way reached a higher academic level than those who were focused solely on the sport and those who combined working and the sport. In addition, the results showed that 87.0% of the male and 89.9% of the female athletes were employed and no differences were found in the income level of the athletes according to the career path. Neither gender nor career path were related to the difficulties experienced after the retirement. The most important difficulties perceived by the athletes were the financial ( $2.35 \pm 1.43$ ) and social-relationships problems ( $2.18 \pm 1.40$ ). Conclusions The career path followed during the mastery stage does not make a difference in the quality of life after the sport career. The results point out that combining the sports with the studies ensures the achievement of higher education studies for male athletes. However, no income level differences were found after the sport retirement. References Alfermann D, Stambulova N, Zemaityte A. (2004). *Phy of Sport and Exer* 5 (1),



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### CAREER TRANSITIONS AND OCCUPATIONAL WELL-BEING OF WOMEN IN LEADERSHIP: THE CASE OF WOMEN AS SPORTS COACHES

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**Introduction:** The United Kingdom (U.K.) is working to develop the world's leading sports coaching system. However, women currently make up only 28% of the profession and very few reach senior levels. Little is known about why career pathways are gendered or how women coaches' occupational experiences affect their health and well-being. Therefore, the aim of this study was to further understanding of the occupational health and well-being of female sports coaches and to investigate the facilitators of and barriers to their career transitions. **Method:** Following institutional ethical approval, women coaches (n = 162) based in the U.K. volunteered to take part. Each coach completed an online version of A Shortened Stress Evaluation Tool (ASSET; Cartwright & Cooper, 2002). This questionnaire is a valid and reliable measure of job characteristics, organisational commitment, health, and psychological well-being. Descriptive statistics were computed using a Statistical Package for the Social Sciences to provide a broad overview of the data. **Results:** The preliminary analyses demonstrate that 97% of the sample categorised themselves as 'White', 'White Irish', or 'White Other,' that the number of respondents over the age of 55 (n = 6) was dramatically lower than the number of responses from younger coaches (n = 156); and that 67% of the sample was educated to undergraduate degree level or higher. Over half of the sample (53%) was employed as a head coach at the time of completion and 56% of these head coaches were employed on a part-time basis. When compared to the normative data for ASSET, our sample reported above average psychological well-being (M = 27.75, SD = 4.87), sense of purpose (M = 18.72, SD = 4.01), and engagement (M = 19.18, SD = 3.78), and reported less strain on their psychological health (M = 21.06, SD = 6.91). However, the results also demonstrate that the coaches experience poorer work-life balance (M = 13.33, SD = 5.35), job security (M = 14.20, SD = 5.39), and work relationships (M = 18.02, SD = 7.88) than the normative sample. **Conclusions:** The findings suggest that, on average, our sample of women coaches are highly engaged with their role, feel a sense of purpose during their coaching practice, and are psychologically well. The results do, however, suggest that women coaches require better work-life balance, more job security, and more meaningful relationships with their colleagues. These findings provide insight to potential facilitators of and barriers to career progression for women coaches and offer interesting applied implications for national governing bodies (NGBs). In particular, NGBs should pay acute attention to interventions that support women coaches to connect with other coaches and effectively balance their personal and occupational commitments. **References:** Cartwright, S., & Cooper, C. L. (2002). ASSET: Management guide. RobertsonCooper Ltd, UK. Contact: F.Didymus@leedsbeckett.ac.uk

## Mini-Orals

### MO-SH03 Sport Statistics & Analysis: Team Sports

#### THE ACTIVITY PROFILE OF GERMAN ELITE FORWARDS WITH REGARD TO MATCH OUTCOME

CHMURA, P., KONEFAŁ, M., ANDRZEJEWSKI, M., KOWALCZUK, E., MROCZEK, D., MAĆKAŁA, K., KAWCZYŃSKI, A., ROKITA, A., CHMURA, J.

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**Introduction** Optimal physical preparation of elite players has become an inseparable part of professional soccer, especially with regard to the increasing physical demands of modern match-play (Yue et al. 2014). Tracking the performance of players in different positions on the pitch allows us to determine factors affecting a successful match outcome. The aim of the study was to determine the activity profile of soccer forwards with regard to match outcome. **Methods** Physical and technical match performance (PTMP) data were collected from 91 forwards from the German Bundesliga during the 2014/2015 domestic season. 516 individual match observations were made with regard to match outcome: won, drawn, loss. The analysis was carried out using the Impire AG motion analysis system (Tiedemann et al. 2011) with records of all PTMP of players in all 306 Bundesliga matches. 65 players' parameters recorded by the system were examined. **Results** In the won matches the forwards featured significantly higher ( $p \leq 0.05$ ) measures of total covered distance in match-play and distances covered with intensities of 11-14 km/h, 21-24 km/h, and above 24 km/h than in the lost and drawn matches. Similar differences were found in the number and length of sprints and in mean running speed ( $p \leq 0.01$ ). The match motion analysis showed that in won matches the forwards also attained a significantly higher number of ball touches ( $p \leq 0.001$ ), % of accurate passes, and % of won one-on-one plays ( $p \leq 0.05$ ) than in drawn and lost matches. **Discussion** The performance parameters of studied forwards' have a decisive impact on match outcome as their levels are much higher in matches won by the forwards' teams. If a notational analyst or a coach has identified that physical and technical aspects of players' performance are adversely influenced by match outcome, possible causes of this impact can be determined and match preparation can focus on reducing such effects (Nasis et al. 2015). Thus, researchers should include match outcome and playing positions in their explanatory models in order to better understand why physical demands vary throughout the game (Lago 2009). The outcome of a soccer match depends to a great extent on forwards' efficiency, and the results of the present study may be used for advancement of physical and technical preparations of forwards in soccer (Carling 2010). **References** - Yue Z et al (2014). *Int J Sports Sci Coa*, 9 (3): 553-560 - Tiedemann T et al. (2011). *Cent Europ J Oper Re*, 19 (4): 571-587 - Nassis GP et al. (2015). *Br J Sports Med*, 49, 609-13 - Lago C. (2009). *J Sports Sci*, 27(13):1463-9 - Carling C. (2010). *J Sports Sci*, 28: 319-326 Contact pawel.chmura@awf.wroc.pl

**REVEALING PARAMETERS THAT INFLUENCE GAME FLOWS IN FOOTBALL USING JORDAN NETWORK**

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**INTRODUCTION** Sometimes the change of game balance in football games is discussed based on the idea of game flows (Alister et al., 2005), however, the quantitative definition has not been clarified. The aim of this study is reveal features that influences game flow factor by constructing and analyzing the game flow models. **METHODS** We use play-action data and game flow data in this study. The play-action data include time series data such as coordination of the ball, the players who play the ball, the type of the play-actions, (e.g. pass, shoot and dribble) and so on. The game flow data are two dimensional vectors represented advantage of both home teams and away teams. Either zero or one are assigned to each element in the vector, for example, if the home team gains an advantage, and in contrast, the away team loses it, the vector becomes (1, 0) and via versa. In order to construct the game flow models, we chose Jordan neural network. The Jordan network is a class of artificial neural networks whose inputs at the time include one of outputs at the time. Since, in football games, the game flows should be closely related to the prior situation, the Jordan network should be suitable to model game flows. We trained network using the play-action data that have over 900 parameters as the input and the game flow data as the output. Afterwards, we applied the sensitivity analysis to the game flow model and revealed parameters that contribute to the game flows. In our experiments, we constructed the game flow model using data of Urawa Reds' (a club of Japan Professional Football League (J-League)) five games and applied the model to other five games to predict their game flows. Moreover, we applied the sensitivity analysis to the game flow model. **RESULTS** We confirmed that the predicted game flows were well explained in the real game situations. This suggests that the constructed game flow model was relevant to predict game flows in Urawa Reds' games. Sensitivity analysis of the obtained neural network shows the frequencies of Makino and Moriwaki handling the ball in front court varying from 0 to 1 cause the large difference of the values of Urawa Reds game flow around 0.97. This shows Urawa Reds' superiority was influenced on whether Makino and Moriwaki, defenders in Urawa Reds, played at the higher position than other games or not. **DISCUSSION** The frequencies that Makino and Moriwaki played at the higher position precisely represent the frequencies that they contributed Urawa Reds' attacks. Urawa Reds is a team with the highest ball possession rate in J-League and it often makes attacks with many of the players. From these reasons, it was reasonable results that Makino's and Moriwaki's attacks influenced on Urawa Reds' game flow. **REFERENCE** Alistair H, Chris H, Andy C. (2005). Momentum in Soccer. Coachwise **CONTACT** ma15040@shibaura-it.ac.jp

**THE ASSOCIATIONS OF SPIKING TYPES WITH TOTAL SCORES AND SCORING OF SERVE RECEIVE-TO-SPIKE IN VOLLEYBALL GAMES: AN INVESTIGATION INTO THE FINAL EIGHT TEAMS IN 2015 ASIAN MEN'S CLUB VOLLEYBALL CHAMPIONS**

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This study aimed to investigate the relationship across total scores, scoring of serve receive-to-spikes and spiking types in 2015 Asian men's volleyball club. In addition, we also interest in the question which spiking styles (i.e., spiking styles and spiking positions) are mostly related to scoring of spikes. We adopted the game performances of the top eight teams in 2015 Asian Men's Club Volleyball Championship for further analysis. We firstly described the recorded data and subsequently conducted Pearson product-moment correlations address this issue. The results revealed that (1) the positions of spiking styles varied according to the spiking areas. In terms of the front court, the greatest contribution can be attributable to the spiking at position 4 (44.87%), intermediate contribution for the position 3 (24.24%), and smallest contribution for the position 2 (24.24%). For the back court, the greatest contribution can be found for the spiking at the position 1 (8.77%), intermediate contribution for the position 6 (3.02%), and smallest contribution for the position 5 (0.09%). (2) The distribution of spiking types were that: for the front court, the most spiking type was the adjusted high ball spikes at the position 4 (19.72%), and then followed by flat spikes at the position 4 (16.08%), type A quick-set spikes (10.52%) at position 3, and high ball spikes in the position 4 (9.08%). For the back court, the most spiking style was high ball spikes at the position 1 (5.11%), and then followed by tipping spikes in the position 1 (3.66%), and flat spikes at the position 6 (3.02%). Importantly, the correlation analysis suggested that there were significant relations of tipping spiking at the position 1 to the serve receive-to-spikes as well as total spiking scores. Taken together, these results indicated that the major spiking styles for Asian men's volleyball were the position 4 for the front rows and position 1 for the back rows, separately. Furthermore, there were significant association of tipping spiking at the position 1 with the scores of serve receive-to-spikes and total scores. The above evidence suggests that an increase of spiking at the position 1 was mostly related to greater scoring in volleyball games. We thus concluded that, in 2015 Asian Men's Club Volleyball Championship, although the greatest contribution of scoring was the spiking at position 4, the success of winning games may be particularly related to the adoption of spiking strategy at the position 1.

**TACKLE AND RUCK PERFORMANCE IN INTERNATIONAL RUGBY – SOUTHERN HEMISPHERE VS. NORTHERN HEMISPHERE**

HENDRICKS, S.1,2, VAN NIEKERK, T.1, SIN, D.W.1, BROWN, J.1, MAREE, W.3, LAMBERT, M.1

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**Introduction** Rugby union is characterized by frequent contact situations known as the tackle and ruck, where opposing players compete for possession of the ball. Winning contact situations is an essential quality of successful teams. For players to win contact situations, players need to be technically proficient in their ability to execute contact techniques. The majority of contact technique research in rugby union relates to the tackle situation and conducted at the franchise level (for example, Super Rugby). Therefore, the first aim of this study was to investigate tackle and ruck contact performance at International level. At the International level, Southern Hemisphere teams seem to be more successful than Northern Hemisphere teams. However, there is limited work on the differences in contact performance between Southern Hemisphere and Northern Hemisphere teams. Therefore, the second aim of this study was to compare tackle and ruck contact performance between the major Southern Hemisphere and Northern Hemisphere International competitions. **Methods** A total of twenty-seven matches were analysed - 15 matches from the 2014 Championship competition and 12 from the 2014 Six Nations competition - this amounted to 4436 tackle contact situations. From the 4436 tackles, 2920 evolved into a ruck. Contact techniques for the tackle were described using descriptors such as tackle type, tackle direction and post tackle activity. Contact techniques for the ruck were described using descriptors such as the number of players at the ruck, ball placement and ruck activity. The association between the de-

scriptors and contact success (tackle break, offload, possession) was determined using multinomial logistic regression and reported as relative risk ratios (RRR). Results For type of tackle, tackling the ball-carrier by the jersey increases the chances of a tackle break occurring compared to using a shoulder tackle (RRR 2.76, 95% CI 1.40 – 5.41,  $p \leq 0.01$ ). The defensive team was 66% more likely to win possession of the ball at the ruck when committing 3-5 players at the ruck (RRR 0.34, 95% CI 0.19 – 0.64,  $p < 0.001$ ) compared to committing 0-2 players. Offloading after contact occurred more frequently in the Six Nations (20% vs. 12%,  $n=4447$ ), whereas tackle breaks occurred more frequently in the Championship (17% vs. 11%,  $n=4447$ ). Conclusion This study is the first study to describe both tackle and ruck contact techniques associated with success in International rugby. The tackle contact techniques associated contact success are similar to those found in other studies. A distinction between the Championship and Six Nations emerged in how teams continued to play if a ruck is not formed.

## EVALUATING THE QUALITY OF OPPOSITION IN BASKETBALL GAMES BASED ON TOPSIS METHOD

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1: INEF, UPM (SPAIN), 2: SCNU (CHINA), 3: INEF, UPM (SPAIN)

**Introduction** It is an important task to determine the strength of the opposition when assessing performance of basketball teams and players. The aim of this study is to develop an evaluation model to assess the offensive, defensive and overall quality of basketball teams based on the Technique for Order Preference by Similarity to the Ideal Solution (TOPSIS). **Methods** Data were collected from all 612 games played by the 18 participating teams in the 2013-2014 regular season of the Chinese professional basketball league. (i) Using the method of TOPSIS assesses the offensive ability, defensive ability and overall strength of the 18 teams based on 9 attacking-related variables, 4 defending-related variables and all variables together. (ii) Testing the reliability of the order estimated by TOPSIS. This step was achieved by testing the correlation coefficient between the TOPSIS-calculated rank of offensive ability, defensive ability and overall strength and the points scored, points against and final season rank. Results A very likely high correlation ( $r = 0.62$ ;  $\pm 90\%$  confidence interval:  $\pm 0.26$ ) was found between TOPSIS-ranked offensive quality and points scored by teams, and a likely moderate correlation ( $r = 0.47$ ;  $\pm 0.32$ ) was tested between the TOPSIS-ranked defensive strength and point against of teams. While there was also a very likely high relationship ( $r = 0.57$ ;  $\pm 0.29$ ) between the end-of-season ranking and TOPSIS-calculated ranking. **Discussion** Existing studies about the determination of quality of opposition mainly depend on the end-of-season classification, either using a symmetric division or employing a cluster analysis procedure (Gomez, et al., 2013). However, the objectivity of these ways has been doubted, and a more scientific systematic solution is called for (Dadelo et al., 2014). Results of our study demonstrates that TOPSIS method can be regarded as an effective method for assessing the quality of basketball teams (Chen et al., 2014), especially for evaluating offensive ability and overall strength of teams. However, the effectiveness when using this method to evaluate the defensive ability is not ideal, which may be caused by the reliability of the defensive variables (Liu et al., 2013). **References** Chen C C, Lee Y T, Tsai C M. Professional baseball team starting pitcher selection using AHP and TOPSIS methods [J]. INT J PERF ANAL SPOR, 2014, 14(2): 545-563. Dadelo S, Turskis Z, Zavadskas E K, et al. Multi-criteria assessment and ranking system of sport team formation based on objective-measured values of criteria set [J]. EXPERT SYST APPL, 2014, 41(14): 6106-6113. Liu, H., Hopkins, W., Gómez, M. A., & Molinuevo, J. S. (2013). Inter-operator reliability of live football match statistics from OPTA Sportsdata. INT J PERF ANAL SPOR, 13(3), 803-821. Contact zsl195180@outlook.com

## THE ANALYSIS OF WINNING PERCENTAGES AND STRENGTHS DURING TOKYO BIG6 BASEBALL LEAGUE

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Keio University

**Introduction** Tokyo Big6 Baseball League is one of the most famous intercollegiate baseball leagues that features six prominent universities in the Tokyo area. All games are played at the same stadium in Tokyo. The six teams play short seasons in the spring and autumn of each year. Each team plays a short series against each of the five other teams in the league. The series format is similar to a three-game playoff, where the first to two wins is given one point. When a team wins the first two games, the third game is not played. In the case of a tie game, there is a rematch in the next day. The champion of the league is determined by the team with the highest points. When some teams have the same highest point, the champion is determined by the team with a highest winning percentage. When some teams have the same highest point and winning percentage, the champion is determined by a playoff after the end of all the league games. There is a possibility that a team falls to second in the standings despite having the highest winning percentage. The aim of this study was to analyze the results with Bradley-Terry model for paired comparison data (Agresti, 2002) and to compare the strengths of the teams between the highest points and the highest percentage. **Methods** We considered 140 seasons of the Tokyo Big6 Baseball League since 1946. First, we calculated the winning percentages of the 1st and 2nd teams in the standings of each season. Second, we sorted up the seasons of which a team fell to 2nd in the standings despite having the highest winning percentage. Third, in order to estimate strengths of the teams by analyzing the outcomes of each season, we conducted the Bradley-Terry model. We didn't consider home advantages and ties. **Results** There were six seasons of which a team fell to 2nd in the standings despite having the highest winning percentage. In the spring in 1949, the set of winning percentages and strengths (set to zero for the first team) of 1st and 2nd teams from the Bradley-Terry model are respectively (60.0%, 0 and 61.5%, 0.409). In the autumn in 1955, (76.9%, 0 and 81.8%, 0.300); in the spring in 1961, (76.9%, 0 and 81.8%, 0.502); in the spring in 1968, (76.9%, 0 and 81.8%, 0.317); in the autumn in 2009, (61.5%, 0 and 66.7%, -0.01); in the spring in 2013, (71.4%, 0 and 81.8%, -0.178), respectively. **Discussion** In every six seasons we found three facts. First, without the matches between the 1st and the 2nd team, both teams had the same points (three or four). Second, in such cases, the winning percentage of the 2nd team were higher than that of the 1st team. Third, at the matches between the 1st and the 2nd team, the 1st team won against the 2nd team with two wins and one loss. From the result and three facts, the result of the third match between the 1st and the 2nd team may decide the champion regardless of the winning percentage and the strength derived from Bradley-Terry model. **References** Agresti A. (2002). Categorical Data Analysis, 2nd ed. Wiley, New York. Contact TORIUMI, T. [bird@keio.jp]

## PHYSICAL DEMANDS OF MATCH-PLAY IN ELITE ULTIMATE

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**Introduction** Ultimate is an increasingly popular sport, played on a 100 x 37 m grass pitch by two teams of 7 players, whose aim is to score points by passing a 175-g plastic disc (known as Frisbee) to a teammate in the opposite 18-m long end zone of the field (Baccarini & Booth, 2008). Despite Ultimate being played worldwide at high competitive levels since some decades, only recently there has been

some attention to the physical demands of this sport (Krustrup & Mohr, 2015). However, no data are still available from matches played at high competitive level. Therefore, this study aimed to assess a selection of physical performance parameters assessed during competitive match in elite Ultimate players. Methods Twelve male players (age: 23 (5) years; body mass: 68 (8) kg; stature: 175 (9) cm), belonging to three elite teams participating to an international Ultimate tournament were involved. Their playing position was handler (n=4), and cutter (n=8). The players were equipped with a GPS device during a selection of matches played during the examined tournament. The following indices were measured: total distance covered, average speed, number of sprints, and average sprint length. Since the number of points played in a match is highly variable between players, point averages were considered for the analysis. For all parameters, the mean is presented with the 95% confidence interval. Results For handlers, observed averages per point for total distance covered, average speed, number of sprints, and sprint length, were, respectively: 178 (147-208) m, 7.7 (7.1-8.3) km/h, 5 (4-6), and 12.9 (11.2 to 14.7) m. For cutters, the same variables showed the following values: 200 (170-230) m, 8.8 (8.2-9.4) km/h, 6 (5-7), and 16.6 (14.9-18.3) m. Discussion The present findings reveal that the physical effort in Ultimate is characterised by several short repeated sprints, interspersed by rather long recovery times. Moreover, the physical demand seems to be rather affected by the playing position, with cutters showing overall higher running speeds and distances covered. These results provide coaches with relevant information for physical conditioning of elite Ultimate players. Specifically, repeated-sprint ability would seem a key physical capacity for the performance in this sport. Future studies are warranted to assess how the number of points played per game by each player, and the number of games per tournament, affect the physical demands in Ultimate. References Baccarini M, Booth T (2008). Essential Ultimate. Champaign: Human Kinetics Krustrup P, Mohr M (2015). J Strength Cond Res, 29, 3386-3391 Contact rocco.dimichele@unibo.it

## INFORMATION ENTROPY IN THE EVALUATION OF MOVEMENT VARIABILITY IN BASKETBALL SHOOTING

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Introduction The considerable redundancy of the human system leads to the variability in repetitive attempts to accomplish the task demand and its performances usually deviated from normal distribution (Newell et al., 1984). The concept of information entropy (IE) is developed from the information theory of communication where high information entropy is parallel to high levels of variability. Previous studies showed that the IE of movement trajectories decreased when the movement was close to the target in aiming task (e.g., Lai et al., 2005). Nevertheless, most of the previous research that applied IE only to the simple movement task. The purpose of this study was to analyze the movement variability of the multi-joint movement (basketball shooting) using information entropy. Methods The Phase-space system (480 Hz), and two JVC cameras (30 Hz) were used for the experimental setup. Seven participants performed 500 jump shots and only the successful shots were analyzed. Kinematics data of six joints (ankle, A; knee, K; hip, H; shoulder, S; elbow, E and wrist, W) were captured and the shooting movement (from the maximum velocity of the hip to the moment of ball release) was separated equally into 10 phases (10 % of normalized time) for IE calculation. The IE was calculated by the probabilities of the actual frequency distribution for the 10 phases within each joint in movement trajectory. Repeated measure ANOVAs were used to compare IE on 10 phases in different joints. Results The shooting average of 76.5% demonstrated the high basketball skill levels of the participants. Four of the six joints maintained relatively high IEs without any noticeable trend over the 10 phases. The IE of W and E shared another pattern where the minimum IE occurred at middle phases ( $p < .05$ ) and followed by an abrupt increase of IE until right before ball release. At the last phase of ball release, the IE of W and E dropped significantly ( $p < .05$ ). Discussion During the jump shot movement, the forearm that was holding the ball had a moment of pause before the final extension. The pause of the forearm movement led to the decrease of the IEs observed in the elbow and wrist joints around the middle phases. As soon as the forearm extended again after the pause, the IEs from the elbow and wrist joints quickly caught up with IE of the other 4 joints. At the last phase where the ball was released from the hand, IE of most joints had a decreasing trend due to reduced movement of these joints. The change of IEs over the different phases of jump shot movement seems to directly relate to the range of movement. Future studies should compare the IE with different groups (e.g., unskilled player) and also take into account of the individual differences. References Lai, S-C, Mayer-Kress, G, Sosnoff, J, Newell, K. (2005). Acta Psychol, 119, 283-304. Newell, K, Carlton, L, Hancock, P (1984). Psychol Bull, 96, 133-151.

## RELIABILITY AND VALIDITY OF TECHNICAL INDICATORS IN THE ULTIMATE FRISBEE

RUSSOMANNO, T.G., COSTA, F.R., SCREMIN, I., EUZEBIO, M.V., SARTORIO, G., MONEZI, L.A., BURATO, M.A.B., SILVA, B.S., MERCADANTE, L.A.

*UnB Universidade de Brasília*

Introduction Ultimate Frisbee is a young team sport compared to other sports like soccer and rugby. The main difference is that the ultimate Frisbee is a non-contact team field sport played with a flying disc. The sport is ruled by the World Flying Disc Federation that was recognized by the IOC in 2015, making the ultimate Frisbee eligible for including in the Olympic Games. As any other team sport the main objective is to make goals, using basics fundamentals to score. Thus, the aim of this work was to analyze the reliability and validity of technical indicators in the ultimate Frisbee. Methods A survey was applied to 5 experts, that aimed to validate technical indicators for game fundamentals, 4 evaluators used the experts answers to elaborate a protocol of variables to be analyzed and validated. The validation protocol was divided in 2 days. First day, in pairs, the evaluators measured the technical indicators, using the Dvideo system, 5500 frames of a world championship game, using the technical indicators standardized by the experts. The frequency of analyses was 7,5 Hz. The standardized technical indicators were 14, including the basics ones like the pull, pass, diving, assistance and others more specific like the kind of the pass. In the second day, the evaluators individually measured another game of the world championship 2015 to test the reliability and validity. This time they measure 9000 frames. The results of the technical indicators of the 4 evaluators were compared using the Kappa Cohen Test. Results The results shows that during the game analysis we had 4 pulls and 3 goals, the USA team had 38 complete passes, 5 incomplete passes, considering that 27 were backhand and 16 forehand, against the Great Britain that had 30 complete passes, 7 incomplete passes, considering that 21 were backhand, 15 forehand and 1 hammer. The score was 3x0 for USA. The reliability of the observations between evaluators were tested using the Kappa Cohen Test. The test was conducted in pairs for all evaluators and the measurement of agreement was 0.867 ( $\pm 0.031$ ). The interpretation of the kappa value by Altman (1991) shows that values between 0.81-1.00 are considerable almost perfect agreement. Discussion The value of agreement indicates that the technical indicators chosen for this study were very strong to define some variables that can be affected by evaluators subjective measurement in the system. The methodology applied for ultimate Frisbee showed a good reliability and validity to measure technical indicators in this event. The analysis can be performed for a whole game, providing a powerful tool for evaluation of the technical indicators of a match. This kind of data can be used to understand the dynamics of the game and improve the knowledge behind the ultimate Frisbee. Further studies should be conducted to evaluate a whole match. References Cohen, J. (1960). A coefficient of agreement for nominal scales.



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**14:00 - 15:00**

## Mini-Orals

### MO-PM46 Nutrition & Supplements

#### PROTECTIVE EFFECTS OF A TRADITIONAL CHINESE MEDICINE, ANGELICA SINENSIS, ON STRENUOUS EXERCISE-INDUCED SPORTS ANEMIA IN RATS

CHANG, C.W., CHEN, Y.M., HSU, Y.J., HUANG, C.C., WU, Y.T., HSU, M.C.

*Kaohsiung Medical University*

**Introduction** Sports anemia is a persistent and severe problem in athletes and attributed mainly to following factors: (a) mechanical destruction of erythrocytes because of oxidative stress, leading to hemolysis (Bonilla et al., 2005); and (b) upregulation in hepcidin-25 expression, an iron-regulating hormone, resulting in iron deficiency (Kong et al., 2014). Angelica sinensis (AS), a familiar traditional Chinese medicine, has been used since antiquity, and is commonly used in Chinese cuisine. The aim of this study is to evaluate the effects of ethanolic AS extract in a 4-week study on sports anemia in female Wistar rats. **Methods** To induce anemia, a strenuous exercise protocol consisting of running and swimming was employed with increasing intensity. Animals were randomly assigned to the following groups: control group; strenuous exercise group; and strenuous exercise and AS extract-treated group (300 mg/kg/d). After 4 weeks, rats underwent exhaustive swimming and forelimb grip strength test. The blood biochemical markers and hepatic antioxidant activity were determined. Hepatic interleukin-6 was observed through immunohistochemical staining. **Results** AS extract (consisting of ferulic acid, Z-ligustilide, and n-butylidenephthalide at 1.57, 17.78, and 0.43 µg/mg, respectively) treatment improved grip strength and rescued exercise-induced anemia by significantly elevating the red blood cell count and hemoglobin as well as hematocrit levels ( $P < 0.05$ ). Furthermore, serum hepcidin-25 levels decreased by 33.0% ( $P < 0.05$ ), whereas iron levels increased by 34.3% ( $P < 0.01$ ). The hepatic injury markers serum alanine aminotransferase and hepatic interleukin-6 were also attenuated, followed by increased catalase expression in the liver ( $P < 0.05$ ). **Conclusion** Our findings first evidenced a novel and promising therapeutic approach for AS treatment for rescuing the anemic condition induced following 4 weeks of strenuous exercise. Further research on the effects of AS in humans is warranted. **References** Bonilla, J.F., Narváez, R., Chuair, L. (2005). Colombia Médica, 36, 281-286. Kong, W.N., Gao, G., Chang, Y.Z. (2014). Cell & bioscience, 4, 19. Contact (Chang, C.W.) wxes9050304@gmail.com

#### RUTOSIDE AND HYDROLYTIC ENZYMES ENHANCE ANTIOXIDANT CAPACITY AFTER VIGOROUS EXERCISE

GRABS, V., HALLER, B., PRESSLER, A., NIEMAN, D.C., HALLE, M., SCHERR, J.

*Technische Universität München*

**Introduction:** Vigorous and prolonged exercise such as marathon running results in a major increase of oxidative stress. Nutritional supplements, especially polyphenol-rich nutrients, are being tested as countermeasures of exercise-induced oxidative stress. **Methods:** In a prospective randomized, double-blind, placebo-controlled Phase I trial we supplemented healthy male runners ( $N=138$ , age  $42 \pm 11$  y) with rutoside (600-1200 mg/day) and hydrolytic enzymes (540-1,080 mg/day bromelain, 288-576 mg/day trypsin) (WOB) or placebo for one week before and two weeks after the Munich Marathon 2013. Blood samples were collected 5 weeks pre-race, and immediately, 24-h, and 72-h post-race, and analyzed for markers of oxidative stress (myeloperoxidase (MPO), total antioxidant capacity (TAC) and oxidative capacity (TOC) as well as muscular damage (myoglobin, MYO). Mann-Whitney-U test was conducted to compare both groups. **Results:** TAC was significantly higher in WOB compared to placebo 24 hours post-race (median [IQR]: 375 [366-386] µmol/L vs. 369 [347-383] µmol/L,  $p=0.036$ ). No significant group differences were observed 24-h post-race for TOC (WOB: 177 [114-229] vs placebo: 176 [100-247] µmol/L,  $p=0.538$ ), MPO (726 [564-942] vs 671 [580-940] ng/ml,  $p=0.730$ ) or MYO (140 [91-206] vs 144 [86-230] µg/L,  $p=0.790$ ). No significant group differences for TAC, TOC, MPO or MYO were seen at all other blood collection time points (all  $P>0.05$ ). Finishing time (WOB: 3h 49min  $\pm$  36min vs. placebo: 3h 37min  $\pm$  38min  $p=0.066$ ) and maximum oxygen uptake ( $VO_{2max}$ ) (WOB:  $3.79 \pm 0.53$  vs. placebo:  $3.87 \pm 0.54$  L/min,  $p=0.351$ ) did not differ significantly between WOB and placebo groups. Furthermore, higher oxidative stress levels (TOC) were associated with higher marathon finishing times (Pearson correlation coefficient:  $r=0.24$   $p=0.005$ ). **Discussion:** Supplementation with rutoside and hydrolytic enzymes before and after a marathon race enhances post-race antioxidant capacity without influencing oxidative stress. Supplementation also had no effects on endurance performance or muscular damage in this group of non-elite male marathon runners.

#### EFFECTS OF DIFFERENT WEIGHT-LOSS PERIODS ON OXIDATIVE STRESS STATE IN MALE COLLEGIATE WRESTLERS

MIO, N., HIROKI, T., HYEON KI, K., KARINA, A., MI, X., MASAYUKI, K., SHIZUO, S.

*Waseda University*

**Introduction** Generation of reactive oxygen species is the physiological metabolic process of normal cells that is controlled by the antioxidant activity. High concentrations of reactive oxygen species result in damage to DNA, proteins, and lipids, which can cause cell and tissue impairment. Rapid weight loss (RWL) is characterized by transitory weight loss of at least 5% of body weight in less than a week (Khodaei et al. 2015). Rapid weight reduction in wrestlers reduced blood adiponectin level and increased their active oxygen level (Yanagawa et al. 2010). The survey of the All Japan Wrestling Championship tournament players reported that in the actual situation, wrestlers had excessive weight loss in a short period of less than 7 days. Extreme rapid weight loss rapidly increases generation of active oxygen species; thus, homeostasis might not be maintained. In the present study, we investigated the effect of different weight loss periods on the oxidative stress state in young male collegiate wrestlers. **Methods** We studied seven student wrestlers (weight:  $66.8 \pm 8.0$  kg) who needed to lose weight rapidly before competing in a tournament. The experiment was conducted in three periods (7 days, 3 days, and 1



day), with a target of 5% weight loss. Each wrestler's body composition and biochemistry index were measured at three time points, namely before weight loss, at weigh-in, and 12 hours after weigh-in. Results For the serum concentrations for the biological antioxidant potential (BAP) test, 2-factor analysis of variance revealed a significant trial-time interaction ( $p = 0.049$ ). No statistically significant differences in the serum concentrations of diacron-reactive oxygen metabolites were observed between trials ( $p = 0.254$ ). Conclusion The present study demonstrates that as an indicator of antioxidant potential, significant interaction was observed between trials in the BAP test. Khodaei M, Olewinski L, Shadgan B. *Curr Sports Med Rep*. 2015;435-441. Yanagawa Y, Morimura T, Tsunekawa K, et al. *Endocr J*. 2010;57(4):339-345. Contact E-mail: mionishimaki@fuji.waseda.jp

### IRISIN INDUCED BY EXERCISE DO NOT RAISE DIET-INDUCED THERMOGENESIS IN HEALTHY ADULTS.

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**INTRODUCTION** Diet-induced thermogenesis (DIT), is the energy cost required for the digestion and absorption of nutrients during the postprandial period and habitual exercise could modulate it. Irisin is a new protein that is secreted from the muscle into the circulation after acute exercise in mice and humans and induces browning of adipocytes. **METHODS** Nine healthy young volunteers ( $32 \pm 4$  years) participated in two experiments. In the exercise (EX) trial, 40 min of exercise on a bicycle ergometer at 60% of heart rate reserve were performed on the day before the assessment of energy expenditure by indirect calorimetry. Serum irisin levels were examined before and immediately after the exercise. In the no exercise (NOEX) trial EE was assessed without exercise in previous day. Blood concentrations of irisin, glucose and insulin were measured before and after the intake of meal. **RESULTS** Irisin was increased following the 40-min exercise. Glucose level increased during the 1-h period after the dietary intake compared with those at baseline in both trials. Serum irisin levels were higher before and throughout the 3-h period after dietary intake in the EX trial compared with those in the NOEX trial, whereas dietary intake did not affect serum irisin level in either trial. Mean diet induced thermogenesis (DIT) was not different between the trials. **DISCUSSION** The potential thermogenic effect of irisin is still controversial in humans. We found the single bout of exercise did not increase DIT measured on the following day. Whether physical activity increases DIT is also a conflicting issue (Lopez. 2000). Previous reports have demonstrated the correlation between habitual exercise and increased DIT. It may be possible that exercise-enhanced sympathetic activity has a synergistic effect on the thermogenic response to dietary intake (Ohnaka.1998). A single bout of exercise improved insulin sensitivity and that the improvement lasted for 12–48 h (Black. 2005). In this study, postprandial plasma glucose level was not different between the trials, indicating that a single bout of exercise did not influence insulin sensitivity. This may be because the healthy subjects originally presented with good insulin sensitivity. **REFERENCES** Lopez(2000). *American Journal of Physiology Endocrinology and Metabolism*, 3, 601-607 Ohnaka (1998). *Annals of Nutrition and Metabolism*, 42, 311-318 Black(2005). *Journal of Applied Physiology*, 99, 2285-2293 **CONTACT:** Nooshin@med.med.osaka-cu.ac.jp

### PHYSICAL ACTIVITY, USE OF PROTEIN SUPPLEMENT AND DAILY LIFE ROUTINE

YASLI, B., ERTETIK, G., BINGÖL, A., SAHIN, F.N.

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**Purpose:** The purpose of this study is to find out the use of protein supplement, physical activity frequency and daily life routine of people who are regularly attending fitness centers in Ankara, Turkey. **Methods:** A face to face questionnaire was applied to 352 participants. 222 of them are males and 130 females (age; males:  $24.91 \pm 4.93$  females:  $24.77 \pm 4.96$ , height; males:  $1.78 \pm 0.07$  females:  $1.68 \pm 0.07$ , weight; males:  $77.38 \pm 12.80$ , females:  $57.68 \pm 12.87$ ). This questionnaire belongs to University of Palermo's Protein Project, in Italy (<http://www.proteinproject.com/p/board.html>). Data have been collected from regular fitness center attendees in Ankara. Participants are between 16 to 55 years old and none of them were professional bodybuilders. The education level of 41 percent of respondents is high school while 59 have bachelor's degrees or graduate level of study. Accordingly, physical activity frequency and daily life routine were investigated. Additionally, the use of protein supplement and dietary behaviours were examined. **Results:** To the question "What kind of physical activity you are doing?" 65 % of the respondents answered "fitness/resistance training", while other answers included: 6 % group fitness, 5 % individual sports, 4 % team sports. 41 % exercise from six months to two years, 37 percent from two to six months, 14 % two to four years and 7 % 4 years or more. Frequency of protein consumption in the participants is 25.8. 97 of them are male and 3 female. 56 of them use addition supplement to protein consumption, mostly amino-acids and creatin. Furthermore 57 % of Protein supplement users use it between two to six months. Mostly participants take whey protein (95 %). When analyzed the adviser, about protein using 74 % of the respondents answer gym coach. At the end of the part in the questionnaire, respondents answer sitting time question to "in a routine day is 5 to 8 hours is 45". **Conclusion:** Frequency of protein consumption has similarities to other surveys like in Palermo, Italy (Bianco et al, 2011, 2014). Amino-acids and creatin are the supplements most frequently associated with protein consumption. Also in Turkey the Gym's Coach seems to have a key role in providing awareness about protein supplementation, so gym instructors should be educated well about ergogenic aids and supplement use. **References :** Protein supplementation and dietary behaviours of resistance trained men and women attending commercial gyms: a comparative study between the city centre and the suburbs of Palermo, Italy, *Journal of the International Society of Sports Nutrition*, 2014, Protein supplementation in strength and conditioning adepts: knowledge, dietary behavior and practice in Palermo, Italy, *Journal of the International Society of Sports Nutrition*, 2011

### TRAINED ATHLETES TYPICALLY CONSUME WELL ABOVE 1.2 G DIETARY PROTEIN PER DAY

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**BACKGROUND** Habitual dietary protein intake should be optimized in all athletes to ensure proper recovery, enhance the skeletal muscle adaptive response to training and improve muscle reconditioning. Besides daily protein intake, the use of specific protein sources as well as the distribution of protein intake over the day are of relevance to optimize dietary protein intake in athletes. **PURPOSE** To assess daily protein intake, dietary protein sources consumed, and protein intake distribution throughout the day in a large cohort of athletes. **METHODS** 553 well-trained (competitive) athletes (327 men and 226 women) completed multiple web-based 24-h dietary recalls and questionnaires within a 2-4 week period. Total energy consumed (MJ) and the contribution of animal and plant based protein sources to daily protein intake (g) were determined and expressed as a percentage of total protein intake. Daily protein intake was categorized into six

eating moments. RESULTS Daily protein intake averaged  $108 \pm 33$  g ( $1.6 \pm 0.5$  g/kg) in men and  $90 \pm 24$  g ( $1.4 \pm 0.5$  g/kg) in women. Daily protein intake correlated highly with energy intake for strength ( $r=0.72$ ,  $P<0.001$ ), team ( $r=0.77$ ,  $P<0.001$ ) as well as endurance athletes ( $r=0.78$ ,  $P<0.001$ ). Dietary protein intake averaged  $19 \pm 8$  g at breakfast,  $25 \pm 13$  g at lunch and  $38 \pm 15$  g at dinner, contributing together 81% of daily protein intake. The amount of protein per main meal was below the recommended 20 g for 58% of the athletes at breakfast, 36% at lunch and 8% at dinner. Of the total dietary protein intake, 57% originated from animal sources, with meat and dairy as dominant sources. Thus, as much as 43% of the protein intake originated from plant based protein sources, with bread as the principle source. CONCLUSIONS Athletes typically consume well above 1.2 g protein/kg/d with their normal diet. Daily protein intake is mainly (>80%) provided by the three meals, with breakfast and dinner providing  $19 \pm 8$  and  $38 \pm 15$  g protein, respectively. Plant based proteins provide more than 40% of daily protein consumption. Partly supported by a grant from Friesland Campina and Eat2Move, the Netherlands.

## THE EFFECTS OF SIX-WEEK PYRAMID RESISTANCE EXERCISE PROGRAM AND SUPPLEMENTARY NUTRITION ON THE INCREASE IN MAXIMUM STRENGTH OF ELITE WEIGHT LIFTER

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The Effects of Six-Week Pyramid Resistance Exercise Program and Supplementary Nutrition on the Increase in Maximum Strength of Elite Weight Lifter Introduction: The pyramid system is one of the advanced training systems in the field of body building and fitness that used for hypertrophy and muscle mass increase. The goal of this study was to examine the effect of the pyramid system and Consumption of ceratine mono-hydrate and carbohydrate Protein supplements on increasing the muscular strength and 1-repetition maximum. Methodology: for this purpose, 29 of the elite Pressers of Esfahan province (age:  $24.58 \pm 2.12$ , weight:  $87.86 \pm 6.46$ ) were selected randomly and divided into 3 groups of resistance training+ supplementation(RTS N=10), resistance training (RT=10) and control(N=9) groups. 72 hours before the first exercise and 72 hours after the last exercise session they were taken a record for their chest press using 1-repetition maximum. Results: the findings of this study showed that there was a significant difference between the control and RTS group after going through a six-week resistance exercise program. However, there was no difference between the control and RT group ( $P > 0.05$ ) and the level of progress in the RTS group was higher than in the other two groups ( $P < 0.05$ ). Discussion: it seems that the combination of the pyramid system and ceratine supplements and carbohydrate protein mixtures causes an increase in muscular strength and 1RM in elite weight lifters and using pyramid system alone without the consumption of any food supplements has no effect on muscular strength in the elite weight lifters. Key words: Chest Press, Monohydrate Ceratine, Carbo-hydrate Protein, pyramid system Reference 1- Fish DE, Krabak BJ, Johnson-Greene D. Optimal resistance training: comparison of DeLorme with Oxford techniques. American journal of physical medicine & rehabilitation. 2003;82(12):903-9. 2- Ploutz-Snyder LL, Giamis E. Orientation and familiarization to 1RM strength testing in old and young women. The Journal of Strength & Conditioning Research. 2001;15(4):519-23. 3- Zuniga JM, Housh TJ, Camic CL, Hendrix CR, Mielke M, Johnson GO, et al. The effects of creatine monohydrate loading on anaerobic performance and one-repetition maximum strength. The Journal of Strength & Conditioning Research. 2012;26(6):1651-6.

## EFFECTS OF A PALEOLITHIC LIFESTYLE ON COGNITIVE PERFORMANCE AND PHYSIOLOGICAL STRESS

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Introduction A paleolithic lifestyle has gained huge popularity among athletes in the recent decade. This lifestyle is associated with a variety of factors (i.e. caloric restriction, altered circadian rhythm, physical exhaustion) that might induce physiological and psychological stress. It has been further shown that stress can lead to an impaired cognitive performance (CP) [2],[3]. Data indicates that HRV can be used as a non-invasive, practical tool in order to reflect physiological heterostasis [1],[2]. Three main objectives were evaluated. First the effect of a paleolithic movement- and diet pattern on physiological cortisol (COR) levels. Second the potential effect of physiological stress on CP. And third the correlation between COR levels and multiple HRV parameters. Methods A group of hikers ( $n=13$ ; age= $21.9 \pm 3.1$  y) were exposed to the rural area of Lapland including extensive hiking and self-obtainment of nutrients over nine days. Pre- and post testing occurred on d0/d10 (three days prior and post intervention in a 72h window). During d1-d3 the group remained fasted due to insufficient food discovery. During d4-d9 the diet (supplied by local shops) remained hypocaloric and compliant to paleolithic standards. Salivary COR-levels and HRV-markers (SDNN, RMSSD, PNN50, HF/LF) were measured immediately after awakening from d0-d10 every morning. CP was tested midday on d0,d8,d10 including optical and acoustical reaction tests, measuring reaction time, reaction stability and false responses. Results COR increased during intervention ( $d0=11.76 \pm 7.91$ ;  $d8=22.10 \pm 8.09$  nmol/l;  $d10=19.50 \pm 5.20$  nmol/l,  $p=.038$ ). It peaked on d4 ( $28.73 \pm 8.34$  nmol/l,  $p=.000$ ) and slowly levelled off till d10. CP did not change from d0 till d10. Likewise no significant correlation between COR and HRV-markers could be detected. Discussion Physiological stress levels (COR) increased dramatically during an extensive paleo oriented hiking tour. This might be mainly caused by physiological exhaustion and caloric restriction. However there were no considerable changes in CP. The representative role of HRV for stress is currently discussed controversially. Recent studies implied that HRV analysis contains valid parameters, emulating stress levels in order to predict CP [1],[2]. Interestingly our data does not confirm this thesis. HRV-data did not reflect COR adequately. Hence it should be applied with caution in that regard. However the small group size might have account for the lack of significant/representative data. Further studies are recommended. Literature [1] Castaldo, R. et. al. (2015). Biomed Signal Process Control, 18, 370-377. [2] Laborde, S. et al. (2014). Biol Psychol, 100, 34-42. [3] Lautenbach, F. et. al. (2014). Psychoneuroendocrinology, 42, 218-224.

## Mini-Orals

## MO-PM05 Body Composition 2

**EFFECTS OF INTERMITTENT FASTING COMBINED WITH ALKALINE MINERAL SUPPLEMENTATION AND EXERCISE TRAINING ON WEIGHT LOSS - A 12 WEEK PLACEBO-CONTROLLED DOUBLE-BLIND TRIAL WITH OVERWEIGHT SUBJECTS**

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**Introduction:** Intermittent fasting (IF) seems to be a potential strategy for weight loss with good feasibility (Johnstone, 2015). In particular IF combined with exercise suggests to have synergistic effects on weight loss (Bhutani et al., 2013). However, possible effects of an additional supplementation with alkaline minerals on weight loss have not been shown yet. Therefore, the aim of this study was to determine influences on weight loss in exercising overweight subjects with or without IF. Additionally, the influence of alkaline mineral supplementation was tested. **Methods:** 80 overweight subjects, aged  $45.5 \pm 7.8$  years were randomly assigned into two groups following different diet strategies. The intermittent fasting group (IFG) followed an IF program (5:2 method) while the non-intermittent fasting group (nIFG) followed a balanced diet for a period of 12 weeks. In a double-blind placebo-controlled design subjects in both groups took either an alkaline mineral supplement ("verum") (Basica@direkt, Protina Pharm. GmbH) or a placebo twice daily. All subjects performed a personalized endurance training (3-4 times a week). Body weight and body composition were measured with Tanita® BC-545N Segment Body analyzer. Capillary blood samples were analyzed by a blood gas analyzer (profile®, phox®Plus M Analyzer, nova@biomedical, UK) and urine-pH in morning urine with pH-sticks (Macherey-Nagel, Germany). **Results:** Two-way ANOVA showed significant differences in mean weight loss between IFG ( $-7.8 \pm 3.9$  kg) and nIFG ( $-4.8 \pm 3.4$  kg). There was also a significant main effect of alkaline supplementation (verum  $-7.4 \pm 4.1$  and placebo  $-5.2 \pm 3.5$ ) on weight loss ( $p < 0.01$ ). No significant difference was found between dietetic strategy and supplement intake. IFG-verum participants lost  $9.45 \pm 3.68$  kg while IFG-placebo lost  $6.51 \pm 3.49$  kg during the 12 weeks of intervention (independent t-test,  $p = 0.034$ ). The weight loss in nIFG-verum ( $5.7 \pm 3.66$  kg) and nIFG-placebo ( $3.89 \pm 3.13$  kg) differed as well, but did not reach statistical significance ( $p = 0.139$ ). Alkaline supplementation significantly increased  $[HCO_3^-]$  and urinary pH in IFG and nIFG with verum intake as well. **Discussion:** Intermittent fasting and exercise result in a significantly greater weight loss than exercise alone. Alkaline supplementation additionally increased weight loss indicating an influence of acid-base balance on body weight especially in IF. Johnstone A., (2015). *IJO*, 39(5), 727-733, Bhutani S., Klempel, MC., Kroeger, CM., Trepanowski, JF., & Varady, K.A (2013). *Obesity*, 21(7), 1370-1379.

**PUBERTAL STATUS INFLUENCES MECHANICAL EFFICIENCY IN OBESE VS. NON-OBESE CHILDREN AND ADOLESCENTS DURING A CYCLING TEST**

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**Introduction** In the physical activity related fields, mechanical efficiency (ME) is defined as the ratio of work done (W) to energy expended (EE) expressed as a percentage ( $ME = (W/EE) \times 100$ ) (Bassett and Howley, 2000). Studies that examined ME in relation to obesity status have been focused on adult population. Among those few that included children some discrepancies in their results have been found (Jabbour et al., 2013; Butte et al., 2007). Therefore, the aim of this study was to analyze ME at the maximal workload during cycling exercise in children and adolescents according to their body mass index (BMI) status depending on their gender and pubertal development. **Methods** A total of 177 participants (normal-weight-NW  $n=58$ ; overweight-OW  $n=42$ ; obese-OB  $n=78$ ; Cole et al., 2000) aged from 7.5 to 16.8 years old took part in the study (42.7 % boys; BMI from 13.2 to 41.1 kg/m<sup>2</sup>). An incremental exercise test to volitional exhaustion on a cycloergometer (Ergometrics 800, Ergoline, Germany) was carried out in order to assess the VO<sub>2</sub> peak (the highest value averaged each 10 seconds), the maximal workload and calculate the EE at the highest intensity (Garby and Astrup's formula, 1987). Finally, self-assessment of the Tanner test in order to register their pubertal development was performed. **Results** ANOVA test showed a significantly higher ME in pubertal children (Tanner IV-V) in comparison to pre-pubertal children (Tanner I-II) ( $F_{2,175}=5.58$ ,  $p=.004$ :  $17.4 \pm 1.5$  % vs.  $16.1 \pm 2.7$  %, respectively,  $p=.009$ ). In contrast, no differences in the ME between boys and girls, neither among NW, OW and OB were found. Nevertheless, when we analyze the data sorted by pubertal development together with obesity status, NW prepubertal children had a higher ME than OB prepubertal children in ME ( $F_{2,98}=3.37$ ,  $p=.038$ :  $16.8 \pm 3.1$  % vs.  $15.4 \pm 2.1$  %, respectively,  $p=.058$ ). **Discussion** Similar to Jabbour et al. (2013), we did not found different ME values in NW, OW and OB participants. However, when children were split according to their pubertal development, our results highlight that different ME between NW and OB children is present. Further research is needed to confirm the mechanism that could explain these differences in obese vs. non-obese children. **References** Bassett DR Jr, Howley ET.(2000). *Med Sci Sports Exerc*,32(1),70-84. Jabbour G, Lambert M, O'Loughlin J, Tremblay A, Mathieu ME.(2013). *Obesity*,21(1), 107-14. Butte NF, Puyau MR, Vohra FA, Adolph AL, Mehta NR, Zakeri I.(2007). *J Nutr*,137 (12),2660-7. Cole TJ, Bellizzi MC, Flegal KM, Dietz WH.(2000). *BMJ*, 320(7244):1240. Garby L, Astrup A.(1987). *Acta Physiol Scand*,129(3),443-4. Contact: mariax44@hotmail.com

**EFFECTIVENESS OF HIGH INTENSITY INTERVAL TRAINING FOR DECREASING ABDOMINAL FAT MASS IN POSTMENOPAUSAL WOMEN WITH TYPE 2 DIABETES**

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**INTRODUCTION:** Estrogen deficiency favors upper body obesity, including visceral fat mass (FM). The combined effects of type 2 diabetes (T2D) and menopause expose this population to a higher risk of cardiovascular disease (CVD). This study compared the effects of moderate-intensity continuous training (MICT) and high intensity interval training (HIIT) for 16 weeks on abdominal FM in postmenopausal women with T2D. **METHODS:** Seventeen women ( $69 \pm 1$  years; BMI:  $31 \pm 1$  kg/m<sup>2</sup>) were randomly assigned to perform MICT [40-min at 55-60% of HRR] or HIIT [60 x 8s at 77-85% of the estimated HRmax, 12s active recovery] cycling program. Dual-energy x-ray absorptiometry (DXA) was used to measure whole-body and regional FM and fat-free mass (FFM). Total and visceral FM at the level L4-L5 were determined from DXA (Martin and Jensen 1991) and CT-scan (Sottier et al. 2013), respectively. Nutritional intake and physical activity level were established with seven-day self-reports. **RESULTS:** Dietary pattern, physical activity level and total body mass did not vary in both groups. Over-

all, total FM decreased and total FFM increased over the time ( $p < 0.05$ ). Total FM reduction at the end of the training intervention was not significantly different between groups. Loss of total abdominal ( $-8.3\% \pm 2.2$ ) and visceral ( $-24.2\% \pm 7.7$ ) FM were only observed in the HIIT group ( $p < 0.05$ ). The CT-scan confirmed the significant loss of visceral FM at the level L4-L5 in the HIIT group ( $p < 0.05$ ). DISCUSSION: Total abdominal and visceral FM were significantly reduced after HIIT but not with the MICT program. In conclusion, for the first time, we demonstrate that HIIT could be proposed as an alternative training program against central obesity and consequently might be used to counteract CVD risks in postmenopausal women with T2D. REFERENCES: Martin ML, and Jensen MD. Effects of body fat distribution on regional lipolysis in obesity. *Journal of Clinical Investigation*. 1991;88(2):609. Sottier D, Petit J-M, Guieu S, Hamza S, Benhamiche H, Hillon P, Cercueil J-P, Krausé D, and Guieu B. Quantification of the visceral and subcutaneous fat by computed tomography: interobserver correlation of a single slice technique. *Diagnostic and interventional imaging*. 2013;94(9):879-84.

### **SKELTAL MUSCLE MASS INDEX AND BONE MINERAL DENSITY IN A GROUP OF LEBANESE ELDERLY MEN**

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**Introduction:** Muscle mass decreases with age, leading to "sarcopenia" or low muscle mass, in elderly people [1]. The aim of this study was to compare bone mineral density in elderly men with sarcopenia and elderly men with normal skeletal muscle mass index. **Methods:** This study included 15 elderly men (aged between 65 and 84 years) with sarcopenia and 37 age-matched controls (with normal skeletal muscle mass index). Body composition and bone mineral density (BMD) were assessed by dual-energy X-ray absorptiometry (DXA). We used the skeletal muscle mass index (appendicular skeletal mass (ASM)/height<sup>2</sup>) to define sarcopenia as previously described [1]. A skeletal muscle mass index (SMI)  $< 7.26 \text{ kg/m}^2$  was defined as the cut point for sarcopenia [1]. Bone mineral content (BMC) and BMD were measured at whole body (WB), lumbar spine (L1-L4), total hip (TH) and femoral neck (FN). **Results:** Weight, lean mass, fat mass, SMI and body mass index (BMI) were significantly higher in men with normal SMI compared to men with sarcopenia. BMC and BMD values were not significantly different between the two groups. In the whole population, SMI was positively correlated to WB BMC, WB BMD, L1-L4 BMD, TH BMD and FN BMD. **Conclusion:** This study suggests that SMI is a positive determinant of bone mineral content and bone mineral density in elderly men. **References:** [1] Baumgartner RN, Koehler KM, Gallagher D, Romero L, Heymsfield SB, Ross RR, Garry PJ, Lindeman RD. Epidemiology of sarcopenia among the elderly in New Mexico. *Am J Epidemiol*. 1998 Apr 15;147(8):755-63.

### **MEASURED AND PREDICTED RESTING METABOLIC RATE IN ADOLESCENT SYNCHRONIZED SWIMMERS.**

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**Introduction** The use of predictive equations is the most viable method for basal metabolic rate (BMR) estimation in both general population and athletes, as equations are easy to apply and costless. However, several authors have shown that equations can be imprecise and can under- or over-estimate BMR, especially when they are applied in high-level athletes or in ethnic groups that differ from the original studies that validated such equations. For this reason the use of indirect calorimetry (IC) is preferable to measure BMR in athletes (Moreira da Rocha et al., 2005). The aim of this study was to evaluate BMR in adolescent practicing synchronized swimming using two methods: IC and two of most recommended equations by the Italian Nutrition Society. **Methods** 13 elite synchronized swimmers (age  $15 \pm 1.0$  years, Body Mass Index  $21 \pm 2.4$ , Fat Mass  $26.7 \pm 8.4\%$ ) took part in the study. BMR was measured after an overnight fast and athletes were instructed to abstain from physical activity for twelve hours before the BMR assessment. During the IC session, oxygen uptake (VO<sub>2</sub>) and carbon dioxide production (VCO<sub>2</sub>) were measured breath by breath by means of a gas analyzer (MedGraphics Breeze, St. Paul, MN) calibrated immediately before each test. With the patient supine and awake, VO<sub>2</sub> and VCO<sub>2</sub> were obtained for 30 minutes. The first 10 minutes of registration were excluded from calculation. BMR was calculated also using two equations: the Schofield' (SCH) and the Harris Benedict' (HB). BMR obtained with the three methods were compared by means of the one-way analysis of variance. Moreover, the Bland and Altman (1986) plot was carried out to estimate agreement among methods. **Results** The two equations systematically underestimated BMR as compared to IC (HB= $1380.0 \pm 71.9$  and SCH= $1377.0 \pm 71.1$  vs. IC= $1542.5 \pm 241.5 \text{ kcal/day}$ ,  $p > 0.01$ ). The Bland and Altman statistics showed that the 95% limits of agreement were within  $+558.7$  and  $-233.5 \text{ kcal/day}$  (IC-HB) and  $+569.0$  and  $-238.0 \text{ kcal/day}$  (IC-SCH). **Discussion** Coaches and athletes need to be aware of limits related to the use of equations for estimating BMR in adolescent synchronized swimmers. Probably, the BMR underestimation is related to a higher free fat mass percentage in our sample with respect to the reference population of control adolescents. **References** Bland JM, Altman DG. (1986). *Lancet*, 1, 307-310. Moreira da Rocha EE, Alves VGF, Silva MHN, Chiesa CA, Da Fonseca RBV. (2005). *Curr Opin Clin Nutr Metab Care*, 8, 319-328. Contact: annalisa.digiaco88@gmail.com

### **THE EFFECTS OF AEROBIC EXERCISE TRAINING ON PLASMA AMINO ACID CONCENTRATIONS IN OVERWEIGHT AND OBESE MEN**

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**Introduction** The plasma amino acid concentrations predict various disorders (e.g., cancer, liver disease and hypertension). The high plasma concentrations of valine, leucine, isoleucine, tyrosine and phenylalanine have been identified as strong predictors for type 2 diabetes mellitus, which are independent of insulin resistance measures. Obesity, a major risk factor for type 2 diabetes mellitus, is related to these increased plasma amino acid concentrations. Previous studies have shown that aerobic exercise training improves insulin resistance in overweight and obese individuals. However, the effects of aerobic exercise training on plasma concentrations of valine, leucine, isoleucine, tyrosine and phenylalanine have not been clarified yet. The purpose of the present study was to investigate the effects of aerobic exercise training on the plasma amino acid concentrations in overweight and obese men. **Methods** Thirty-five overweight and obese men completed the 12-week aerobic exercise training. The subjects participated in aerobic exercise classes for up to 90 minutes/day, 1-3 times /week for 12 weeks. The exercise program includes 10-15 minutes warm-up session, 40-60 minutes walking and/or jogging session and 15-20 minutes cool-down session. In addition, participants were instructed not to change their dietary habits. Anthropometric measures, homeostasis model assessment of insulin resistance (HOMA-IR) and plasma concentrations of amino acid were evaluated before and after the intervention. **Results** After the 12-week aerobic exercise training, the number of steps increased significantly, whole body mass, body mass index, waist circumference and HOMA-IR decreased significantly. The plasma concentrations



of valine, leucine, isoleucine, tyrosine, and phenylalanine significantly decreased after the program. Discussion In the present study, the plasma concentrations of valine, leucine, isoleucine, tyrosine and phenylalanine significantly decreased after the 12-week aerobic exercise training in overweight and obese men. Additionally, similar to the previous studies, HOMA-IR significantly decreased after the program. We firstly suggest that the 12-week aerobic exercise training in overweight and obese men has anti-diabetic effects through not only the improvement of insulin resistance, but the decreases in the plasma amino acid concentrations.

## Mini-Orals

### MO-PM11 ESSA-ECSS Exchange (Cardiovascular)

#### CARDIOMETABOLIC BENEFITS OF MODERATE-TO-HIGH INTENSITY INTERVAL TRAINING COMPARED TO TRADITIONAL TRAINING MODALITIES

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**Introduction** High-intensity interval training (HIIT) may be a time efficient strategy compared with traditional endurance (END) and resistance (RES) training for inducing cardiometabolic adaptations. Most HIIT protocols incorporate maximal or supramaximal repeated sprints which require a high level of conditioning and are difficult to undertake, especially for the lesser trained. A moderate-to-high intensity interval training programme (MO-HIIT) is a modification, which incorporates longer, less intense intervals. It is unknown if MO-HIIT confers similar adaptations to cardiometabolic and psychosocial health as traditional training. **Methods** Participants were matched for baseline VO<sub>2</sub>peak and assigned (n=9 per group) to either a non-exercise control (CON) or one of three, 6-wk supervised training modalities (3 sessions per week). 1) MO-HIIT: 28-min cycle ergometer protocol involving 5 x 2-min intervals at 80%, 88% and 97% PPO (wks 1-2, 3-4 and 5-6) interspersed with 2-min recovery (50W); 2) END: 55-min protocol involving 45 minutes of continuous cycling at 55%, 61% and 67% PPO (wks 1-2, 3-4 and 5-6) plus 10-min warm up and recovery; or 3) RES: 55-min gym-based training involving 8 exercises; 3 sets at ~80% 1RM. Pre- and post-intervention measures were: a direct VO<sub>2</sub>peak estimation, oral glucose tolerance test (OGTT), safety rates, participant adherence and experience measured using Profile of Mood State (POMS). **Results** Thirty-six males (VO<sub>2</sub>peak; 36.9 ± 7.2 ml/kg/min) were recruited. For MO-HIIT, VO<sub>2</sub>peak increased 15.4% (d: 5.3; 95% CI, 2.9 to 7.8 ml/kg/min; P=0.001), and in the END group, VO<sub>2</sub>peak increased 9.4% (d: 3.5; 95% CI, 2.0 to 5.0 ml/kg/min; P=0.001), with no differences between conditions (P=0.46). In RES, there was a non-significant increase in VO<sub>2</sub>peak (3.6%; d: 1.4; -1.0 to 3.8 ml/kg/min; P=0.21) and in CON, VO<sub>2</sub>peak remained unchanged (0.7% increase; d: 0.2; -1.4 to 1.8 ml/kg/min; P=0.73). Following OGTT, blood [glucose] decreased in RES (14.9%; d: -1.0; -1.7 to -0.3 mmol/L; P=0.01), with no differences in the other groups (P>0.05). Exercise adherence was >95%, with no differences between conditions (P=0.29). No participant withdrew from a training group due to safety. The POMS indicated RES and END improved mood pre-post exercise, MO-HIIT resulted in reductions in mood. **Discussion** Our MO-HIIT protocol provided similar cardiometabolic adaptations as a traditional END programme, in half the training time. Therefore, MO-HIIT may be a more time-efficient strategy which offers similar levels of safety and adherence. Further research is required in wider cohorts including women, sedentary groups, and the elderly. Contact d.gleadall-siddall@hull.ac.uk

#### ESSA-ECSS EXCHANGE: ECCENTRIC EXERCISE IN PATIENTS WITH CHRONIC HEART FAILURE

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**Introduction:** Patients with chronic heart failure (CHF) exhibit profound levels of exercise intolerance and impaired aerobic capacity (VO<sub>2</sub>peak), with implications for clinical outcome. Exercise training improves VO<sub>2</sub>peak, and consequent prognosis, but prescription is challenging, as exercise performed at workloads sufficient to induce adaptation can be associated with significant cardiovascular burden and disease exacerbation. In healthy populations, eccentric (ECC) exercise can be performed at a lower O<sub>2</sub> demand, compared to concentric (CON) at matched workloads. ECC exercise therefore potentially represents a clinically relevant alternative to conventional CON exercise for CHF patients, but there is a paucity of research pertaining to this. We hypothesised that, when matched for external workload, an ECC exercise bout would be performed at a lower VO<sub>2</sub> than CON in CHF patients. **Methods:** Seven CHF patients (6 males) with impaired left systolic function (EF: 35±7%) completed a cycle VO<sub>2</sub>peak test, with subsequent ECC and CON cycling protocols set to 70% of individual maximal power. VO<sub>2</sub>peak, respiratory exchange ratio (RER), minute ventilation (VE), heart rate (HR), rate pressure product (RPP) and mean arterial pressure (MAP) were compared between the ECC and CON exercise conditions. **Results:** Results indicated that ECC was performed at 15% lower VO<sub>2</sub> (11.3±1.3 vs 13.3±1.6 ml.kg<sup>-1</sup>.min<sup>-1</sup>, P<0.01), lower RER (0.86±0.03 vs 0.90±0.04, P<0.01) and VE (31.9±4.1 vs 34.6±5.2 L/min, P=0.05) compared to CON, despite closely matched workloads (Watts). RPP (11,903±847 vs 10,884±311 bpm.mmHg<sup>-1</sup>, P=0.23) and MAP (91±0.1 vs 89±1.6 mmHg, P=0.32) were similar between conditions. **Discussion:** Achieving a similar exercise workload, with a significantly lower oxygen demand, is a clinically relevant and novel finding for CHF patients who are characterised by dyspnoea and poor exercise tolerance. Results also indicated that MAP and RPP were similar between conditions, an important finding confirming that ECC exercise can be performed with a similar haemodynamic burden to CON exercise in CHF patients. The corollary of these findings is that at a matched %VO<sub>2</sub>peak, higher workloads can be performed during ECC than CON. Attaining greater stimulus at the muscle to induce peripheral adaptations, without a concomitant rise in haemodynamic burden, suggests that ECC exercise represents a new and promising paradigm for cardiac rehabilitation in severely deconditioned humans. Contact: lauren.mckeown@research.uwa.edu.au

#### CARDIOPULMONARY RESUSCITATION CHARACTERIZATION: IS IT DIFFERENT FOLLOWING A 100M RUN?

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CARDIOPULMONARY RESUSCITATION CHARACTERIZATION: IS IT DIFFERENT FOLLOWING A 100m RUN? Sousa, A.1, 2, Rodrvaguez, N. 3, Fernandes, R.J.1,2, Abrales, J.A. 1, 4 1: CIFI2D, Faculty of Sport (University of Porto, Portugal); 2: LABIOMEPE (University of Porto, Portugal); 3:



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**Introduction** The quality of cardiopulmonary resuscitation (CPR) is a crucial determinant of outcome following cardiac arrest (Adelborg et al., 2011). Traditionally, the CPR is not performed by the rescuer in resting conditions, but after an intense run towards the victim. This could lead to differences in the quality of the inflations for the victim, who requires an optimal quality of oxygen. The cardiopulmonary characterization of the CPR in these two distinct conditions has not been investigated, still being unknown the effect of 100m running on subsequent CPR.

**Methods** Sixteen male highly trained health emergencies technicians (mean  $\pm$  SD; age:  $25.9 \pm 6.1$  yrs, height:  $177.5 \pm 5.5$  cm and body mass:  $76.7 \pm 9.4$  kg) performed two experiments (both on a manikin): (i) 4 min CPR preceded by 3min baseline and (ii) 4min CPR preceded by a 100m maximal run. CPR was performed according to the European Resuscitation Council 2005 guidelines (Handley et al., 2005). Cardiopulmonary parameters were assessed breath by breath (averaged 10s) using a portable and telemetric gas analyser (K4b2, Cosmed, Italy) and their peak values (VO<sub>2</sub>peak and HRpeak) determined as the higher values during the 4min CPR exercises.

**Results** When preceded by 3min baseline, VO<sub>2</sub> and HR kinetics evidenced a fast exponential increase in the first seconds of exercise followed by a slow increase towards the end of the exercise. When CPR was preceded by 100m maximal run, the kinetics of both parameters evidenced the opposite trend (exponential decrease). The mean ( $\pm$ SD) values for VO<sub>2</sub>peak and HRpeak were:  $25.3 \pm 4.8$  vs  $41.1 \pm 5.5$  ml.kg<sup>-1</sup>.min<sup>-1</sup> ( $P < 0.001$ ) and  $125.5 \pm 9.3$  vs  $168.1 \pm 12.1$  bpm ( $P < 0.001$ ) when preceded by 3min baseline and 100m maximal run, respectively. The 100m maximal run induced an increase of  $\sim 64$  and  $\sim 35\%$  in VO<sub>2</sub>peak and HRpeak, respectively.

**Discussion** Results indicate that performing a previous 100m maximal run induces changes in the kinetics of VO<sub>2</sub> and HR, as well as significant increases in their peak values during 4min CPR. This data highlights the importance of a fatigue state when conducting CPR that should be considered as an effective training stimulus when technicians in health emergencies perform this maneuver, ensuring a high quality of the inflations for the victim.

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### THE EFFECT OF SPORT ON COMPUTERIZED ELECTROCARDIOGRAM ST AND J AMPLITUDE IN AMATEUR ATHLETES\*

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**Introduction** The addition of the electrocardiogram (ECG) to the pre-participation examination (PPE) of athletes has been a topic for debate. Defining the ECG difference among sports modalities is crucial to help initiate its implementation in the PPE. In addition, ECG early repolarization (ST and J-point elevation) was associated with reduced overall survival and an increased risk for arrhythmic death (Tikkanen et al., 2009). Thus, we endeavored to provide more insight on the influence of sports modalities on ST and J-point amplitude in amateur athletes.

**Methods** Computerized 12-lead ECGs were obtained in 131 male athletes (mean age  $24.2 \pm 3.5$  years) and 48 matched sedentary male controls (mean age  $24.5 \pm 2.7$  years) with a normal cardiovascular physical examination and without family and personal history of heart disease. Athletes were engaged in 9 different sports and were grouped into 4 categories: long-distance running, football/basketball/handball, judo/karate/taekwondo/boxing and dragon boat. The analysis focused on ST segment and J-point voltages of ECG 12 leads. Results ANOVA analysis yielded significant ST segment and J-point amplitude differences among sports in V3, V4, V5 and V6 ( $p < 0.05$ ). Specifically, The highest ST segment and J-point amplitude were found in long-distance runners and the shortest ones were found in players of judo/karate/taekwondo/boxing (V3-V6) and/or controls (V5). No significant amplitude differences among sports were found in ST segment and J-point in other leads ( $p > 0.05$ ).

**Discussion** This study was intended to provide a set of amateur athlete data to validate the implementation of the ECG in the amateur athletic PPE. The present study showed that the differences in ST and J amplitude in amateur athletes are strongly associated with sports modalities. This suggests that sports-specific criteria for abnormal ECG findings are necessary to facilitate a more effective approach to the ECG screening in amateur athletes. Establishing the different parameters set for various sports modalities ECG would help to reduce false positives. Our data can help facilitate the development of a more large scale and in-depth ECG analysis for screening amateur athletes in the future.

\*The study was supported by a research grant from Macao Polytechnic Institute (RP/ESEFD-01/2012).

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### STRENGTH AND FLEXIBILITY IS IMPAIRED IN CHILDREN AND ADOLESCENTS WITH CONGENITAL HEART DISEASE

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**Introduction:** While the mortality rate of children with congenital heart disease (CHD) has decreased it's becoming more important to observe long-term outcomes. In fact, many studies have shown that an adapted level of activity for children, adolescents and adults with CHD is safe and beneficial. Cardiovascular, muscular, functional and psychological benefits were reported. Nevertheless, many of these young patients tend to be inactive [1]. The aim of this study is to evaluate strength and flexibility, as important factors for a healthy development.

**Methods:** 425 children (aged 6-18 years) with CHD were recruited during their follow-up appointment at the German Heart Centre Munich from July 2014 until February 2016. All patients were assigned to one of the following diagnostic subgroups: Aortic Coarctation/Aortic Stenosis (CoA/AS n=100), Tetralogy of Fallot/Pulmonic Stenosis (ToF/PS n=65), Atrial Septal Defect/Ventricular Septal Defect/Atrioventricular Septal Defect (Shunts n=115), Transposition of the Great Arteries (TGA n=50) and Univentricular Heart (UVH n=65). All patients ( $12.6 \pm 3.3$  years, 161 female) performed five motoric tests. Strength was tested by the number of completed Curl-Ups (abdominal strength) and Push Ups (upper body strength). Further three flexibility tests were performed: trunk lift, sit and reach (determining hamstrings) and shoulder stretch. Patients' data were compared to 1018 healthy children ( $11.9 \pm 2.6$  years, 534 female). A multivariate regression model was calculated to control sex and age. Results: Compared to healthy controls, children and adolescents with CHD had deficits in motor development, even after correction for sex and age. In average they performed less than seven Curl-Ups ( $p < .001$ ), showed lower trunk strength/flexibility ( $B = -7.3$ cm;  $p < .001$ ), shoulder flexibility ( $B = -4.5$ cm;  $p < .001$ ) and hamstring flexibility ( $B = -4.4$ cm;  $p < .001$ ). According to Push-Ups, there were no differences. In-between the diagnostic subgroups, there were no differences found in strength tests. Trunk ( $B = 1.9$ cm;  $p = .046$ ) and shoulder flexibility ( $B = 2.2$ cm;  $p = .044$ ) was better in CoA/AS patients, while patients with UVH showed less shoulder flexibility ( $B = -2.7$ cm;  $p = .027$ ).

**Conclusion:** Nowadays, cardiologists explicitly recommend an active lifestyle for children with CHD, but the patients still have deficits in strength and flexibility. For these young people it is important to evaluate motor skills in routine examinations, to give individualized recommendations for a healthy development.

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**THE EFFECT OF SPORT ON COMPUTERIZED ELECTROCARDIOGRAM QRS AMPLITUDE IN AMATEUR ATHLETES\***

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1: MPI (Macao, China). 2: UMAC (Macao, China). Introduction Intensive sport training is associated with physiologic cardiac remodeling, which are reflected on the electrocardiogram (ECG) most frequently as an increase of QRS voltages (Corrado et al., 2010). Because of the partial overlap of ECG signs of cardiac hypertrophy, athlete's heart is often in the differential diagnosis with hypertrophic cardiomyopathy, which is the leading cause of sports-related cardiac arrest in young athletes. Though the criteria for abnormal QRS amplitude, requiring additional testing, have been recommended for pre-participation exams of athletes, the criteria have not considered the sport in which athletes participate. Therefore, we examined the effect of sports modalities on the computerized ECG QRS amplitude obtained in amateur athletes. Methods Computerized 12-lead ECGs were obtained in 131 male athletes (mean age  $24.2 \pm 3.5$  years) and 48 matched sedentary male controls (mean age  $24.5 \pm 2.7$  years) with a normal cardiovascular physical examination and without family and personal history of heart disease. Athletes were engaged in 9 different sports and were grouped into 4 categories: long-distance running, football/basketball/handball, judo/karate/taekwondo/boxing and dragon boat. The analysis focused on QRS voltages (R and S wave) of ECG 12 leads. Results ANOVA analysis yielded significant R wave amplitude differences between sports only in V2, V3, V4 and V5 ( $p < 0.05$ ). Specifically, The highest R was found in long-distance runners and the shortest one was found in gymnasts (V2, V4 and V5) or controls (V3). No significant amplitude differences among sports were found in S wave in all 12 leads ( $p > 0.05$ ). Discussion This descriptive study, which shows that R wave amplitude differences exist between sports, is a pioneering step toward the development of sport-specific criteria for abnormal ECG findings. The recognition of the existence of differences in ECG measurements between sports opens the door for further research which should link these ECG changes with structural cardiac changes. Although the significance of these differences in R wave amplitude between sports are not known, it is important to bear in mind the existence of these differences when testing athletes. Therefore, sport-specific ECG criteria for abnormal ECG findings should be developed to obtain a more useful approach to ECG screening in athletes. \*The study was supported by a research grant from Macao Polytechnic Institute (RP/ESE FD-02/2012). References Corrado D, Pelliccia A, Heidbuchel H (2010). Eur Heart J, 31,243–59. Contact qdshi@ipm.edu.mo

**INFLUENCE OF MATURATION ON MUSCLE DAMAGE AND ARTERIAL STIFFENING AFTER ELBOW FLEXOR ECCENTRIC EXERCISE**

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Introduction The magnitude of muscle damage after eccentric exercise of the elbow flexors (EF) is significantly smaller for boys than adult men, and for pre-adolescent than adolescent (1). However, it is not known whether this is also the case for women. The present study compared changes in indirect muscle damage markers after EF eccentric exercise among pre-adolescent, adolescent and post-adolescent women. This study also compared changes in carotid-femoral pulse-wave velocity (cfPWV) after EF eccentric exercise among the three age groups, since it is not known whether an increase in arterial stiffness after eccentric exercise (2) is affected by age and the magnitude of muscle damage. Methods Thirteen healthy untrained girls (9-10 y), teens (14-15 y) and adults ( $\geq 20$  y) performed two bouts (EC1, EC2) of 30 submaximal EF eccentric contractions using a dumbbell set at 60% of pre-exercise maximal voluntary isometric contraction strength at 90° elbow flexion with their non-dominant arms (3.6-14.3 kg) separated by 2 weeks. Several indirectly markers of muscle damage [e.g. maximal voluntary concentric contraction torque (MVC-CON), muscle soreness, plasma creatine kinase activity] and cfPWV were measured before to 5 days after each exercise. Results MVC-CON and cfPWV before EC1 were different ( $P < 0.05$ ) among the girls (MVC-CON:  $10.0 \pm 0.7$  Nm; cfPWV:  $903 \pm 106$  cm/s), teens ( $14.3 \pm 0.5$  Nm,  $967 \pm 108$  cm/s) and adults ( $19.1 \pm 1.0$  Nm,  $1103 \pm 115$  cm/s). Changes in all muscle damage variables after EC1 were smaller ( $P < 0.05$ ) for girls and teens than adults, and for girls than teens. After EC2, changes in all muscle damage variables were smaller ( $P < 0.05$ ) than those after EC1 for all groups, but the magnitude of the changes was the same order as that after EC1. Significant increases in cfPWV (peaked 2-3 days post-exercise) were evident for teens and adults, and the magnitude of the increase was smaller ( $P < 0.05$ ) for teens (EC1: 10%, EC2: 2%) than adults (20%, 7%). Discussion These results show that the magnitude of muscle damage after eccentric exercise is less for younger than older women, confirming the findings of the previous study in men (1). The increase in cfPWV appears to be related to the magnitude of muscle damage; the greater the damage, the greater the increase in arterial stiffness. It is concluded that the extent of muscle damage and arterial stiffness changes after unaccustomed eccentric exercise increases with maturation. The less effect of eccentric exercise on the variables seen for children especially for girls may be due to their greater flexibility of muscles. References 1) Chen et al. (2014) EJAP, 114, 1183-95. 2) Barnes et al. (2010) JAP, 109, 1102-8.

**THE EFFECT OF SWIMMING ON CARDIAC MITOCHONDRIA FUNCTION OF ADRIAMYCIN INDUCED CHRONIC HEART FAILURE RATS**

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Introduction Exercise intervention has been widely applied in clinical rehabilitation of chronic heart failure (CHF) patients, however, the effect of swimming on cardiac mitochondria function of CHF rats is rarely. Methods 9 weeks aged male SD rats were randomly divided into ADR group and control group (C). ADR were IP by 2,3,3,3,2 mg per kg body weight every 6 days for 5 times respectively. After that rats were divided again into 4 groups: group C, ADR, FEE (begin swimming after 5th IP) and FEL (begin swimming at 4th week after 5th IP). Rats swim 1 time/day and 6 days/week for 6 weeks (15min/time in 1st week, and gradually increased to 25min/time in another two weeks, and to 35min / times in 4th weeks lasting for another two weeks. 6 rats in each group were killed in 3th, 6th, 9th weekend after 48 hours of last swimming. Rats' ECG and Ventricular blood flow index were acquired by iwox214 system. Myocardial mitochondria membrane potential (MMP) were measured by fluorescence spectrophotometer and flow cytometry, metabolic enzyme by semi-automatic biochemical analyzer. Results After 6W the rats' ECG appeared apparent irregular waveform, T-wave inversion, overlapping waves, etc. On LVEDP, FEE and FEL were lower 41.7% ( $p < 0.01$ ) and 18.4% ( $p < 0.05$ ) than ADR group in 6W, FEL lower 25.6% ( $p < 0.05$ ) in 9W. On  $+dp/dt_{max}$ , FEE were 146.2% and 140.1% of ADR group ( $p < 0.01$ ) in 3W and 6W respectively, FEL were 146.8% and 118% ( $p < 0.05$ ) of the ADR group in 6W, 9W respectively. Compared to ADR group, myocardial mitochondrial  $Na^+K^+-ATPase$  activity in FEE were 3 times and 2.3 times respectively, and FEL were 2.2 times and 19.4% ( $p < 0.05$ ). On myocardial mitochondrial  $Ca^{2+}-ATPase$  activity, FEE were 1.12 times and 3.2 times ( $p < 0.01$ ) of ADR group. On myocardial mitochondrial  $Ca^{2+}-Mg^{2+}-ATPase$  activity, FEE were 1.4 times and 3.4 times ( $p$

<0.01) of those in ADR group while FEL were 2 times and 1.7 times ( $p < 0.05$ ). On myocardial mitochondrial  $Mg^{2+}$ -ATPase activity, FEE were 1.2 times and 2.6 times ( $p < 0.01$ ) of those in ADR group while FEL were 1.9 times of ADR group in 6W and 9W respectively. The myocardial mitochondrial MMP by flow cytometry in ADR Group were 83%, 40% and 56.7% ( $p < 0.01$ ) respectively. Compared to ADR group, those in FEE were 1.2 times and 1.9 times, and FEL were 2 times ( $p < 0.01$ ) and 1.4 times, respectively. Discussion Cardiac mitochondrial  $Na^+$   $K^+$ -ATPase,  $Ca^{2+}$ -ATPase,  $Ca^{2+}$ - $Mg^{2+}$ -ATPase,  $Mg^{2+}$ -ATPase activity in CHF rat decline in varying degrees, which can be hampered by exercise intervention (Ahmed and El-Maraghy 2013), and early exercise intervention may be better than late intervention. Early and late exercise intervention are conducive to prevent the decline of MMP in myocardial mitochondria (Montaigne, Marechal et al. 2011), then protect mitochondrial membrane integrity. References Ahmed, L. A. and S. A. El-Maraghy (2013). Biochemical Pharmacology 86(9): 1301-1310. Montaigne, D., et al. (2011). Mitochondrion 11(1): 22-26. Contact zhiguan1980@163.com. The study was supported by Guangdong province natural science fund (No.S2012040006742).

## Mini-Orals

### MO-PM10 Fatigue

#### REOXYGENATION EFFECTS AFTER PERIPHERAL FATIGUE INDUCED BY ELECTROSTIMULATION WITH OXYGEN DEPRIVATION

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**INTRODUCTION:** Peripheral fatigue is defined as a failure in the muscle contractile mechanism or a decrease in muscle contraction amplitude. Neuromuscular electrostimulation (NMES) combined with oxygen deprivation can induce muscle fatigue and impair muscle mechanical properties. The aim of this study was to investigate the kinetics of muscular contractile properties during recovery after a fatigue protocol induced by NMES. **METHODS:** Nine physically active men were recruited for this experiment (age:  $23.0 \pm 3.7$  years, height:  $178.1 \pm 5.8$  cm, body mass:  $71.9 \pm 3.9$  kg). One leg was randomly selected to apply a NMES fatigue protocol with oxygen deprivation. The motor point of the vastus medialis was determined and electrodes were placed to apply the NMES fatigue protocol and to conduct TMG measurements (Dm: maximum displacement; Td: delay time; Tc: contraction time). The NMES fatigue protocol consisted of 5 cycles of 72 seconds (1s contraction/1s recovery), with a total of 36 contractions per cycle at a frequency of 40Hz. Intensity was set at individual tolerable limit. Rest between cycles was 40 seconds. A cuff was placed on the leg at groin level and inflated to 300 mmHg for 5 minutes before NMES started, to reduce muscle oxygenation considerably, until the end of fatigue protocol. Immediately after the end of fatigue protocol, the cuff was deflated and muscle recovery started. Measurements of TMG were taken at baseline (PRE), at the end of the fatigue protocol (FAT) and every minute for 10 minutes during recovery (RECn). Muscle oxygen saturation was monitored on the vastus lateralis during the experiment. **RESULTS:** Mean oxygen saturation was  $66.0 \pm 5.7\%$  at PRE,  $1.6 \pm 1.6\%$  at FAT,  $50.24 \pm 7.1\%$  at REC1,  $75.2 \pm 6.2\%$  at REC2 and from minute 3 to 10 it was restored to basal levels ( $67.0 \pm 8.0\%$ ). Dm was approximately 45% lower after FAT compared to PRE ( $4.31 \pm 1.99$  mm vs  $7.89 \pm 1.39$  mm,  $P < 0.001$ ), and Td was significantly higher in FAT compared to PRE ( $33.55 \pm 9.7$  ms vs  $22.29 \pm 1.3$  ms,  $P < 0.05$ ). During recovery Dm was significantly lower in REC1 ( $3.89 \pm 1.84$  mm,  $P < 0.001$ ), REC2 ( $4.99 \pm 2.12$  mm,  $P < 0.001$ ), REC3 ( $5.93 \pm 2.62$  mm,  $P < 0.05$ ) and REC4 ( $6.35 \pm 2.69$  mm,  $P = 0.064$ ) compared to PRE. However, Td was only significantly higher in REC1 and REC2 compared to PRE ( $25.00 \pm 2.08$  ms and  $23.76 \pm 1.82$  ms, respectively,  $P < 0.05$ ). Tc did not change significantly. **CONCLUSION:** Dm started to increase when the blood circulation was restored. This suggests a progressive muscle fiber activation and increasing muscle contraction amplitude. Furthermore, muscle contractile amplitude was restored to PRE level after 5 minutes of recovery. However, muscle response time (Td) returned to baseline values after three minutes of reoxygenation. This data suggest that the recovery of muscle excitability is faster than the recovery of muscle contractile amplitude. On the other hand, oxygen appears to be the main mediator of the recovery of muscle contractile properties. CONTACT: jcalleherrero@gmail.com

#### MENTAL FATIGUE DOES NOT IMPAIR EXERCISE PERFORMANCE IN TRAINED AND UNTRAINED INDIVIDUALS

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**Introduction:** Mental fatigue has been associated with a decrement in physical performance in sedentary individuals (Marcora, Staiano, & Manning, 2009) but the impact of mental fatigue on performance in trained athletes, who may exhibit greater mental toughness, has not been investigated. The aim of this study was to compare the effect of mental fatigue on exercise performance in trained and untrained individuals. **Methods:** Following ethical approval, 10 untrained (UNT) ( $VO_{2max}$   $38.9 \pm 7.3$  ml·kg<sup>-1</sup>·min<sup>-1</sup>) and 10 trained (TR) ( $VO_{2max}$   $58.3 \pm 4.1$  ml·kg<sup>-1</sup>·min<sup>-1</sup>) men performed in a randomised crossover design a 6-min cycling time trial (TT) immediately following a 30-min period of mentally demanding cognitive tasks (MF) and after watching a 30-min documentary film (CON). Heart rate (HR) was measured throughout testing and a positive and negative affect schedule questionnaire was administered at baseline, post MF or CON task and post exercise. **Results:** During the cognitive functioning tasks the UNT group had an elevated HR during the MF condition compared to the CON condition (MF  $75 \pm 9$ , CON  $69 \pm 7$  bpm) ( $P < 0.05$ ), but there was no difference in the TR group (MF  $59 \pm 6$ , CON  $58 \pm 7$  bpm) ( $P > 0.05$ ). In the TR group, positive mood was decreased during both MF and CON (Baseline: MF  $33.4 \pm 9.1$ , CON  $33.4 \pm 10.7$ , Post: MF  $25.7 \pm 9.9$ , CON  $28.5 \pm 12.0$ ) ( $P < 0.05$ ) and they had a greater negative mood ( $P < 0.05$ ) post MF ( $15.10 \pm 3.7$ ) than after CON ( $12.2 \pm 2.7$ ). The UNT group experienced a lower positive mood post MF compared to post CON condition (MF  $19.9 \pm 7.5$ , CON  $24.3 \pm 4.6$ ) ( $P < 0.05$ ). TT performance was not different between MF and CON in UNT (MF  $75.1 \pm 11.0$ , CON  $73.9 \pm 12.2$  kJ) or TR (MF  $102.7 \pm 12.1$ , CON  $101.8 \pm 12.2$  kJ) ( $P > 0.05$ ). **Discussion:** Both the TR and UNT individuals exhibited a negative mood profile after the MF intervention compared to the CON intervention. Consistent with past research using the same methods, the intervention to induce mental fatigue was effective in this study. The UNT individuals manifest an elevated HR after the MF intervention whilst the TR individuals did not. However, despite a greater mental fatigue in MF than CON, the physiological responses during exercise and exercise performance were not different between the MF and CON interventions in either TR or UNT individuals. These findings challenge the notion that mental fatigue prior to exercise compromises exercise performance. References: Marcora, S. M., Staiano, W., & Manning, V. (2009). Mental fatigue impairs physical performance in humans. J Appl Physiol (1985), 106(3), 857-864.

## EFFECTS OF COMBINED RECOVERY INTERVENTION ON MATCH CHARACTERISTICS, PHYSIOLOGICAL LOAD AND MARKERS OF FATIGUE DURING A MALE SINGLES TENNIS TOURNAMENT

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**Introduction** A survey of national and international elite tennis players showed that especially a combination of active recovery (AR), stretching (S), cold-water immersion (CWI) and massage (M) appears to be most popular among athletes to improve recovery following tennis training and competition. However, scientific evidence of the efficiency of combined recovery intervention is limited. Therefore, the aim of this study was to assess the effects of a combined use of the aforementioned recovery strategies on match characteristics, physiological variables and performance during a singles tennis tournament. **Methods** In a crossover design nine male tennis players (age:  $24.1 \pm 4.6$  years) with a national ranking position were divided into two groups. During a first five-day clay-court tennis tournament, group A received a combined recovery intervention (CRI) that consisted of AR, S, CWI and M, followed by no recovery intervention (passive recovery, PR) for a second five-day clay-court tournament. Group B did not receive a recovery intervention during the first tournament and received the CRI during the second contest. Match characteristics were determined by filming each competitive match with video cameras. Blood lactate concentration (LAC), heart rate (HR) and rating of perceived exertion (RPE) were recorded during each match. In addition, markers of fatigue (countermovement jump height, CMJ; serum concentration of creatine kinase, CK; delayed onset muscle soreness, DOMS) were measured 24 h before, during as well as 24, 48 and 72 h after the tournament. **Results** No significant intervention  $\times$  time interactions ( $p=0.29-0.86$ ) were found for markers of fatigue. DOMS and CK significantly ( $p<0.05$ ) elevated during the tournament peaking after the 3rd and 4th match and returning to baseline values 48 h after the tournament. Mean LAC [ $2.26 \pm 0.78$  vs.  $2.45 \pm 0.94$  mmol $\cdot$ l $^{-1}$ ] (data in brackets are presented as CRI vs. PR) and HR [ $142 \pm 13$  vs.  $146 \pm 14$  b $\cdot$ min $^{-1}$ ] as well as RPE values [ $5.3 \pm 0.9$  vs.  $5.1 \pm 1.4$  (i.e., hard)] and match characteristics [i.e., total net running distance ( $2526 \pm 1061$  vs.  $2558 \pm 1068$  m), number of sprints ( $98 \pm 51$  vs.  $119 \pm 68$ ), total distance that has been covered sprinting ( $273 \pm 139$  vs.  $321 \pm 158$  m), total points won, percentage of first serves, number of aces, double faults, errors, and winners] were not significantly different ( $p=0.24-0.92$ ) between conditions. **Discussion** The results suggest that a five-day tennis tournament induces significant changes in markers of fatigue. This is in line with previous research showing increased muscle damage and soreness following a tennis tournament (Ojala & Häkkinen, 2013). Furthermore, the main finding of the study was that a CRI as applied in our study is not able to contribute to a faster recovery during and after a tennis tournament compared to PR and does not affect both match performance variables and physiological responses associated with match play. **References** Ojala, T. & Häkkinen, K. (2013). *J Sports Sci Med*, 12, 240-248

## ADOPTING AN EXTERNAL FOCUS OF ATTENTION ALTERS PROCESSING WITHIN THE PRIMARY MOTOR CORTEX AND REDUCES FATIGUE

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**Introduction** Although it is well established that an external focus (EF) contrasted to an internal (IF) or neutral focus of attention enhances motor performance and learning, little is known about the neural mechanisms underlying these behavioral improvements. This study aimed to i) clarify whether the focus of attention influences the motor performance when executing identical fatiguing tasks of the first dorsal interosseus muscle (FDI) and ii) outline differences in activity of M1. Subthreshold transcranial magnetic stimulation (subTMS) was used to inhibit ongoing motor cortical output without affecting spinal structures [1]. Thus, differences in subTMS-induced EMG suppression between EF and IF indicate distinct activity of M1. **Methods** In session 1, 14 subjects (22-33y; 8 men) performed an isometric index finger abduction at 30% MVC until task failure with either an IF or EF. In a separate session 2, the same task was performed with the other focus. The subTMS protocol comparing the activity of M1 during EF and IF was measured in session 3, but only 10 of the 14 subjects could be used for the final analysis. To prevent the effect of fatigue on the amount of subTMS-evoked EMG suppression, the same motor task as in sessions 1 and 2 was performed, but only at 10% MVC. EMG suppression in FDI was calculated as the difference in the area below the rectified EMG with and without subTMS (cumulative trapezoidal numerical integration). **Results** The time to task failure was significantly prolonged in EF compared to IF ( $p = 0.01$ ). When regarding the background EMG activity, no significant effect of conditions (EF vs. IF) was found. SubTMS resulted in a significantly larger suppression of EMG activity in EF compared to IF ( $p = 0.001$ ). **Discussion** Adopting an EF resulted in a prolonged time to task failure. This was accompanied by a different activity within M1, manifesting in a larger subTMS-induced EMG suppression. As levels of background EMG activity did not differ between EF and IF, we argue that the focus of attention was the dominant modulatory influence on EMG suppression induced by subTMS. From this perspective, the larger inhibition of the ongoing EMG activity suggests that the activity within M1 was greater in the EF condition. In line with the present data, a previous fMRI study has shown an enhanced level of activity within M1 when adopting an EF [2]. As this previous study used a between-subject design, the present within-subject study shows for the first time that the activity within M1 is modulated depending on the type of focus of attention. **References** 1. Davey et al. (1994). *J Physiol*, 477(2), 223-235. 2. Zentgraf et al. (2009). *J Mot Behav*, 41(6), 535-541. Contact yves-alain.kuhn@unifr.ch

## INCREASED FATIGUE AND FATIGABILITY IN PATIENTS WITH MILD TRAUMATIC BRAIN INJURY

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**Introduction** Fatigue is a disabling symptom for patients with mild traumatic brain injury (MTBI), and can persist for several months post-injury. One model suggests that fatigue is mediated by two dimensions (Kluger et al., 2013): perceptions of fatigability comprise factors influencing fatigue perception by the individual, and performance fatigability refers to impaired task performance. **Methods** Fatigue was quantified in 16 MTBI- and 16 age- and sex-matched control participants using the Fatigue Severity Scale (FSS, Krupp et al., 1989). Performance fatigability was assessed using a fatiguing muscle task. Force recordings were obtained during brief and sustained (2 minute) maximum voluntary contractions (MVC) of the right first dorsal interosseous muscle (index finger abduction). Changes in cortical activation during the sustained MVC were measured using functional MRI (fMRI) and compared between MTBI- and control groups. For the fMRI analysis 10 additional control participants were included. **Results** MTBI reported higher FSS scores (MTBI:  $5.2 \pm 0.9$ , control:  $2.8 \pm 1.1$ ,  $p<0.01$ ). Maximal index finger abduction force was not significantly different for MTBI- and control participants ( $36.0 \pm 7.4$  vs.  $37.4 \pm 9.2$  N,  $p=0.64$ ). Force decline, corrected for MVC, was greater in MTBI ( $61.5 \pm 9.3$  vs.  $56.0 \pm 10.8$  % decline,  $p<0.01$ ) and was positively associated with the FSS scores ( $R=0.45$ ,  $p=0.012$ ). During the sustained MVC, fMRI analysis revealed similar patterns of cortical activation in both



groups including: contra- and ipsilateral sensory-motor cortex, ipsilateral cerebellum, and supplementary motor cortex (cluster activation,  $P < 0.05$ , family-wise error corrected). Over the course of the contraction, control participants showed a significant increase in activity in frontal (left superior and middle frontal gyrus;  $p < 0.001$ , uncorrected) and medial areas (bilateral paracentral lobules;  $p < 0.001$ , uncorrected). This increase in frontal activity was not observed in MTBI participants; and a significant difference in activation over time was observed between groups in these areas ( $p < 0.001$ , uncorrected). Discussion Increased fatigue (FSS) and performance fatigability were observed in MTBI participants. Overall, performance fatigability was positively associated with FSS scores. fMRI data showed no change in cortical motor activity between the groups suggesting no major differences in cortical drive. However, MTBI participants were unable to increase activation of frontal and medial areas similar to control participants. This change could reflect differences in the integration of effort- or attention related input. References Kluger BM, Krupp LB, Enoka RM (2013) *Neurology*, 22;80(4), 409-416. Krupp LB, LaRocca NG, Muir-Nash J, Steinberg AD (1989) *Arch Neurol*, 46(10), 1121-1123. r.f.prak@umcg.nl

## WHAT IS THE BEST METHOD TO EVALUATE MUSCLE FATIGUE? AN EXAMINATION STUDY FOR MEAN POWER FREQUENCY, LACTATE AND CREATINE KINASE

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Introduction Muscle fatigue is generally defined as an activity induced loss of the ability to produce force with the muscle In the previous studies, different variables were used to evaluate the effects of fatigue mean power frequency (MPF), Lactate and creatine kinase (CK) separately. Therefore the purpose of this study was to investigate the relationship between Mean power frequency, Lactate and creatine kinase for lower extremity muscle during 60s continuous jump with bent legs. Methods Nine male college (age=18.2  $\pm$  0.8 y; height=179.4  $\pm$  2.9 cm; mass=85.2  $\pm$  14.5 kg). A Bertec force plate (500Hz) and (Megawin ME 6000 wireless system, Mega Electronics Ltd., Finland) for data collection. Quadriceps Rectus femoris (RF), vastus lateralis (VL), vastus medialis (VM) and biceps femoris (BF) were selected. Root mean square (RMS) used to rectify the signal and the area under signal was calculated for each muscle to determine the percent of contribution on the performance (work/loading) and mean power frequency (MPF) to determine the slope of fatigue. The subjects performed a 15-min warm-up and each player performed two trials of continuous vertical jump for 60s (VJ) Results Lactate result show positive significant relationship ( $p < 0.01$ ) with vastus medialis (VM). CK show an inverse significant relationship ( $p < 0.01$ ) with RF and positive significant relationship ( $p < 0.05$ ) with VL and BF. Also there was a significant relationship between CK and Rectus femoris (RF) ( $p < 0.05$ ) and no significant relationship between other parameters. Discussion This study showed that no significant relationship between lactate and MPF and this is agreed with the results of other studies (Jansen, et al., 1997; J. T. Viitasalo, Luhtanen, Rahkila, & Rusko, 1985), but no significant change in MPF during repeated measurements. Although we can predict muscle fatigue from MPF unless there was a relationship between the changes in blood lactate and MP. According to our study and other studies for general there no significant correlation between lactate and CK with MPF but there were a significant correlation between CK and muscle activation during the test. The big standard deviation of MPF for some muscles may not found significant relationship. Because it depends on the indication of the slope line values and this is a different between the subjects for each muscle. In the present study CK and work / loading are high correlate and this is lead us to use these parameter to evaluate muscle fatigue References Jansen, R., Ament, W., Verkerke, G. J., & Hof, A. L. (1997). Median power frequency of the surface electromyogram and blood lactate concentration in incremental cycle ergometry. *Eur J Appl Physiol European Journal of Applied Physiology and Occupational Physiology*, 75(2), 102-108. Contact dr.mansour.ataallah@alexu.edu.eg

## EXERCISE-INDUCED FATIGUE IN SEVERE HYPOXIA IS ATTENUATED IN HEALTHY HUMANS FOLLOWING AN INTERMITTENT HYPOXIC PROTOCOL

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Introduction Severe, acute hypoxia leads to an increased development of supraspinal fatigue during whole body exercise (1). This is alleviated following acclimatisation to severe altitude (2), although the development of peripheral fatigue is not (3). Prolonged exposure to severe altitude involves substantial logistical demand, a high incidence of acute mountain sickness and immunological consequences. We assessed the mechanisms of exercise-induced fatigue in severe hypoxia before and after a protocol of intermittent hypoxic exposure and training. Methods Nineteen recreationally-active males performed constant-load cycling trials (186 $\pm$ 12W) in normobaric hypoxia (FIO<sub>2</sub> 0.115) before and after an intermittent hypoxic protocol (IH, FIO<sub>2</sub> 0.115, n=11) or control protocol in normoxia (FIO<sub>2</sub> 0.21, n=8). Groups completed ten 2 hr exposures over 14 days. Seven sessions involved cycling for 30min at 77 $\pm$ 5W in IH, and at the same relative heart rate in control. Total haemoglobin mass (THbmass) was assessed before and after IH and control using the optimised carbon monoxide re-breathing technique. Peripheral haemoglobin saturation, cerebral oxygenation and blood velocity in the left middle cerebral artery were measured throughout trials. Before and immediately after trials, responses to transcranial magnetic stimulation and femoral nerve stimulation were obtained to assess corticospinal and neuromuscular function, respectively. Results Constant-load cycling performance was improved following IH (535 $\pm$ 213 vs. 713 $\pm$ 271,  $p < 0.05$ ), but not in control. At task failure during baseline cycling trials, maximum voluntary force (MVC), potentiated twitch force (Q<sub>tw,pot</sub>) and cortical voluntary activation (CVA) for the knee extensors were reduced ( $p < 0.05$ ) in both groups. The reductions in these measures were the same at task failure after IH and control ( $p > 0.05$ ). However, following an isotime trial in the IH group, the reductions in MVC, Q<sub>tw,pot</sub> and CVA were attenuated ( $p < 0.05$ ). There were no differences in THbmass in IH or control ( $p > 0.05$ ). Discussion Exercise-induced supraspinal fatigue, as quantified via changes in cortical voluntary activation, was alleviated after an intermittent hypoxic protocol in comparison to exacerbated levels in acute hypoxia. IH also attenuated the substantial impact of hypoxia on the development of peripheral fatigue. These novel data suggest that improvements in exercise performance in severe hypoxia after IH might, in part, be explained by an attenuated development of both central and peripheral fatigue. References (1)Goodall et al (2012). *J Physiol*, 590(11), 2767–82. (2)Goodall et al (2014). *Acta Physiol*, 210(4), 875–88. (3)Amann et al (2013). *J Appl Physiol*, 115(5), 634–42. Contact R.C.Twomey@Brighton.ac.uk



**CEREBRAL BLOOD FLOW AND OXYGENATION DURING SPRINT EXERCISE AT TASK FAILURE: ROLE OF METABOREFLEX**

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**Introduction** During sprint exercise pulmonary ventilation (VE) is dramatically increased, likely due to a strong activation of the central command. Consequently, the arterial CO<sub>2</sub> pressure is reduced what may cause lower cerebral blood flow (CBF) and oxygenation. When the sprint exercise is performed immediately after task failure, the PaCO<sub>2</sub> at the start of the sprint is even lower. Since metaboreflex activation increases VE, it could contribute to further reduce CBF and oxygenation. Thus, the aim of this study was to determine the effects of metaboreflex activation on CBF and oxygenation during sprint exercise. **Methods** Eleven young men (age: 23±3 yr; weight: VO<sub>2</sub>max: 3.6±0.5 L/min, mean±SD) were studied on different days. NIRS optodes were used to measure frontal lobe oxygenation (FLO) and vastus lateralis oxygenation (VLO), and Doppler probes to assess bilaterally middle cerebral arteries velocities (MCAv). After warm-up, subjects performed a 10s isokinetic all-out sprint at 80 RPM (control sprint), followed by an incremental exercise test to exhaustion. At exhaustion, the circulation was occluded bilaterally (300 mmHg, Hokanson) during either 10 or 60 s. At the end of the occlusion the cuff was released at the same time the subjects performed another 10s isokinetic sprint. The same experiments were repeated without occlusion during the 10 and 60 s recovery periods. **Results** MCAv was reduced during the control sprints from 47.8±8.1 to 40.8±6.2 cm/s (P<0.05), FLO from 64±5 to 61.8±5.3% (P<0.05) and VLD from 73±5 to 56±6%. During sprint exercise at task failure MCAv and FLO were even lower, with this effect being more marked after the 60s recovery, coinciding with a lower PETCO<sub>2</sub> than during control sprints (P<0.05). Ischemic recovery prevented the reduction of MCAv. Sprint performance was reduced at task failure, but was higher after 60s of ischemic recovery than after 10s of ischemic recovery (P<0.05). However, greater recovery of performance was observed after 60s of open circulation recovery despite lower MCAv and similar FLO. **Discussion and conclusion** This study shows a reduction of CBF during sprint exercise and a small but significant reduction of frontal lobe brain oxygenation. This effect may be prevented by the application of ischemia at the end of and incremental exercise to exhaustion, despite greater reduction of PETCO<sub>2</sub> during the sprints after Ischemia. These findings suggest that task failure is not caused by a reduction of CBF or FLO. Moreover, ischemic recovery helps to maintain CBF despite a marked reduction of PETCO<sub>2</sub>. Thus, the metaboreflex contributes to maintain CBF close to exhaustion. *Granted by Cátedra Real Madrid-Univ Europea de Madrid (2015/04RM).*

**AN ACUTE BOUT OF COLD STRESS INCREASES CEREBRAL AUTOREGULATION IN HEALTHY INDIVIDUALS**

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**Introduction:** Sufficient continuous cerebral blood flow (CBF) is imperative for appropriate neural function and is controlled via (i) blood (perfusion) pressure (BP), (ii) cerebral autoregulation (ability of the brain to control its flow independently of changes in BP) and (iii) local changes in carbon dioxide (CO<sub>2</sub>) levels. Cold exposure increases CBF and may have favourable benefits on the maintenance of CBF under conditions that jeopardise/attenuate it, e.g., orthostatic stress (Wilson et al., 2002). Despite the seemingly beneficial effects of cold stress on CBF, our aim was to investigate if the underlying control mechanisms of CBF (cerebral autoregulation and CO<sub>2</sub> reactivity) are altered by an acute bout of cold stress. We hypothesised that a bout of cold stress would increase cerebral autoregulation. **Methods:** Following sample size estimation, CBF was quantified in the middle cerebral artery (MCA; Transcranial Doppler) in 12 individuals (32±16 yrs). Cerebral reactivity to CO<sub>2</sub> (rebreathing gas concentration of 5% CO<sub>2</sub>) and cerebral autoregulation (manipulations of BP with squat-stand manoeuvres at 6 and 12 Hz.min<sup>-1</sup>) were assessed while wearing a tube-lined suit perfused with 34°C water (thermoneutral) and with 12°C water to induce whole body skin surface cooling (cold). MCAv, end tidal partial pressure of CO<sub>2</sub> (PETCO<sub>2</sub>), BP (Finometer) and skin (T<sub>sk</sub>) and core temperatures (T<sub>c</sub>) were measured throughout. CBF and BP during the squat-stand manoeuvres were analysed using transfer function analysis in the high, low and very low frequencies for gain, phase and coherence. Data were analysed using paired t-tests and presented as mean±SD. **Results:** T<sub>sk</sub> was reduced by 5.5±1.4°C (P≤0.001) and T<sub>c</sub> was unchanged following skin surface cooling. Basal MCAv did not differ, PETCO<sub>2</sub> was lower (thermoneutral 38.6±2.6 vs cold: 37.7±4.7 mmHg P=0.05) and MAP higher (thermoneutral 82±5 vs cold: 87±5 mmHg; P=0.002) following cooling. At 6 Hz.min<sup>-1</sup> squat-stands coherence between MCAv and MAP in the low frequency domain was lower following cooling (thermoneutral: 0.84±0.07 vs cold: 0.75±0.10, P=0.02). At 12 Hz.min<sup>-1</sup> squat-stands phase was higher in the high frequency domain following cooling (thermoneutral: 105.2±12.7 vs cold: 114.8±10.9°, P=0.05). Coherence was also lower in the very low and high frequency domains following cooling (P=0.04). There were negligible differences in the MCAv CO<sub>2</sub> reactivity following cooling (thermoneutral: r=0.84±0.10 vs cold: r=0.76±0.23; P=0.11). **Conclusion:** These novel findings indicate that an acute bout of cold stress enhances the brain's ability to autoregulate, thus maintain its own flow independent of BP. Cold exposure could possibly be used as a strategy to improve autoregulation in individuals with impaired cerebrovascular function. Wilson TE et al. 2002. JAP, 93, 85

**Mini-Orals****MO-PM03 Ageing 1****MUSCULAR ACTIVIN RECEPTOR IIB EXPRESSION IS ASSOCIATED WITH DYNAPENIA, AGE AND BODY MASS**

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**Introduction** During the ageing process strength and power decline more rapidly than muscle mass, whereby this decline is defined as 'dynapenia' [1]. Nevertheless, muscle mass is one of the main determinants of strength [2]. Therefore, many studies focused on the influence of hypertrophy and atrophy signals on muscle mass, but there is a lack of knowledge how these signals relate to the loss of muscle strength. The aim of this study was to investigate whether key members of the TGF-beta superfamily (activin A, activin receptor IIB (ActRIIB), growth differentiation factor-15 (GDF-15), myostatin), follistatin and Insulin-like growth factor-1 (IGF-1) differ between older women with or without signs of dynapenia. **Methods** In this cross sectional study, 38 women (69-92 years) were categorized into non- (n=9), mild (n=17) and severe (n=12) dynapenic groups based on cut-off levels for isokinetic peak torque of knee extension (PTE) as described previously [3].

Biopsies from m. vastus lateralis were obtained in a resting state. Total RNA was isolated by standardized procedures and mRNA of activin A, myostatin, GDF-15, ActRIIB, IGF-1 and follistatin were quantified by real-time RT-PCR using GAPDH for normalisation. In addition, body composition was determined by bioimpedance analysis. Differences between groups were detected by ANOVA followed by post-hoc analysis with Bonferroni correction. Results Severe dynapenic women were older ( $p=0.004$ , +8 years) and had lower body mass ( $p=0.003$ , -20 %) than non-dynapenic women. Most interestingly, ActRIIB expression was higher in severe ( $p=0.002$ , +88 %) and mild dynapenic ( $p=0.023$ , +76 %) as compared to non-dynapenic participants. Furthermore, ActRIIB mRNA expression significantly correlated positively with age ( $p=0.535$ ,  $p=0.001$ ) but negatively with PTE ( $p=-0.485$ ,  $p=0.002$ ), handgrip strength ( $p=-0.603$ ,  $p<0.001$ ), muscle mass ( $p=-0.375$ ,  $p=0.020$ ) and fat mass ( $p=-0.379$ ,  $p=0.019$ ). None of the other parameters were influenced by strength level. Discussion The findings from this study suggest that the loss of muscle strength during the ageing process is associated with changes in ActRIIB. Besides inducing atrophy signals, ActRIIB regulates key determinants of muscle energy metabolism endowing skeletal muscle with high oxidative capacity and low fatigability [4]. As both, endurance and strength are important for healthy ageing there is an urgent need to have a closer look on ActRIIB signaling in this context. References [1] Barry & Carson (2004) J Gerontol A Biol Sci Med Sci, 59(7):730-54 [2] Clark & Manini (2008) J Gerontol A Biol Sci Med Sci, 63(8):829-34 [3] Hofmann et al (2015) Exp Gerontol, 64:35-45 [4] Relizani et al (2014) Mol Ther, 22(8): 1423-1433 Contact marlene.hofmann@univie.ac.at

## THE WAY YOU SPEND YOUR SEDENTARY TIME ALSO MATTERS: AN ANALYSIS OF THE ASSOCIATION BETWEEN SEDENTARY TIME, SEDENTARY PATTERNS AND FRAILTY IN THE ELDERLY

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Introduction Time spent in sedentary activities has been associated with negative health outcomes in older people (Stamatakis et al., 2012). However, the role that sedentary behaviour patterns play on health has been scarcely investigated in this population group. The ability of performing well in the diverse activities of the daily life is partially determined by the level of frailty (García-García et al., 2014). However, no studies have been conducted yet to clarify the role of sedentary behaviour on frailty. We therefore examined the associations of daily sedentary time (DST) and sedentary patterns (SP) with frailty in elderly. Methods A triaxial accelerometer (ActiGraph, ActiTrainer 3X) was used to determine the DST and SP in 234 males and 285 females aged between 67 and 95 years in the ETES study (Carcaillon et al., 2012). Using the z-scores of the number of 10-min sedentary behaviour bouts and the average duration of those bouts, a SP composite score was created, according with other previous studies (Artero et al., 2011). Frailty was calculated using the Frailty Trait Scale (FTS). Different linear regression models were performed in order to analyse the associations of DST and SP with FTS. All models were adjusted for gender, age, educational level, Charlson index, Katz index, Mini Mental State Examination, and number of drugs. Results After adjusting for the mentioned potential confounders, a statistically significant association was found between SP and FTS (B [95%CI]: 1.573 [0.364, 2.781],  $\beta=0.104$ ,  $p<0.001$ ). DST was also significantly associated with FTS (B [95%CI]: 0.015 [0.002, 0.028],  $\beta=0.095$ ,  $p<0.001$ ). Discussion Both sedentary patterns and daily sedentary time are associated with frailty in older people from the ETES study. Our results suggest that interventions should not only be focused on reducing the total time spent in sedentary activities but also on how that time is accumulated in order to prevent frailty in elderly people. References Artero E, Ruiz J, Ortega F, España-Romero V, Vicente-Rodríguez G, Gutiérrez A, et al. (2011). *Pediatr Diabetes*, 12(8): 704-712. Carcaillon L, Blanco C, Alonso-Bouzon C, Alfaro-Acha A, García-García F, Rodríguez-Mañas L. (2012). *Plos One*, 7(3): e32401. García-García F, Carcaillon L, Fernandez-Tresguerres J, Alfaro A, Larrión J, Rodríguez-Mañas L, et al. (2014). *J Am Med Dir Assoc*. 15(5), 371. Stamatakis E, Davis M, Stathi A, Hamer M. (2012). *Prev Med*, 54(1), 82-87. Contact Asier.Manas@uclm.es

## MENTAL SIMULATION OF LOCOMOTOR TASKS IMPROVES REHABILITATION OUTCOME IN ELDERLY ADULTS AFTER HIP SURGERY

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Introduction: Prolonged immobilization and inactivity after injury and/or surgery may lead to serious motor/cognitive dysfunction, especially in older adults. Previous work has revealed that mental simulation such as action observation (AO) or motor imagery (MI) activates similar brain regions as actual motor execution and increases corticospinal excitability (Wright, Williams & Holmes, 2014); mechanisms that may accelerate (re-)learning and rehabilitation of motor skills (e.g. Mulder, 2007). This study aimed to determine whether the combination of AO and MI could positively affect locomotor performance and prefrontal cortex (PFC) oxygenation when tested 60-days post hip surgery. Methods: Of an initial 405 participants [database of the Orthopaedic Hospital Valldoltra (Slovenia)], 26 eligible patients were screened (e.g. no significant co-morbidities) of whom 21 successfully completed all study measurements. They were randomly split into 2 groups: Control (CON;N=11;63±6y) which followed a standard rehabilitation protocol, and Intervention (INT;N=10;64±4y) which received additional cognitive interventions (AO+MI of locomotor tasks) for 30 min/day in the hospital, then 3x/week in their homes, for a period of 2 months. Gait and postural control during dual-tasking (DT; balancing/walking while subtracting by threes), Timed Up and Go (TUG) and Four Step Square Test (FSST) were measured before and 60-d after hip surgery. Additionally, PFC (O2Hb and HHb levels, by continuous-wave near-infrared spectroscopy [NIRS]) was assessed during postural/DT control. Interaction effects (groups x time) were evaluated using a 2x2 mixed ANOVA. Results: At baseline, both groups were matched in their cognitive and functional abilities ( $p>0.341$ ). There were significant interactions for TUG ( $p=0.045$ ), FSST ( $p<0.001$ ), gait performance ( $p=0.028$ ), and mental arithmetic while DT ( $p=0.042$ ) exhibited better outcomes for the INT vs. CON. No interactions were found for NIRS ( $p>0.221$ ) and balance ( $p>0.229$ ) parameters. Discussion: These results demonstrate that mental simulation provides positive outcomes on motor-cognitive measures after hip surgery in elderly people. Interestingly, all parameters associated with locomotor activities improved significantly, whereas balance skills were not affected by AO+MI, demonstrating the specificity of the training intervention. From a functional perspective, it is positive that cognitive performance during DT-walking improved, although these adaptations were not accompanied by changes in PFC. Overall, utilizing AO+MI training during rehabilitation is advised, especially when physical practice is constricted or not possible. References: Wright DJ, Williams J, Holmes PS. (2014). *Front Hum Neurosci*, 8, 951. Mulder T. (2007). *J Neural Transm*, 114(10), 1265-1278. uros.marusic@upr.si

## EFFECTS OF INCREASED DAILY PHYSICAL ACTIVITY ON BRAIN-DERIVED NEUROTROPHIC FACTOR, SEROTONIN AND OXIDATIVE STRESS MARKERS IN OLDER ADULTS

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**Introduction** Brain-derived neurotrophic factor (BDNF), serotonin and oxidative stress are associated with the development of depression and dementia. Although many studies have shown that exercise training improves depression, little is known about the effectiveness of daily physical activity on depression biomarkers in older adults. The purpose of this study was to investigate the effects of increased daily physical activity during the intervention period for 8 weeks on levels of BDNF, serotonin and oxidative stress markers in older adults. **Methods** Thirty-eight healthy postmenopausal women ( $71 \pm 1$  years old [mean  $\pm$  SD]) were randomly assigned to one of the following two groups: control (C,  $n=19$ ) and active (PA,  $n=19$ ). The participants in the PA group were asked to increase their physical activities above their usual lifestyle levels for 8 weeks. They were free to decide the duration and intensity of their chosen activities. The participants in the control group maintained their usual lifestyle for 8 weeks. All participants were asked to wear a uniaxial accelerometer during the 8-week period. Blood samples were obtained at the baseline and the end of the intervention. **Results** After the intervention for 8 weeks, the step counts of the participants in the PA group have increased from  $6043 \pm 696$  (at baseline) to  $7978 \pm 869$  steps/day ( $P < 0.05$ ). The serum concentrations of BDNF and serotonin have significantly increased in the PA group ( $P < 0.05$ ) but not in the C group after 8 weeks compared with the baseline values. The serum concentrations of derivatives of reactive oxygen metabolites and biological antioxidant potential did not change after intervention in either group. **Discussion** These findings seem to suggest that promotion of daily physical activity in older adults is effective for improving the function of nervous and endocrine system without any change in oxidative stress. **References** Rawdin B.J. et al. (2013). *Brain, Behavior and Immunity*, 31, 143-152. Erickson K.I. (2012). *The Neuroscientist*, 18, 82-97. Contact Please include your email address at the very end of your abstract [m-takahashi@aoni.waseda.jp]

## EFFECT OF AGING ON SEX DIFFERENCES IN FAT OXIDATION.

TABATA, H.1, KIM, H.K.1, KONISHI, M.2, ANDO, K.1, XIANG, M.1, SUZUKI, K., HIGUCHI, M.2, SAKAMOTO, S.2

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**Introduction** Fat oxidation rate during exercise observed interindividual variation. Previous studies have suggested that physical activity, cardiorespiratory fitness, and sex are determinants of fat oxidation rate (Venables et al, 2005). Although young women have greater fat oxidation during exercise than young men (Chenevière et al., 2011; Horton et al., 1998), it is unclear whether these sex differences are applied to elderly. The basal metabolic rate decreases with increase in age, and women experience menopause during middle age. Therefore, the aim of this study was to investigate the influence of aging on sex differences in fat oxidation rate. **Methods** 236 healthy men and women (161 men and 75 women, 40-87 years) who participated "Waseda Alumni's Sports, Exercise, Daily Activity, Sedentari-ness Health Study" from March to December 2015 performed a graded exercise test on a cycle ergometer. Peak oxygen uptake ( $VO_{2peak}$ ), maximal fat oxidation (MFO), and the intensity at which MFO occurred (Fatmax) were measured with indirect calorimetry during exercise. These data were categorized into 6 groups by sex and age (40's: 40-49, 50's: 50-59, and over 60 years:  $\geq 60$  years). Comparison of mean values of the groups was performed using two-way analysis of variance with Bonferroni post-hoc test. **Results**  $VO_{2peak}$  values were significantly higher in men than in women and decreased with increase in age in both, men and women; the  $VO_{2peak}$  values for subjects in their 40's were significantly higher than those for subjects in their 50's and those over 60 years of age. MFO was not significantly different across sex and age. Fatmax values was significantly higher in men than in women. Fatmax values increased with age, and were significantly higher for subjects in their 50's than for those in their 40's. Fatmax values were significantly higher in subjects older than 60 years of age than in subjects in their 40's and 50's; this was true for both, male and female subjects. **Discussion** There were no sex differences in fat oxidation rate in middle-aged elderly people. Given it is well documented that women have greater fat oxidation rate than men in young people, fat oxidation rate may alter in the period from young age to middle age. **References** Chenevière X, Borrani F, Sangsue D, Gojanovic B, Malatesta D. (2011). *Appl Physiol Nutr Metab* 36, 88-95. Horton TJ, Pagliasotti MJ, Hobbs K, Hill JO. (1998). *J Appl Physiol*, 85(5), 1823-1832. Venables MC, Achten J, Jeukendrup AE. (2005). *J Appl Physiol*, 98(1), 160-167. Contact: tbt-aaa-0963@ruri.waseda.jp

## INFLUENCE OF ENERGY COST OF WALKING ON GAIT SPEED AND PHYSICAL ACTIVITY LEVEL IN ELDERLY WOMEN

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1: Laboratorio di Anatomia Funzionale dell'Apparato Locomotore, Dipartimento di Scienze Biomediche per la Salute, Università degli Studi, Milano, Italia, 2: Corso di Laurea in Scienze Motorie, Università Cattolica del Sacro Cuore, Milano, Italia, 3: Laboratorio di Fisiologia Sperimentale, Dipartimento di Psicologia, Università Cattolica del Sacro Cuore, Milano, Italia **INTRODUCTION** It has been demonstrated that the age-associated increase in energy cost of walking (CW) may result in a slowing of gait speed (Schrack 2012). Physical activity level (PA) also declines with age (Troiano 2008). However, in our knowledge, no studies have examined the influence of CW on PA habitually maintained. Therefore, the aim of this study was to define the influence of CW on both gait speed and PA. **METHODS** 42 healthy young (YA) and older (OA) women (YA: age,  $22.6 \pm 2.9$  yr; BMI,  $22.5 \pm 2.6$  kg/m<sup>2</sup>; OA: age,  $68.3 \pm 3.3$  yr; BMI,  $26.1 \pm 3.0$  kg/m<sup>2</sup>) were recruited in the study. NetCW was analysed with indirect calorimetry during treadmill walking at different speeds and calculated subtracting resting metabolic rate measured during standing from gross metabolic rate. Gait speed, defined as the preferred walking speed (PWS) of the subject, was measured as the time taken to walk the middle 10m of 14m. To assess PA, subjects wore a multisensor activity monitor for a whole week, inferring time spent in moderate to vigorous PA (MVPA > 3METs). MVPA were analysed in bouts of at least 10 consecutive minutes (MVPAbout) and in overall minutes (MVPA<sub>tot</sub>). **RESULTS** No significant differences were found between the two groups for NetCW at the speed closest to the PWS, the gait speed and both MVPAbout and MVPA<sub>tot</sub> (YA: NetCW,  $2.89 \pm 0.38$  J/kg/m; PWS,  $5.0 \pm 0.7$  km/h; MVPAbout,  $28 \pm 29$  min/day; MVPA<sub>tot</sub>,  $61 \pm 52$  min/day; OA: NetCW,  $3.07 \pm 0.63$  J/kg/m; PWS,  $4.8 \pm 0.5$  km/h; MVPAbout,  $29 \pm 42$  min/day; MVPA<sub>tot</sub>,  $61 \pm 64$  min/day). MVPAbout was significantly lower than MVPA<sub>tot</sub> for both groups ( $p < 0.0001$ ) and only MVPA<sub>tot</sub> exceeded current PA guidelines ( $p = 0.001$ ). Regression analysis, adjusted for age and BMI, revealed that neither PWS nor PA were related to a lower NetCW at the speed closest to the PWS. Only fastest walkers had higher daily level of PA independently of age ( $r = 0.376$ ,  $p = 0.013$ ;  $r = 0.324$ ,  $p = 0.035$ ; for MVPAbout and MVPA<sub>tot</sub>, respectively). **DISCUSSION** In our study elderly women did not show a decrease of PWS and PA due to age. Moreover, an equivalent NetCW of walking was found in healthy elderly women when compared to younger counterparts while walking at their PWS. The present results showed that in healthy elderly women CW is not affected by age allowing a

high PWS and an elevated level of PA. REFERENCES Schrack JA. (2012). J Am Geriatr Soc, 60(10), 1811-1816. Troiano RP. (2008). Med Sci Sports Exerc, 40(1), 181-188.

### ASSOCIATION BETWEEN GRIP STRENGTH AND FALLS WITHIN THE LAST 12 MONTHS IN OLDER ADULTS IS MEDIATED BY UNBALANCE: RESULTS FROM THE KORA-AGE STUDY

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**Introduction:** Impaired muscular strength is strongly related to activity limitations and physical disability in middle-aged and aged individuals. However, studies evaluating the relation between muscular strength and risk of falling in older adults whilst taking the indirect effect of potential mediators into account are lacking. Thus, the objective of this study was to examine this association in a population-based study. **Methods:** Data originate from the KORA (Cooperative Health Research in the Region of Augsburg)-Age study (Peters et al., 2011). 1079 individuals (mean age $\pm$ SD: 76 $\pm$ 7 years) were enrolled. Handgrip strength was measured using the JAMAR Dynamometer. Multivariable logistic regression analysis was used to determine adjusted odds ratios (OR) with 95% confidence intervals (95%CI) for falls within the last 12 months. Potential confounders were pre-selected based on literature and expert opinion. Path analysis was used to assess the indirect effect of potential mediators on the association between grip strength and falls. **Results:** The risk for falls within the last 12 months was reduced by 3% (OR (95%CI): 0.97 (0.95-0.99)) per one kilogram increase in maximum grip strength after adjusting for significant confounders (i.e., age, nutritional status, number of prescribed drugs, and level of physical activity). Higher grip strength was significantly associated with lower risk of falls (0.96 (0.94-0.98)) and lower unbalance level ( $p < 0.0001$ ). The indirect effect of grip strength through the mediator variable unbalance was statistically significant ( $p = 0.002$ ). The significant association between grip strength and falls continued to exist after controlling for the mediator unbalance (0.97 (0.95-0.98)). **Conclusion:** Muscular strength is inversely and independently associated with falls in the old age. This association is partly mediated by unbalance. However, balance itself may affect muscle strength through transfer effects. In the LiFE approach, which embeds strategies to improve balance, ankle strength, a prime factor for postural stability, significantly improved compared with a structured control program (Clemson et al., 2012). Thus, the integration of both balance and muscle-strengthening exercises into daily life activity may reduce the rate of falls in older people. **References:** Clemson L et al. (2012). BMJ, 345, e4547. Peters A et al. (2011). Z Gerontol Geriatr, 44, 41-53. Contact: Barbara.Strasser@i-med.ac.at

### EFFECTS OF A BRISK WALKING PROGRAM AND 2-YEAR FOLLOW-UP ON THE SARCOPENIC RISK PROFILE IN SEDENTARY OBESE POSTMENOPAUSAL WOMEN

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**Introduction** Although the impact of walking on subjects' cardiometabolic risk profile has been largely investigated (Asikainen et al., 2004, Mosca et al., 2007; Tudor-Locke et al., 2014), no study has examined yet the influence of a brisk walking program on the sarcopenic risk profile of sedentary and moderately obese, postmenopausal women. Aim of the present study was to examine the effects of a 4-month brisk walking program on the sarcopenic risk profile, and its impact two years after the intervention. **Methods** 67 initially sedentary and overweight-to-obese (mean body mass index, BMI = 30.0  $\pm$  4.7 kg/m<sup>2</sup>) postmenopausal women (60.9  $\pm$  6.2 yr-old) were subjected to a 4-month walking program (3 sessions of 45 min each/week at 60 % of their heart rate reserve), while 19 women of similar age (60.6  $\pm$  5.3 yr-old), adiposity (BMI = 29.9  $\pm$  5.6 kg/m<sup>2</sup>) and menopausal status remained inactive during the same period. Following measurements were performed before and after the 4-month study-period, as well as two years later in both groups: CRF assessed by the 2-km walking test and estimated VO<sub>2</sub> max then calculated (Laukkanen et al., 1993), height, weight (BMI calculated) and waist circumference measured using standardized procedures, as well as fat mass and lean body mass determined by bioelectrical impedance (Roussel et al., 2009; Garnier et al., 2013) and lean body mass index (LBMI) calculated (Heber et al., 1996). **Results** Four months later, CRF increased, body weight and fat mass decreased ( $p < 0.0001$ ) in the walking group exclusively, while LBMI was maintained in the two groups. Two years later, increase in CRF and body weight and fat mass losses were maintained ( $p < 0.01$ ) in the 67 women who completed the study, while LBMI remained unchanged in the two groups. **Discussion** The low sarcopenic risk profile was maintained after this 4-month walking program and two years later, despite the body weight reduction. However, more studies are needed to examine whether age may influence the evolution of LBMI, irrespective of women's menopausal status. **References** Asikainen TM, et al. (2004) Sports Med, 34, 753-778. Garnier S, et al. (2013) Menopause 20, 804-812. Laukkanen RMT, et al. (1993). Scand J Med Sci Sports, 3, 267-272. Manson JE, et al. (2002) New Engl J Med, 347, 716-725. Mosca L, et al. (2007) J Am Coll Cardiol, 49, 1230-1250. Roussel M, et al. (2009) Menopause, 16, 566-575. Tudor-Locke C, et al. (2014) BMC Public Health, 14, 168-175. Heber D, et al. (1996) Am J Clin Nutr, 64 (3 Suppl): 472S-477S. Contact sophie.garnier@univ-tlse3.fr

## Mini-Orals

### MO-PM33 Strength Training & Testing

#### RELIABILITY OF ADDUCTORS/ABDUCTORS ISOKINETIC TESTING AND ITS RELATIONSHIP TO ICE HOCKEY SPRINT PERFORMANCE

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**Introduction** Skating performance is a key parameter of ice hockey performance. Adductors/abductors muscles are highly involved in this locomotion pattern and are poorly investigated in the literature. The aims of this study are: 1) to evaluate the reliability of an adductors/abductors isokinetic test, 2) to compare ice hockey players results to a non-skating sport population, 3) to analyse the relationships between isokinetic test results with off-ice and on-ice tests in elite ice hockey players. **Methods** In order to evaluate reliability, 12 controls performed two side-lying isokinetic hip tests separated by 6.9  $\pm$  0.7 days. Another group of 9 elite ice hockey players performed an



isokinetic hip test  $5.6 \pm 0.7$  days after performance tests (Countermovement jumps, 36.5m off-ice and on-ice sprints). All of the isokinetic tests were analysed with gravity correction. Results The ICC range of the control group were 0.71-0.95, with 75% of the values being above 0.8 (moderate to high) showing a good reliability. The ice hockey players showed a significant difference on adductors isokinetic strength at every speed vs. control group values. No differences were found on the abductors values between the two groups. A significant correlation was found between isokinetic muscle strength of right adductors at  $120^\circ/\text{s}$  in concentric and skating time at 36.5 meters (CC: -0.78 /  $p = 0.01$ ). There is also a relationship between off-ice and on-ice sprints (CC: 0.78;  $p = 0.005$ ). As well, the vertical jumps and the on-ice sprints were correlated (CC: -0.603;  $p = 0.05$ ). Discussion Isokinetic hip testing in side-lying position seems to be reliable in a better way than previously described (Emery et al., 1999). Ice hockey players develop significantly higher adductors strength compared to a non-skating sport population, rejoining results from a similar investigation (Kea et al., 2001). Adductors strength seems to be linked with on-ice sprint performance in elite ice hockey players. Finally, there is a relationship between off-ice countermovements jumps and 36.5m sprints with on-ice 36.5m sprint performance, confirming relationships between off-ice and on-ice performance seen in previous studies (Janot et al., 2015, Mascaro et al., 1992) References Emery CA, Maitland ME, Meeuwisse WH. (1999). Clin J Sport Med. Apr;9 (2),79-85. Kea J, Kramer J, Forwell L, Birmingham, T. (2001). Journal of Orthopaedic & Sports Physical Therapy, 31(8), 446-455. Janot JM, Beltz NM, Dal-leck LD. (2015). Journal of Sports Science & Medicine, 14(3), 522-529. Mascaro T, Seaver BL, Swanson L. (1992). Journal of Orthopaedic & Sports Physical Therapy, 15(2), 92-98. Contact Cyril.Besson@chuv.ch

### LOW LOAD BENCH PRESS AND PUSH UP WITH SIMILAR INTENSITY INDUCE COMPARABLE MUSCLE HYPERTROPHY AND STRENGTH GAIN IN UNTRAINED MEN

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1: Sports Training Center, Nippon Sport Science University. (Tokyo, Japan), 2: Department of Exercise Physiology, Nippon Sport Science University. (Tokyo, Japan), 3: Graduate School of Health and Sport Science, Nippon Sport Science University. (Tokyo, Japan) Introduction The push-up can be performed without any additional tools and the intensity can be altered with several variations, thus making it suitable for almost every level of fitness. The purpose of present study was to investigate the effect of push up training with similar load of 40% 1 repetition maximal (RM) bench press on muscle hypertrophy and strength gain in untrained men. Methods Eighteen untrained men (age;  $20.2 \pm 0.73$  years, age range; 19-22 years, height;  $169.8 \pm 4.4$  cm, weight;  $64.5 \pm 4.7$  kg) volunteered to participate in this study. Subjects were randomly assigned to the experimental group as follows: 1) bench press exercise with 40%1RM (BP group,  $n = 9$ ), 2) push up with adjusted their position (e.g. kneeling) to be the same load of 40%1RM of bench press (PU group,  $n = 9$ ) in 8 weeks. We measured bench press 1RM, maximal repetition at 50%1RM. Three sites of muscle thickness (MT), biceps (BB), triceps (TB) and pectoralis major (PM), and power out put performance (medicine ball throw) were also measured. All parameters were assessed before and after the training periods. Results Significant increases in 1RM and MT (TB and PM) were observed in BP group (1RM;  $60.0 \pm 12.1$  kg to  $65.0 \pm 12.1$  kg,  $p < 0.01$ , MT-TB;  $26.3 \pm 3.7$  mm to  $27.8 \pm 3.8$  mm,  $p < 0.01$ , MT-PM;  $17.0 \pm 2.8$  mm to  $20.8 \pm 4.8$  mm,  $p < 0.01$ ) and in PU group (1RM;  $61.1 \pm 12.2$  kg to  $64.2 \pm 12.5$  kg,  $p < 0.01$ , MT-TB;  $27.7 \pm 5.7$  mm to  $30.4 \pm 6.6$  mm,  $p < 0.01$ , MT-PM;  $17.0 \pm 2.8$  mm to  $20.8 \pm 4.8$  mm,  $p < 0.01$ ). Significant increase in MT-BB was observed only in BP group ( $28.4 \pm 3.3$  mm to  $31.5 \pm 3.7$  mm,  $p < 0.01$ ). There is no significant increase in power out put performance and muscle endurance capacity in both groups. Discussion This is the first investigation for compare muscle hypertrophy and strength gain between low intensity bench press and push up training performed with similar intensity, rest interval and speed of movement. Our result suggested that push up exercise with similar load of 40%1RM bench press is effective in muscle hypertrophy and strength gain as well as bench press exercise in 8 weeks training. Contact N.kikuchi@nittai.ac.jp

### SCAPULAR MUSCLE ACTIVITY IN FEMALE VOLLEYBALL PLAYERS WITH STATIC SCAPULAR ASYMMETRY DURING CLOSED CHAIN EXERCISES

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Introduction Resting scapular asymmetry is a common postural deviation in overhead athletes (Burkhart et al., 2003; Oyama et al., 2008). It has been proposed that possible alterations in the EMG activity of scapular muscles, due to asymmetric position of the scapulae, may alter their kinematics leading to shoulder pathology (Burkhart et al., 2003). The aim of the current study was to identify alterations in the EMG activity of the scapular stabilizers in healthy volleyball female athletes with static scapular asymmetry. Methods Static scapular position with regard to scapular protraction (difference between scapulae spinal's root-to-midline horizontal distances) and depression (vertical distance between spinal's root-to-midline horizontal projections of both scapulae) was determined in 46 professional female volleyball players. Twenty two players with protraction ( $\bar{x} \pm \text{SD} = 0.8 \pm 0.5$  cm) and depression ( $\bar{x} \pm \text{SD} = 1.1 \pm 0.6$  cm) of the dominant scapula (most common scapular malpositioning) completed two upper extremities closed chain exercises on a stable (floor) and an unstable surface (BOSU platform). The EMG activities of upper trapezius (UT), middle trapezius (MT) and serratus anterior (SA) were recorded bilaterally and reported as the geometric mean (95% CI) of the percentage of each muscle's MVC. Results Our findings revealed no significant differences between the dominant and non-dominant sides with regard to the EMG activity of UT [15 (12-19) vs. 14 (11-17) %MVC], MT [10 (9-12) vs. 12 (10-14) %MVC] and SA [61 (49-77) vs. 70 (55-88) %MVC], during knee push-ups with hands on the floor. Similarly, the differences between the dominant and non-dominant sides for the EMG activity of UT [19 (15-24) % vs. 16 (13-21) %MVC], MT [11 (9-13) vs. 12 (10-15) %MVC] and SA [56 (45-69) vs. 69 (56-86) %MVC], were not significant during knee push-ups with hands on the BOSU platform. Discussion Based on the findings of the present study, bilateral EMG activity of scapular stabilizers were not affected by resting scapular asymmetry in volleyball athletes. Although not significant, the lower SA activation of the dominant side compared to the non-dominant side, in conjunction with the relatively similar bilateral activation of UT and MT could probably predispose these athletes in poor scapular stabilization during closed chain exercises. Bilateral differences in the EMG activity of scapula stabilizers could be more pronounced in overhead athletes with greater levels of scapular asymmetry. References Burkhart S, Morgan C, Kibler WB. (2003). Arthroscopy, 19 (6), 641-661. Oyama S, Myers J, Wassinger C, Ricci D, Lephart S. (2008). J Athl Train, 43 (6), 565-570. Contact dimkara@phed.uoa.gr



## EFFECTS OF RANGE OF MOTION IN RESISTANCE TRAINING EXERCISES ON MUSCLE ARCHITECTURE AND FORCE-LENGTH RELATIONSHIP

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**Introduction:** Range of Motion (ROM) can be manipulated in resistance training programs in order to improve strength gains and sports performance. To the best of our knowledge, only two studies (Bloomquist et al. 2013; McMahon et al. 2014) have shown that different ROM training might lead to specific adaptations on muscle size, muscle force and fascicle geometry. However, in these studies, the training volume was not equalized, which might have affected the final results. Therefore, the aim of this study was to determine the effect of a 15-week partial ROM knee extension strength training on the vastus lateralis (VL) muscle architecture and mechanical properties, when the time under tension (TUT) was equalized. **Methods:** Nineteen male physical education students were randomly distributed to a control (CG; n = 8) or training (TG; n=11) group. In the TG the subject's legs were also randomly selected to be trained with full ROM (FULL) or partial ROM (PAR). They performed isokinetic knee extensors concentric training on a isokinetic dynamometer (Biodex System 3 research, USA) for 15 weeks with 3 sessions per week, with either a FULL (100° of knee flexion to 0°) and PAR (60° of knee flexion to 0°) ROM. Training volume between conditions was equalized based on TUT. The VL muscle thickness (MT), fascicle length (FL) and pennation angle (PA) were assessed for both thighs by B-mode ultrasonography at rest and during maximal isometric knee extension contractions (MVCs) at fifteen knee joint angles, ranging from 30 to 100° of knee flexion (full extension=0°). VL fascicle force was calculated from MVCs with superimposed stimuli, accounting for the VL moment arm length, muscle architecture, and antagonist co-contraction. **Results:** MT, PA, and maximal fascicle force (MFF) increased significantly from baseline to post-training in both training groups ( $p < 0.001$ ). The changes ( $\Delta\%$ ) were respectively for FULL and PAR, MT:  $8.4 \pm 2.9\%$  and  $6.7 \pm 3.0\%$ ; PA:  $9.5 \pm 2.4\%$  and  $12.2 \pm 2.4\%$ ; MFF:  $28.8 \pm 19.5\%$  and  $19.0 \pm 10.8\%$ . Significant differences between FULL and PAR were found only on FL, which increased  $4.9 \pm 1.9\%$  ( $p < 0.001$ ) in FULL group, with no changes in PAR group ( $\Delta$ :  $-1.1 \pm 3.4\%$ , n.s.). The PAR group showed a specific effect on the VL force-length adaptations, presenting higher force levels at the trained angular positions. **Discussion:** The morphological and mechanical muscle adaptations seem to be influenced by the ROM of strength training exercises. When the ROM stimulates large muscle amplitudes, the fascicle length tends to increase. Conversely, when the amplitude of muscle action is restricted to reduced muscle lengths we are promoting identical pennation angles but specific force adaptations. **References** Bloomquist, K., H. Langberg, et al. (2013). 'Effect of range of motion in heavy load squatting on muscle and tendon adaptations.' *Eur J Appl Physiol* 113(8): 2133-2142 McMahon, G. E., C. I. Morse, et al. (2014). 'Impact of range of motion during ecologically valid resistance training protocols on muscle size, subcutaneous fat, and strength.' *J Strength Cond Res* 28(1): 245-255

## EFFECT OF ECCENTRIC AND CONCENTRIC PHASE DURATION MODULATION IN SQUAT EXERCISE ON MAXIMUM REPEATITIONS IN SETS AND MUSCLE DAMAGE

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**Introduction** The number of repetitions determines resistance-training volume, and is influenced by the time spent for eccentric (ECC) and concentric (CON) contractions in a set. A previous study (1) showed that the maximum number of repetitions in leg extension was greater when a longer duration (5 s) was set for ECC than CON. However, the effect of ECC and CON duration on the maximum repetitions in squat exercise is unknown. The present study compared two protocols in which the duration of the ECC and CON phase in squat was different on the maximum repetitions and muscle damage. **Methods** Ten physically active male students (age:  $20.6 \pm 1.1$  y, height:  $172.8 \pm 3.5$  cm, body mass:  $63.8 \pm 3.8$  kg, squat 1RM:  $103.5 \pm 12.0$  kg) participated in this study. After a familiarisation session in which a parallel back squat exercise (2 s for CON and 2 s for ECC) was performed as many repetitions as possible for 3 sets, (a) 2 s for CON and 4 s for ECC (C2E4), and (b) 4 s for CON and 2 s for ECC (C4E2) with a 3-min rest between sets were performed in a randomised order separated by a week. For each protocol, the number of successful repetitions in each set over 3 sets of the squat at 75% 1RM was recorded, and rate of perceived exertion (RPE) after each set was assessed. Blood lactate (BLa) was measured before and 5, 10, and 15 min post-exercise. Maximal voluntary contraction strength of knee extension (MVC) was measured before, immediately after and 1 day after exercise, and muscle soreness (SOR) was assessed by a 100-mm visual analogue scale before and 1 day after exercise. **Results** Average RPE ( $17.9 \pm 0.8$  vs  $17.8 \pm 0.8$ ) and peak BLa ( $6.7 \pm 0.9$ , vs  $7.5 \pm 1.0$  mmol/L) were similar between C2E4 and C4E2. The number of repetitions was greater ( $P < 0.05$ ) for C4E2 ( $13.3 \pm 3.6$ ) than C2E4 ( $10.6 \pm 2.0$ ) in the 1st set only, and decreased ( $P < 0.05$ ) in the 2nd ( $8.3 \pm 1.5$ ,  $7.9 \pm 2.2$ ) and 3rd sets ( $6.5 \pm 1.4$ ,  $6.2 \pm 1.7$ ) similarly. MVC decreased by 17% immediately after and 4% at 1 day after exercise ( $P < 0.05$ ), and minor SOR developed ( $27 \pm 16$  mm) without a significant difference between C2E4 and C4E2. **Discussion** Contrary to the previous study (1), the longer ECC did not result in greater number of repetitions in the present study. This might be due to a difference in exercise (leg extension vs squat) and the time ratio (1:5 vs 2:4). The difference in the repetitions between C2E4 and C4E2 was evident in the 1st set only, and muscle damage was minor and not different between conditions. These results suggest that the modulation of the ECC and CON phase duration in squat exercise has minimal effects on performance and muscle damage. **Reference** 1) Goto et al. (2009) *EJAP* 106:731-9 Contact k\_shibata@edu.hokudai.ac.jp

## ACID-BASE RESPONSES DURING A COMBINED AEROBIC AND CIRCUIT RESISTANCE TRAINING PROTOCOL

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**Introduction** Resistance training produces a number of acute and chronic adaptations in the musculoskeletal, nervous, cardiovascular, endocrine and immune systems (Saikko, 2015). The aim of this study was to investigate the acid-base responses to three different Circuit Weight Training (CWT) protocols in moderately active individuals. **Methods** Twenty-four healthy participants ( $21.3 \pm 2.9$  years;  $68.8 \pm 10.3$  kg) non-smoking and moderately active individuals completed three CWT sessions on separate occasions. These consisted of machine weights circuit (MC), free weights circuit (FW), and combined aerobic and machine weight circuit (CAM). All circuits had the same duration in time, number of exercises and targeted the same muscle groups. Before commencing the CWT protocols, participants completed a Wingate (WG) and VO2Max incremental test (VM) on different days. Blood samples were taken post test/circuit at 0min, 3min and 5min, measuring pH level, concentration of lactate (La-), Bicarbonate ( $\text{CHCO}_3^-$ ) and standard base excess (cBase[Ecf]). **Results** pH measures were significantly higher at 0min for CAM vs the rest of the tests; CAM continued to have greater values than WG at 3min, and than MC and FW at 5min. La- measures were significantly lower at 0min for CAM vs MC, FW and WG vs FW: at 3min for CMA vs VM, MC:

5.69±0.48 vs 9.22±0.50, 10.54±0.89; at 5min for CAM vs VM, WG, MC, FW: 5.04±0.48 vs 9.47±0.65, 9.70±0.55, 10.30±0.77, 8.76±0.74.  $\text{CHCO}_3^-$  measures were significantly higher at 0min for WG vs VM, MC, CAM, FW: 24.67±0.64 vs 17.72±0.68, 17.31±0.78, 19.81±0.67, 19.42±0.82; at 5min for CAM vs VM, MC, FW: 19.53±0.64 vs 14.56±0.45, 15.19±0.70, 16.82±0.74.  $\text{cBase[Ec]f}$  measures were significantly higher at 0min for WG vs VM, MC, CAM, FW and CAM vs FW: -3.94±0.70 vs -10.57±0.63, -11.44±0.94, -7.20±0.73, -8.76±0.82; at 5mins for CAM vs VM, WG, MC, FW: -7.02±0.70 vs -14.32±0.52, -11.65±0.67, -12.62±0.89, -10.16±0.89. Discussion Taken together, our findings indicate that CAM leads to higher levels of pH,  $\text{CHCO}_3^-$ ,  $\text{cBase[Ec]f}$ , and lower levels of  $\text{La}^-$ . This suggests that in comparison with CWT and tests, it reached the lowest level of acidosis. This is most likely due to the aerobic component of CAM; thus allowing acid-base regulation to reoccur and homeostasis to be reached. Therefore, CAM would be the most beneficial CWT in the construction of a resistance training program where a high anaerobic capacity is not required. References Saikko, V. (2015). Acute incremental endurance performance and explosive strength training period: muscle activity, acid-base balance and hormonal responses. Zabala, M., Peinado, A. B., Calderón, F. J., Sampedro, J., Castillo, M. J., & Benito, P. J. (2011). Bicarbonate ingestion has no ergogenic effect on consecutive all out sprint tests in BMX elite cyclists. *European journal of applied physiology*, 111(12), 3127-3134. Contact 1302317@my.brunel.ac.uk

### SELECTIVE RECRUITMENT OF DIFFERENT MUSCLE GROUPS USING AN ADJUSTABLE INNOVATIVE NON-MOTORIZED TREADMILL

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**Introduction** In sports and exercise, treadmills are a widely used device. However, it is rare to use a traditional treadmill to activate the upper body. Equipped with an adjustable resistance and upper limb support for both pushing and pulling exercises the Skillmill (SKM), a non-motorized, innovative treadmill made by Technogym, was evaluated in the present study assessing its ability to recruit multiple muscle groups. The aim of the study was to assess the muscle activation of healthy males when performing ten different exercises on the SKM. **Methods** Eight healthy male subjects with similar levels of fitness participated. Each subject was asked to perform the following exercises: a 6 km/h walk (W), a 12 km/h run (R) and sprint (S) at maximal speed, a resisted walk at 6 km/h (RW), side shuffle (both legs leading) (SSR, SSL), galloping with a resisted harness, assessing both legs (GR, GL) and pushing against the front handle in a high or low grip (PH, PL). Surface EMG of 12 muscles on right side of each subject were investigated, applying 2 pre-gelled bipolar electrodes on the belly of each muscle: Tib. Ant. (TA), Gastr. Med. (GM), Vastus Med. (VM), Biceps Fem. (BF), Rectus Fem. (RF), Gluteus Max. (GLM), Rectus Abd. (RA), Adductor (AD), Erector Spinae (ES), Pect. Major (PM), Lat. Dorsi (LD), Triceps Brach. (TB). The kinematics data was collected by means of an optoelectronic system (BTS Bioengineering), using 12 reflective markers placed in specific bony landmarks. EMG signals were rectified, integrated with a moving window of 200 ms, filtered at 6 Hz and normalized to the gait cycle. Following this, an average signal over 5 consecutive cycles was concluded, defined between two consecutive right heel strikes. Results Sprinting on the SKM resulted in a maximized average of the cycle activation of GM, BF and GLM; when sprinting against a resistance and pushing against a low handle (PL) at a similar intensity, the activation of VM and RF of the forward leg was significantly increased; walking sideways highly activated the ES, whereas AD did not show any noticeable activity. Pushing on high grips (PH) activated mainly the PM and TB, however a greater recruitment of those muscles occurred when galloping and sprinting. **Discussion** The results of the study highlights the possibility of recruiting differently muscle groups at high intensities on a non-motorized treadmill equipped like the SKM with front handles and restraints, as well as rear support for belt or harness running. References Sinclair J, Richards J, Taylor PJ, Edmundson CJ, Brooks D, Hobbs SJ. (2013). *Sports Biomech*, 12(3), 272-282. Smoliga J, Hegedus E, Ford K. (2015). *Physical Therapy in Sport*, 16(3), 262-267. Contact pbenvenuti67@gmail.com

### EARLY MECHANICAL RESPONSES OF THE PATELLAR TENDON TO SUBMAXIMAL ECCENTRIC RESISTANCE TRAINING IN YOUNG INDIVIDUALS

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Tendon tissue is known to adapt to resistance exercise interventions by increasing in biomechanical stiffness (1,2). While the majority of literature investigates adaptations pre and post intervention, typically over 8 weeks, previous research has demonstrated that resistance training results in morphological changes in muscle as early as 10 days (3). One would assume that following muscular hypertrophy, the corresponding tendon must also adapt in order to maintain an effective muscle-tendon unit. However, any early tendinous adaptations to RET (i.e. during the first weeks) have not been studied. We have therefore, undertaken a study to map the temporal responses of tendon tissue to resistance exercise. We recruited 6 young males (27.5±6yrs) for a 4-weeks resistance exercise intervention. Eccentric training took place 3x week upon a leg press, consisting of 4 sets of 12 repetitions at 60% 1-RM. Ultrasound-based measurements of patellar tendon stiffness and measurements of MVC and rate of torque development (RTD) between 0-50ms, were taken every 2 weeks. Patellar tendon stiffness showed a trend to increase from week 0 to week 2 (1376±139N/mm vs 1558±163 N/mm, P=0.070) and was significantly increased by week 4 (1376±139N/mm vs 1950±214 N/mm, P=0.007). Similarly, RTD showed a trend to increase by week 2 (959±154 N.s-1 vs 1139±178 N.s-1, P=0.111) and significantly increased by week 4 (959±154 N.s-1 vs 1222±146 N.s-1, P=0.007). However, MVC showed no significant increase between 0 and 2 weeks (230±20 vs 242±18, P=0.160) and only a trend to increase by week 4 (228±24 vs 249±17, P=0.052). The present data suggest that 4 weeks of submaximal eccentric training are sufficient to increase both tendon stiffness and RTD and that these changes precede those of MVC. Therefore it is plausible to suggest that hypertrophy has a slower time course than tendon changes. An increase in tendon stiffness may be responsible for the increase in RTD, as a stiffer tendon would require less time for the tension to develop within the muscle. Taken collectively, these data demonstrate that adaptations in muscle and tendon may occur in a coordinated fashion, presumably to maintain the efficacy of the muscle-tendon unit. 1) Malliaras et al, 2013. *J Biomech* 46; 1893-9. 2) Reeves et al, 2003. *Muscle Nerve* 28; 74-81. 3) Seynnes et al, 2007. *J Appl Physiol* 102; 368-373.

## Mini-Orals

## MO-PM52 Sports Medicine: Sports Injuries

**THE RELATIONSHIP BETWEEN FUNCTIONAL MOVEMENT SCREEN SCORE AND THE PAST HISTORY OF INJURY IN HIGH SCHOOL WOMEN'S VOLLEYBALL PLAYERS**

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**Introduction** In order to prevent sports related injury is one of the essential roles as athletic trainers. Prior to the start of the each season, athletic trainers implement to physical evaluation to recognize their physical characteristics and abilities. Functional Movement Screen® (FMS) is one of the evaluation tools to identify the athletes' movement pattern, related to expected injuries (Cook, 2010). Therefore, the purpose of this study is to discover relationship between FMS score and the past history of injuries, to identify which region of injury has a great effect on FMS score. **Method** Forty-eight high school women volleyball players, without a current history of injuries, completed questionnaire which included the past history of injuries, frequency of injuries, and the period of injuries. FMS consists of seven fundamental movement patterns testing athletes' mobility, stability, and coordination. The data were analyzed by using SPSS statistical software. To determine the relationship between FMS score and history of injuries, we computed 2 stepwise multiple regressions. FMS scores were dichotomized using 14 as the cut point (Kiesel et al., 2007). Odds ratios were calculated using Mantel-Haenszel method with the corresponding 95% confidence intervals. **Result** The ankle was found the most frequently injured region, followed by fingers, the knee, the lower legs and the lower back. The average of FMS score was  $11.42 \pm 3.03$ . The athletes who exposed the knee ( $\beta = -.39$ ,  $p = .002$ ), the shoulder ( $\beta = -.33$ ,  $p = .002$ ), and the ankle ( $\beta = -.27$ ,  $p = .027$ ) injuries more than three times had negative influence to FMS score. Where as, the athletes who have no histories of the lower back injuries had positive influence for FMS score (adjusted  $R^2 = .36$ ). FMS score of the athletes who did not have histories of the lower back injuries ten times as high as that of the athletes who had histories of the lower back injuries (odds ratio = 10.26, CI95 = 1.2-87.5). **Discussion** Participation in high school athletics comes with risk for injury. To identify risk factors of sports related injury is significant important as athletic trainers. This study suggests without history of the lower back injury provides storing influence to improve FMS score. Having a history of the lower back injury appears to change movement patterns (McGill et al., 2012). Therefore, athletic trainers should provide core strength training such as static or dynamic to improve athletes' movement pattern. **Reference** Kiesel K, Plisky P, Voight M. (2007). *N Am J Sports Phys Ther*, 2(3), 147-158. Cook G. Movement. Aptos, Ca: On Target Publications; 2010. McGill S, Andersen J, Horne A. (2012). *J Strength Cond Res*, 26(7), 1731-1739. Contact yukowh@kyushu-nu.ac.jp

**IS THE DROP OF CUSHIONED RUNNING SHOE A KEY FEATURE FOR INJURY PREVENTION?**

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**Introduction** Until now, a clinical consensus as to whether or not the reduction of the drop of the shoes is protective against running-related injury (RRI) has not yet been reached. Several studies compared minimalist shoes with conventional shoes, but they provided conflicting results on the association with injury risk. Additionally, minimalist shoes are characterised by many specific features, thus preventing the identification of important shoe features for injury prevention. Therefore, the purpose of this randomised controlled trial was to determine if the drop of standard cushioned running shoes influences injury risk, and whether running regularity (>6 months of regular weekly practice over the last year) modifies the association between shoe drop and injury risk. **Methods** Leisure-time runners ( $n=553$ ) were recruited for this randomised controlled trial and were required to report all information relative to their running activities, other sport practice, as well as any injury (time-loss definition, at least 1 day) on an internet based platform: [www.tipps.lu](http://www.tipps.lu). The participants received a pair of running shoes with a heel to toe drop of 10 mm (D10), 6 mm (D6) or 0 mm (D0). Apart from the shoe drop, the 3 versions were strictly identical. Cox regression analyses were used to compare RRI risk between the three groups based on hazard rate ratios (HR) and their 95% confidence intervals (95%CI), controlling for potential confounders. A stratified analysis was conducted to separately investigate the effect of shoe drop on RRI risk in occasional and regular runners. **Results** The participants recorded a total of 13160 hours of running, and 136 of them (25%) sustained at least one RRI during the 6-month follow-up. Most of the RRI affected tendons (53%) and the most often concerned anatomical locations were the lower leg (30%) and the knee (23%). The proportion of injured participants were 21.6%, 27.4% and 24.6% in the D10, D6 and D0 groups, respectively. The overall incidence was 10.3 RRI/1000h of running (95%CI=10.28; 10.39). The overall injury risk was not different amongst the participants who had received the D6 version (HR=1.30; 95%CI=0.86-1.98) or the D0 version (HR=1.17; 95%CI=0.76-1.80) when compared to the conventional D10 version. The stratified analysis revealed that low drop shoes (D6 and D0 grouped together) were associated with a lower RRI risk in occasional runners (HR=0.48; 95%CI=0.23-0.98), and with a higher injury risk in regular runners (HR=1.67; 95%CI=1.07-2.62). **Discussion** Overall, RRI risk was not influenced by the drop of standard cushioned running shoes. However, low drop shoes could be more hazardous for regular runners while they seem to be preferable for occasional runners to limit injury risk.

**THE INFLUENCE OF SHOE CHARACTERISTICS ON INJURY IN DISTANCE RUNNERS**

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**Introduction** Evidenced-based recommendations on footwear for injury prevention are scarce. There is limited evidence that suggests transitioning from traditional to minimalist shoes increases the incidence of injury, particularly of the foot and leg (Ryan et al.). However, no evidence exists for the effects of different cushioning levels or heel-to-toe drop. The aim of our study was to assess incidence of injury in distance runners after a 4-week training period in zero-drop running shoes with varying levels of cushioning. **Methods** Thirty experienced runners (15 males; 15 females) were enrolled. Data from three participants were excluded from analyses due to incomplete participation. Subjects ran at 70%  $\dot{V}O_{2\max}$  speed for 10 minutes in their habitual shoe (HAB), a minimal shoe (MIN; New Balance Minimus), and a maximal shoe (MAX; Altra Paradigm), which were selected for their zero-drop, similar fit, and disparate midsole thickness (11 and 25 mm). Runners were randomly assigned MIN or MAX to wear for all runs for four weeks. Details of all runs, including mileage, time, intensity, surface, and musculoskeletal complaints were monitored using electronic training logs. Data were analyzed using multiple

linear regression analysis. Results Approximately 26% of the runners became injured and had to either stop running completely or significantly alter their running mileage, duration, and/or speed during the 4-week period (i.e., major complaint). Another 37% reported minor musculoskeletal complaints during some of their runs. All injuries and complaints were of the foot or leg. Shoe type was significantly associated with injury with all injuries occurring in the MIN group ( $p=0.005$ ). Difference in heel height from HAB to novel shoe demonstrated a trend ( $p=0.10$ ), while heel-to-toe drop difference from HAB to novel shoe was not significantly associated with injury ( $p=0.51$ ). The difference in shoe weight from HAB to novel shoe increased as injury severity increased. Runners who reported no pain had a 38.6 g change, those with minor complaints had a 45.9 g change, those with major complaints had a 78.7 g change, and those who had to stop running completely had a 92.3 g reduction in shoe weight. Discussion All injuries occurred in the MIN group with half of the runners in this group becoming injured over four weeks. Individual characteristics such as age, gender, running experience, typical weekly mileage, or mileage during evaluation period did not add significantly to the explanation of injury. Since both MIN and MAX shoes had a zero heel-to-toe drop, it appears that other factors influence injury risk when transitioning to a new shoe. Additional research is needed to determine what is unique about runners in the MIN group who were able to adapt successfully to the novel shoe. References Ryan M., et al. (2013) Br J Sports Med 48(16): 1257-62.

## IMMEDIATE EFFECTS OF ELASTIC KNEE BRACES ON FRONTAL PLANE MOTION BIOMECHANICS IN HEALTHY MEN

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Introduction Knee joint damage, is commonly occurred in soccer players, especially the fraction of anterior cruciate ligament, medial collateral ligament and medial meniscus (Cowley, Ford, Myer, Kernozek, & Hewett, 2006). Moreover, players often return the court without recovery of injuries. Chronic knee joint injury may progressively lead to osteoarthritis (OA). Current treatment includes medical therapy, surgery and exercise; besides, wearing knee joint braces, wedged insoles and elastic knee sleeves are alternative ways for relieving symptoms and delaying the disease progression (Schween et al., 2015). Previous study (Ota et al., 2015) has demonstrated that decreasing knee adduction moment is considerable important on preventing OA. The purpose of this study is to examine immediate effects of elastic knee braces on frontal plane motion biomechanics. Methods A crossover study was carried by 15 healthy men. The participants were requested to wear either nothing (control), elastic brace 1 (EB1; with metal sticks supported) and elastic brace 2 (EB2; with plastic sticks supported) in a random manner. Afterwards, they performed three movements (i.e. straight walking, straight running and cutting) commonly seen in soccer players. 3D motion analysis system and force plates were used to measure the kinematic and kinetic parameters of the knee frontal plane. One-way ANOVA with Tukey's post hoc was applied to compare all parameters between treatments. Results In EB1 treatment, the results showed the knee abduction angle in cutting was significantly less than control ( $P < 0.05$ ); however, it did not differ in walking and running. In EB2 treatment, there were no differences in the knee abduction angle in three movements compared to control. In addition, no differences were found in knee abduction moment in three movements between each treatment. Discussion Previous study (Schween et al., 2015) investigated the effect of wearing elastic braces on knee adduction when performing 10-m straight walk in OA patients. In our study, we first confirmed the impact on the additional two movements (i.e. running and cutting). EB1 provided better protective benefits on the cutting, the movement needed more stability due to turning right angles. The materials of elastic braces played an extremely important role on remaining stability. Our study demonstrated that the EB1, with metal sticks supported, exerted better stiffness. In conclusion, our data provided the novel evidences of elastic brace on decreasing knee abduction angle when performing cutting. References Cowley, H. R., Ford, K. R., Myer, G. D., Kernozek, T. W., & Hewett, T. E. (2006). Journal of Athletic Training, 41(1), 67. Guo, L.-Y., Yang, H., Wu, L., & Su, C. Hip, 5(10), 15. Ota, S., Kanai, A., Torii, Y., Taniyama, H., Imaizumi, F., & Matsui, Y. (2015). Nagoya journal of medical science, 77(1-2), 95. Schween, R., Gehring, D., & Gollhofer, A. (2015). PLoS One, 10(1), e0115782. doi: 10.1371/journal.pone.0115782. Contact (J.Y. Li) a904011620022002@gmail.com

## WAVELET ANALYSIS OF ISOKINETIC KNEE EXTENSION TORQUE CHARACTERISTICS OF VOLLEYBALL PLAYERS DURING THE ANNUAL MACROCYCLE

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Introduction Isokinetic extension and flexion peak torques are frequently used to assess strength possibilities of volleyball players in different periods of an annual macrocycle (Hadzic et al., 2010; Rousanoglu et al., 2013). Much less attention has, however, been paid to quantify irregularities on isokinetic torques time-curves occurring during the competitive season. The aim of this work is thus to inspect such undulations using a discrete wavelet transform methodology. It was hypothesised that a time-frequency analysis was suitable to quantify the changes in the knee extension torque characteristics throughout the annual macrocycle. Methods The research was conducted among 13 volleyball players from a second-division team. The torque of knee extensors was measured using Biodex System Pro4. The measurements were done at the end of four different periods of the annual macrocycle: the transition period, the preparatory period, as well as the first and the second rounds of the competition. A Daubechies 4 wavelet was chosen for a time-frequency analysis of the signal originating from the dynamometer. ANOVA with repeated measures was applied to check the differences among the research variables. Results The wavelet decomposition revealed significant differences in high frequency energy content between the first and fourth ( $p<0.0087$ ), the second and fourth ( $p<0.0097$ ) and between the third and the fourth ( $p<0.021$ ) measurements. There were no statistically significant differences between the first three measurements. Discussion The high frequency energy contained within the details of the decomposed signal detected after the second round of the competition may reflect indirectly a fatigue of the knee extensors. The changes in energy spectrum have been already observed in biomechanics Tsepis et al. (2004) who reported the higher-frequency content in the isokinetic time-torque characteristics of ACL deficient knees compared to the intact ones. The obtained results may be of practical value, since they can help to assess the players' muscle fatigue during the macrocycle, verify and modify the training methods which are being used, and adopt an individual approach to each player. References Hadzic V, Sattler T, Markovic G, Veselko M, Dervisevic E. (2010). Isokinet Exerc Sci, 8(6), 31-37. Rousanoglou EN, Barzouka KG, Boudolos KD. (2013). J Strength Cond Res, 27(4), 1108-1117. Tsepis E, Giakas G, Vagenas G, Georgoulis A. (2004). J Biomech, 37 (6), 857-864. Contact adam.czaplicki@awf-bp.edu.pl



**IS FEAR OF INJURY ASSOCIATED WITH BREAKFALL KINEMATICS FOR OSOTO-GARI IN NOVICE JUDOKAS?**

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**Introduction** It has been reported that direct head contact to mat by being thrown backward with osoto-gari is the leading cause of judo-related head injury, including catastrophic injuries, such as acute subdural hematoma (Kamitani et al, 2013). Judo experts have agreed that breakfall for osoto-gari is a physically and mentally demanding skill, explaining the higher risk of injuries in novice judokas. The perception of risk and incidence of injury may lead to a judoka's fear of injury, which could even be more detrimental to breakfall kinematics. However, studies on the association of perceived fear with breakfall kinematics are limited; therefore, we aimed to study this association in novice judokas. **Methods** We recruited 10 novice judokas who had not previously participated in judo competitions but had attended a minimum of 10 sessions of a judo course offered by Ryotokuji university. The test protocol included three sets of breakfall in response to being thrown with osoto-gari onto the mat. Subsequently, all participants were asked by one assessor to gauge their fear of injury and were evaluated using a 5-rank Likert scale. Four participants who answered 'felt fear in the breakfall motion' were assigned to the fear group (F group), whereas four participants who answered 'not much fear felt' were assigned to the no fear group (NF group). Two participants who answered 'neither' were eliminated from further analysis. We obtained three-dimensional marker trajectory data of the 41 attached markers using an 18-camera Mac3D motion analysis system (Motion Analysis, Inc. CA, USA). (500 Hz) and calculated neck, trunk, right/left hip and right/left knee joint angles in the sagittal (z-x) plane as well as the peak neck extension momentum during the breakfall motion. **Results** There were no remarkable differences in neck, trunk, hip and knee angle pattern during the breakfall motion for osoto-gari between the F and NF groups; the groups showed similar characteristics as reported previously (Koshida et al, 2014). In addition, we found little difference in peak neck extension momentum between the groups [F group: 1.04 (0.77–1.22) kg m<sup>2</sup>/s–1; NF group: 1.01 (0.70–1.18) kg m<sup>2</sup>/s–1]. **Discussion** The results indicate that the fear of injury may not be associated with breakfall kinematics and possible risk of injury associated with being thrown with osoto-gari in novice judokas; this suggests that a coach should probably not rely only on the learner's feeling of fear when making progress on the breakfall learning process. Considering the severity of head injury that occurs by being thrown with osoto-gari in novice judokas, it is necessary that coaches develop appropriate skills to evaluate breakfall motion for osoto-gari. **References** Kamitani T, Nimura Y, Nagahiro S, Miyazaki S, Tomatsu, T. (2013). *Am J Sport Med*, 41(8), 1915–21. Koshida S, Koshida S, Ishii T, Matsuda T, Hashimoto T. (2014). The proceedings of 32th Annual Conference of Biomechanics in Sports, Johnson city, TN, USA, June, 2014. Sentaro Koshida Ph.D, ATC, CSCS, JASA-AT [koshida@ryotokuji-u.ac.jp]

**EPIDEMIOLOGY OF BACK PAIN IN GERMAN ELITE ATHLETES**

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**Introduction** The importance of physical activity in the treatment of back pain (BP) is generally accepted. However, an increase in physical activity has been suggested to be both a preventive factor and a possible risk factor for BP. It is well known that sports participation generally influences our health in a positive way, but there is a lack of knowledge about the optimal dose-effect relation. There is evidence for an association between high physical workloads and back injury. In sports, BP is commonly reported to be a frequent disorder but it is still unclear if its prevalence is higher than in nonathletes. The aim of this investigation was to determine lifetime prevalence (LT), 12-months prevalence (12m-P) and point prevalence (PP) of BP in German elite athletes regarding the pain intensity and the exact localization at the spine. **Methods** The study was designed as a cross-sectional survey among athletes competing at the national elite level in different sports. An online-based questionnaire was sent to N=4000 athletes from different sports disciplines by the German Olympic Sports Confederation. The questionnaire consisted of several validated questionnaires on BP (Nordic questionnaire [1]), questionnaire for grading the severity of chronic pain [2]). Additionally a self-developed questionnaire focusing different aspects of training and competition was used to evaluate the athletic workloads. **Results** A sample of N=1094 German elite athletes (583 females, 508 males, 20.7±5.0 years, 176.6±10.5 cm, 70.6±14.1 kg, training volume: 18.3±7.9 hours/week) took part in the survey (response rate≈25%). LT of BP was 88.7%, 12m-P was 81.4% and PP was 49.2%. The most often occurred localization was the lower back with a LT of 77.6%, 12m-P of 65.5% and PP of 33.8%. Regarding the sports disciplines individually LT of BP and low back pain ranges 57.9–100% and 42.1–92.9%, respectively. Very high prevalence rates of 94.7–100% were found in canoeing, dancing, rowing and water-polo. **Discussion** The results of this investigation indicate that BP is a present problem in German elite athletes. Especially sports disciplines with high mechanical loads on the spine seem to be affected. High training volume up to 45 hours per week might be responsible for high prevalence rates. The results of this investigation underline the necessity of BP prevention in German elite athletes. **Acknowledgement:** The study was supported by the Federal Institute for Sport Science, Germany (ZMV11-080102A/11-18). **References:** [1] Kourinka I. et al. (1987). *Appl Ergon.* 18, 233–37. [2] von Korf M. et al. (1992). *Pain.* 50(2), 133–48 **Contact:** Katharina.Trompeter@rub.de

**PRECONDITIONING WITH ISCHEMIC EXERCISE PRESERVES QUADRICEPS FEMORIS MUSCLE ENDURANCE PERFORMANCE FOLLOWING ACL RECONSTRUCTION**

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**Introduction** Quadriceps f. (QF) muscle weakness is recognised as a key factor of poor knee function, despite optimal reconstruction of ACL. Limb surgery performed with tourniquet induces mechanical compression and augments ischemic stress, which can further accelerate QF muscle weakness (Appell et al, 2004). Preconditioning of skeletal muscle with periods of intermittent ischemic exposures has been shown to have positive effects on cell survival (Murphy et al, 2010). In addition, muscle ischemia in combination with low-load exercise was proven to be superior from free blood flow exercise in terms of enhancing vascular function (Patterson & Ferguson, 2010), oxygen delivery and muscle endurance (Kacin & Strazar, 2011). Present study thus assessed effects of short-term preconditioning with ischemic exercise can preserve QF endurance within the first 12 wks after ACL reconstruction. **Methods** Twenty subjects, undergoing ACL reconstruction with ipsilateral hamstrings autografts, performed 5 exercise sessions during the last 10 days before surgery. They were quasi-randomly assigned into two groups: ISCHEMIC group - performing low-load blood flow restricted (ischemic) knee-extension exercise or SHAM group - replicating the same exercise volume with free blood flow. Tissue hemoglobine kinetics (NIRS) and surface EMG were measured on QF muscle during isometric contraction performed at 30% MVIC torque to volitional failure prior to preconditioning and at 4 and 12 weeks post-surgery. **Results** Time of sustained QF contraction decreased ( $p=0.002$ ) in SHAM group by  $100\pm91$  s at 4 wks and returned to preoperative values at 12 wks. No decline in contraction time was observed in ISCHEMIC group at 4 wks, whereas an in-

crease of  $54 \pm 50$  s was observed at 12 wks post-surgery. A  $33 \pm 8\%$  increase ( $p=0.018$ ) in RMS EMG amplitude, with concomitant  $56 \pm 16\%$  increase ( $p=0.010$ ) in muscle blood flow, was observed only in ISCHEMIC group at 4 wks after surgery. Discussion This is the first study to demonstrate a positive effect of short-term ischemic exercise on QF muscle endurance in patients after arthroscopic ACL reconstruction. Enhanced endurance of QF muscle was brought about by augmented muscle fibre recruitment for the given torque output. This most likely resulted from combination of preserved muscle activation capacity and enhanced regulation of oxygen delivery to the muscle. The latter may be an evidence of persisting effect of ischemic preconditioning on density and function of muscle microcirculation within first 4 wks after surgery with prolonged tourniquet application. The authors acknowledge the financial support from the Slovenian Research Agency (research applied funding No. L3-5509). References Appell HJ, Glöser S, Duarte JA, Zellner A, Soares JM. (1993). Eur J Appl Physiol Occup Physiol, 67, 342-7. Murphy T, Walsh PM, Doran PP, Mulhall KJ. (2010). J Transl Med, 8, 46. Patterson S, Ferguson R. (2010) Eur J Appl Physiol, 108, 1025-33. Kacin A, Strazar K. (2011). Scand J Med Sci Sports, 21, e231-41.

### A LONGITUDINAL ANALYSIS OF RENAL FUNCTION IN TRANSPLANTED CYCLISTS

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**INTRODUCTION** It's well known that solid organ transplant recipients may return to sport practice after transplantation. However, no study has still evaluated the effects of competing in a cycling marathon (CM) on renal function change across years in transplanted cyclists (TC). The purpose of this case series was to analyse the renal function in TC having participated to three consecutive editions of an annual 130-km road MC. **METHOD** The renal function of 5 males TC (age:  $52 \pm 11$  yrs; BMI:  $24.7 \pm 3.1$  kg/m<sup>2</sup>), who underwent transplant (1 heart, 2 liver, 2 kidney)  $7.6 \pm 6.1$  yrs before the first examined MC, were evaluated through venous blood and urine specimens: basal, measured the day before the race (Pre), immediately after the race finish (Post), and 24 hours after the race finish (24h). **RESULTS** All participants aimed to successfully complete all CMs, with everyone's individual final time being approximately the same in the three editions. No meaningful change was observed regarding basal values of examined blood and urine indices during the study period in any subject. For any cyclist, there were no relevant changes across years of Pre/Post, Pre/24h, and Post/24h differences for Hb, haematocrit, urea, and urine specific gravity. Similarly, Pre/Post changes observed for eGFR, creatinine and proteinuria (on average -7%, +26%, and +58%, respectively) were almost the same in the three CM editions. Also, in all CT and for all CM editions, these variables showed values returning to baseline at 24h. **DISCUSSION** The present findings are in agreement with a previous study (Neumayr et al., 2003), reporting that, in healthy subjects, renal functional parameters significantly increase immediately after a cycling race, but return to baseline values after 24 hours. This demonstrates that a temporary "impairment of renal function" may be a physiological response to the CM. An increased proteinuria was observed immediately after intense physical efforts (Bellinghieri et al., 2008), likely related to the high muscular work required by the effort. The present results show, also for proteinuria, that the response to a prolonged physical effort in TC involves physiological changes similar to those exhibited by healthy subjects. Furthermore, in well trained TC, the ability to recovery after a CM seems to be maintained across years.

## Mini-Orals

### MO-SH12 Psychology: Team Sports

#### INFLUENCE OF TEAM COHESION AND MOTIVATIONAL CLIMATE ON SATISFACTION WITH TEAM PERFORMANCE AT A LACROSSE WORLD CUP

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**Introduction** Several studies show that the team cohesion as well as the coach created motivational climate in a team have an influence on other important team variables like satisfaction with the team or team performance. In general, high values of the four factors of group cohesion as well as a mastery climate are linked to positive outcomes, whereas an ego climate is associated with more negative outcomes. The aim of our study was to examine the influence of team cohesion and motivational climate on satisfaction with performance during the women's Lacrosse World Cup. **Method** In total, 127 players from nine different teams (of 19 participating teams) took part in the survey. The mean age was 26.0 years ( $SD = 4.6$ ) with an average of 3.4 years ( $SD = 3.2$ ) with their current team. Players answered questions regarding team cohesion (KIT-L2; Ohlert, Kleinknecht & Kleinert, 2015) and coach created motivational climate (PMCSQ-2; Newton, Duda & Yin, 2000) prior to the first World Cup game. After completion of the last game they were asked questions regarding their satisfaction with team performance (STP) and personal performance (SPP) throughout the World Cup. Canonical correlations were performed to analyse the interactions between both group cohesion and the two satisfaction variables as well as motivational climate and satisfaction. **Results** The canonical correlation between cohesion and satisfaction (.42) indicates that all four factors of cohesion are associated with both STP and SPP, as all factors correlated with the canonical variate (.55 to .89). However, for motivational climate (.38 in total), only a mastery climate was associated with STP and SPP (.99), as ego orientation only correlated at .15 with the respective canonical variate. **Discussion** Our results indicate that higher group cohesion predicts both to higher STP and SPP throughout a World Cup tournament. For motivational climate, it is important to notice that a coach induced ego climate had no effect on satisfaction with performance (personal and team), whereas a mastery climate shows the expected effect. A possible explanation might be that a high competitive environment of a World Cup tournament comes with high ego climate within a team anyway. Thus, focus of coaches should be on a mastery climate, especially within a highly competitive situation. **References** Newton, M. L., Duda, J. L., Yin, Z. (2000). J Sports Sci, 18, 275-290. Ohlert, J., Kleinknecht, C., Kleinert, J. (2015). Sportwissenschaft, 45, 116-126. Contact j.ohlert@dshs-koeln.de

### SHARED MENTAL MODELS IN HANDBALL AND SOCCER ELITE TEAMS.

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Shared mental model (SMM) is held as important facilitating team performance and it is considered a useful construct for analysing elite team practice. Canon-Bowers, Salas, & Converse (1993) describe SMM as knowledge structures held by members of a team that enable them to form accurate explanations and expectations for the task, and in turn, to coordinate their actions and adapt their behaviour to demands of the task and other team members. Giske, Rodahl & Høigaard (2015) argues that SMM is a useful construct for analysing elite team practice and coaching behaviour. The aim of this study is to explore how elite coaches in handball and soccer reflect on team cognitive properties and how these attributes are developed through team practice. In study 1 we investigated the reflections on shared mental models and coaching efforts to develop it in National handball teams. Three coaches participated. In study 2 we elaborate coaches' reflections and players' experience of how shared notions of game tasks is affected by practice in two elite soccer teams. Two UFFA-pro coaches from Norwegian Premier League, and four elite players volunteered to participate. A qualitative content analysis (Morgan, 1993) of the verbatim transcription was undertaken. The interviews in both studies revealed that measurements such as use of video, team meetings, and field practice were used in both ballgames to enhance a shared mental model. The national coaches in handball reported systematic practice with intention to promote coordination where repetitions of the coordinative patterns in typical game situation were emphasized. Distribution of tasks in game situations and timing seems to be vital pedagogical content elements contributing to establish shared situational awareness. Implicit communication is a characteristic of teams sharing a mental model and this seems to be especially prominent in handball coaches' reflections and proactive distinct bodily movements are emphasised as a crucial requirement for coordination. The soccer players' draws attention towards knowledge about team member attributes within more explicit task team generic guidelines. References Cannon-Bowers, J. A., Salas, E., & Converse, S. A. (1993). Shared mental models in expert team decision-making. In N. J. Castellan (Ed.), *Individual and group decision making: Current issues* (pp. 221-246). Hillsdale, NJ: Erlbaum. Giske, R., Rodahl, S.E., & Høigaard, R. (2015). Shared mental task models in elite ice hockey and handball teams: Does it exist and how does the coach intervene to make an impact? *Journal of applied sport psychology*, 27, 20-34. Morgan, D. L. (1993). Qualitative content analysis: A guide to paths not taken. *Qualitative health research*, 3, 112-121.

### A CORRELATIONAL ANALYSIS OF PERFORMANCE STRATEGIES AND MOOD STATES IN TWO UNIVERSITY BASKETBALL TEAMS

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**Introduction** Performance strategies play an important role in sport success from college (Dachen, 2012) to Olympic levels (Taylor, Gould & Rolo, 2008). One of the key strategies is to learn how to control emotions and develop optimal emotional states in training and competition. The aim of this research was to investigate the relationship between performance strategies and mood states in a British University and College Sport (BUCS) first and second division basketball teams in training and competition situations. **Methods** Fourteen male university students (mean age=22.9 years) volunteered for the study. They were from a BUCS league's first (n=7) and second (n=7) division teams in the North East of England. Players completed the Test of Performance Strategies scale and the Brunel Mood Scale prior to training and match conditions. Data were analysed by performing descriptive statistics, Pearson's correlation, and independent and paired-samples T-tests using IBM SPSS (v22) software package. **Results** All players reported higher vigor ( $p=.02$ ) and used more self-talk ( $p=.03$ ) in training than in competition. Players in the first team exhibited higher levels of automaticity than players in the second team ( $p=.004$ ). In training, a positive correlation was found between attentional control and emotional control ( $r=.57$ ,  $p<.05$ ) as well as between goal setting and tension ( $r=.56$ ,  $p<.05$ ). During the matches automaticity was positively associated with relaxation ( $r=.61$ ,  $p<.05$ ) and negatively with tension ( $r=-.79$ ,  $p<.01$ ), while activation was inversely related to both negative thinking ( $r=-.58$ ,  $p<.05$ ) and depression ( $r=-.54$ ,  $p<.05$ ). **Discussion and Conclusions** The findings show that higher level performers in the first team use more automated technical and tactical skills than lower level players in the second team, which is in accord with current knowledge (Taylor et al., 2008). Further, the here investigated teams (placed at the bottom in their own league) appeared to be intimidated to use self-talk during matches, when vigor also dropped. The correlations are based on a low sample size and, therefore, with larger samples they would be even more powerful. Nevertheless, they show that activation and automaticity are linked to positive mood states during matches. Another positive link between emotional and attentional control suggests that stable emotions may be paired with better concentration. The positive link between goal setting and tension could reflect an inner struggle to achieve the set goals. **References** Dachen, I. (2012). *Int. J. Beh. Soc. Mov. Sci.*, 1 (14), 139-147. Taylor, MK., Gould, D., Rolo, C. (2008). *Hi. Ab. Stud.*, 19(1), 19-36.

### VISUAL SEARCH BEHAVIOUR IN SOCCER: WHICH PREDICTOR COULD EXPLAIN COMPETITIVE LEVEL?

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**Introduction** As one of the perceptual-cognitive skill, the visual search behaviour allows soccer players to seek relevant information that helps them in deciding the accurate actions to execute during a match. In this sense, the aim of this study was to identify which predictors of visual search behaviour during a prolonged intermittent exercise protocol could explain competitive level. **Methods** Sixteen soccer players were separated in two groups of eight players each, according to Elite (mean age = 24.6 yr, SD=3.9 yr; Semi and professional level 5.1 yr, SD =2.4 yr) and Non-elite (mean age = 26.3 yr, SD=2.9 yr; amateur level = 2.1 yr, SD=2.4 yr). The Applied Science Laboratories (ASL) 3000 eye-movement registration system was used by participants during the whole protocol test. To simulate the physiological demands of a soccer game, an intermittent exercise protocol was used (Drust, Reilly, & Cable, 2000). The protocol was consisted in 119 minutes divided in first half (52 minutes), recovery phase (15 minutes) and second half (52 minutes). Data were collected in four moments of test sessions (1<sup>st</sup> and 2<sup>nd</sup> in first half time, 3<sup>rd</sup> and 4<sup>th</sup> in second half). The measures from visual search behaviour comprised the Number of fixation per locations (NFL) (ball, teammate, opposition, player in possession of the ball, and undefined), and mean fixation duration per trial. The undefined category was excluded (less than 1%). The inter-observer agreement value was 99% (were reanalysed 25% of the data). In order to explain the variance of the dependent variable logistical regression were performed, as well as the correlation coefficient of determination and Beta value ( $\beta$ ). The alpha significant value was set at .05. **Results** The logistic regression model was statistically significant,  $\chi^2(1)=7.31$  ( $p=0.007$ ). The model effect size was 0.36 and correctly classified 50.0% of cases. The increasing tendency of

fixation durations values on the player in possession of the ball could explain the expertise level (i.e. elite or not-elite) of soccer players ( $OR=0.99$ ;  $p=0.04$ ). Discussion The results showed that the fixation durations on the player in possession of the ball could explain the competitive level when verified this variable in the 2<sup>o</sup> half time (3<sup>o</sup> moment). Thus, elite players demonstrated superior fixation duration on the player in possession of the ball. In this way, our results suggested that the superior performance of elite players was associated with the selectivity of the perceptual resources, also suggested by others researchers (Martins et al., 2014). References Drust, B., Reilly, T., & Cable, N. T. (2000). Physiological responses to laboratory-based soccer-specific intermittent and continuous exercise. *Journal of Sports Sciences*, 18(11), 885-892. Contact rafabagatin@hotmail.com fcasanova@fade.up.pt

## **SUPPORTING ATHLETE CAREERS AND DEVELOPMENT – CHANGING APPROACHES FOR A CHANGING WORLD**

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Introduction Athlete career support has developed over a quarter of a century in Australia and has followed a similar pattern to European models. The Life Skills for Elite Athletes Program (LEAP) was launched in 1991 motivated by the lack of opportunity for athletes seeking a career at the conclusion of their sporting careers. This was followed by an expanded Athlete Career and Education Program. It was possible to identify two discrete threads in these programs. A basic thrust on facilitating a healthy transition from athletic retirement, influenced by findings from literature on athlete development that many athletes over-invested in their identity as athletes, thus foreclosing on other aspects of personal development and identity. Review Our review shows that in Australia as in Europe much attention was focused on facilitating athletes' ability to continue in academic study and prepare for an alternative career to move into on completion of their sporting careers. However data from our own research (Saunders & Pink, 2004) are used to support our belief that the nature of Athletes' work has changed and a different response is now needed by those who work in athlete development to provide more effective support. Findings We argue that recent changes in the demands of the professional sport have led to increased time and commitment required for the development and maintenance of the sports career (Pink, Saunders, & Stynes, 2015). This has led to diminished relevance of the concepts of dual and/or alternative careers. Paradoxically we provide evidence that there has been increasing length in the careers experienced in many sports alongside increasing opportunities for 'switching' into jobs within the sport and related industrial sectors. Conclusion Current approaches such as the AIS Personal Excellence program have focused on the notion of holistic personal development or, as expressed by the Max360 initiative of the AFLPA, "changing the 'preparing for life after football' narrative, to 'assisting players to maximise the opportunities that an AFL career provides'." This is consistent with strategies adopted to avoid burnout in early careers outside of sport (Schaufeli, Leiter & Maslach, 2009). Future research should seek to identify means for such approaches to be fully supported by athletes' sporting organisations and how their cultures can more accurately meet the needs of the athletes heavily immersed in their athletic career. References Pink, M., Saunders, J. & Stynes, J. (2015) Reconciling the maintenance of on-field success with off-field player development: A case study of a club culture within the Australian Football League. *Psychology of Sport and Exercise* 21, 98-108 Saunders, J. & Pink, M. (2014) The Relationship between Player Off-field Engagement and On-field Performance. Final Report. Unpublished AFL Research Board, Melbourne. Schaufeli, W. B., Leiter, M. P. & Maslach, C. (2009) Burnout: 35 years of Research and Practice. *Career Development International*. 14: 3, 204-220 Contact: john.saunders@acu.edu.au

## **WHEN GIRLS ARE MORE EMPATHIC AND NORM-ENFORCING THAN BOYS ON THE FOOTBALL FIELD?**

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Introduction A key revolution in the past three decade is the enormous growth in women's football. This raises intriguing questions that include and go beyond the evolution of sex differences. How are women and men different, when they are playing soccer? Being more empathic in general, might we, for example, see young female football players exhibit greater empathy on the field? If so, how? And when do girls and boys differ corrective behaviors by showing disapproval of one another's fouls? Such knowledge should ultimately help us generate new solutions to enduring problems in soccer, such as violence in and around the field. Methods In total, 107 children (55 boys, 52 girls, age 10-18) participated in a web-based experiment. They were asked to imagine themselves at the soccer field being in control of the ball when another player falls on the ground. Using a within-participants design, we manipulated location (distant or close to the other team's goal) and team of fallen player (own or other team). We assessed the extent to which participants thought they would quickly stop to look how the fallen player was doing, which served as our measure of empathy. Also, we examined the likelihood of girls and boys "openly disapproving" of a foul enacted by a player of their own versus the other team. Results All participants exhibited greater empathy when the other player fell on a location farther away from the other team's goal, and when the player was from the own team. Most interestingly, boys and girls differed in one key aspect: At midfield, boys and girls were about equally empathic, but closer to the goal of the other team (when scoring is a clear possibility) boys were far less empathic than girls. Disapproval of fouls also uncovered intriguing differences. Reportedly, while girls were about equally likely to show disapproval against player of their own versus the other team, boys were far more likely to do so when the foul was conducted by a player from the other (versus own) team. Discussion When do sex differences in football become manifest? We find that when scoring becomes a real possibility (when the distance to the goal is small), girls still enact empathy while boys move on to continue playing. This finding is consistent with the notion that men more than women are oriented on pursuing a single goal rather than multiple goals. We also find differences in showing fault disapproval. While boys are clearly biased in favor of their own team, girls are about equally "corrective" towards players of their own and the other team. The latter finding is important, because it is possible that showing disapproval of especially unnecessary fouls (e.g., at the midfield) by own team players may often help the team to win – and to win by proper means. Contact Paul A. M. Van Lange [pam.van.lange@psy.vu.nl]

## **EVALUATION OF PSYCHOLOGICAL SKILLS IN FEMALE SOCCER PLAYERS OF DIFFERENT CATEGORY LEVELS. A LONGITUDINAL STUDY DURING ONE-YEAR LEAGUE COMPETITION**

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Introduction Several studies have already dealt with the physiologic demands of soccer; however, little attention has been paid to the influence of psychological aspects, particularly in female participants. The purposes of this study were: 1) to describe the profile of psycho-



logical skills in different Spanish players of female soccer; 2) to examine the influence of age and the level of practice on these skills. **Methods** A sample of 101 female soccer players completed a validated Spanish version of the Athletic Coping Skills Inventory (ACSI-28) (Graupera et al., 2011) in the National League from 2013 to 2014. The stratification of the sample included 20 players belonging to the first national division, 33 competing in the second national division, and 48 from inferior categories. The ACSI-28 questionnaire (Smith et al., 1995) examines perceptions in the practice and competition of the athletes: coping with adversity, peaking under pressure, goal setting/mental preparation, concentration, freedom from worry, confidence and coachability. The test was administered in three stages: at the beginning, at middle stage, and at the end of the tournament. Psychological profile of were compared in relation to the division (Wilcoxon test). Correlations between factors from ACSI-28 (Spearman Rho) at the beginning and at the end of the season were also analyzed. **Results** The analysis of the questionnaires showed differences between the national and the other categories of players. At the end of the season the players of lower categories had better scores than the first and second national divisions in two factors: coping with adversity ( $p < 0.05$ ) and coachability ( $p < 0.01$ ). Likewise, these players improve their ability in coping with adversity ( $p < 0.05$ ). The players of first division significantly decreased their coachability ( $p < 0.05$ ). The results of the factors analyzed were independent of the level of education of the players. There were significant differences between playing positions and results of capacity concentration (lower in goalkeepers,  $p < 0.05$ ) and general coping resources (lower in forwards,  $p < 0.05$ ). **Discussion** The first division players were better prepared to deal with psychological distress involving soccer competition and reported better emotional self-control. The use of the ACSI-28 allows a friendly approach to the specific psychological skills required in soccer. A better understanding of the psychological factors underlying female soccer at different categories might allow for the development of interventions to improve psychological skills of participants.

## Mini-Orals

### MO-SH02 Sport Statistics & Analysis

#### THE ROLE OF SIDE ENTREES IN GERMAN AGE-GROUP SWIMMING

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**INTRODUCTION** Every nation aims to send successful athletes to international top events. For this reason national swimming associations provide multi-year training plans to operate long term development for identified young talents. To quantify the role of side-entrees (newcomers at progressed developmental level,  $\sigma > \text{age } 15$ ,  $\eta > \text{age } 14$ ) into German Age Group Swimming a longitudinal investigation of careers was made. **METHODS** To examine the rate of lateral entrees into German competitive swimming the 100 best age-group swimming performances (long course) of eight subsequent years (2004-2013) were analyzed. Here the focus was on the age-groups 1993 - 1995 ( $\sigma n = 1.862$ ;  $\eta n = 1.993$ ). The athletes were assigned to one of the following groups: Survivors (athletes who remained in the rankings in all previous years), Returnees (athletes who had at least one year without ranking and made it back into the top 100) and Newcomers (athletes who got ranked for the first time). **RESULTS** The Newcomer rate for male swimmers decreased within the ages of 12-14 years in boys (23,1%; 16,7%; 12,3%), stabilizes over the ages 15-17 ( $10,97\% \pm 0,12\%$ ) and increases again at the age of 18 (14,5%). For girls the rate decreases as well from 12-14 years (20%; 14,3%; 12,3%), stabilizes at age 15/16 ( $14,0\% \pm 0,7\%$ ) and increases earlier than the rate of boys at the age of 17 (15,4%) until 18 (21,3%). **DISCUSSION** We conclude that there are only a few continuous carriers among German age-group-swimmers. The role of side-entrees increases with progression of development. The rates decrease in the same age-groups of male and female swimmers but increase one year earlier for the girls. Future research should analyse the qualitative role of these Newcomers. **REFERENCES** Côté, J. et. al (2007). Handbook of sport psychology Ericsson, A. K. et. al (1993). Psychological Review Güllich, A. (2013). Sport Güllich, A., & Emrich, E. (2012). European Journal for Sport and Society CONTACT i.staub@dshs-koeln.de

#### BALL PLACEMENT IN A TENNIS MATCH OF WORLD-CLASS PLAYERS AS A CASE STUDY

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*Purdue University*

**Introduction** In a tennis match, the basic idea is that the players endeavor to score winning points as well as to prevent their opponent from scoring points. The outcome of their effort is embedded in tennis ball placement. If one player strikes the ball to the opposite side of his opponent, then the receiver has to change his behavior to return the ball on the court. This unique behavior in tennis can be described by analyzing ball placement, and ball placement data also can be a performance indicator in a tennis match. **Methods** The 1st round match of men's singles in the 2013 Australian Open was selected for analysis. The match was converted to jpg files for every frame. The frames contain the ball placement on the court and a custom-made Matlab program caught the ball placement. The center of the court was the origin point as (0,0). The x-axis and y-axis corresponded to the horizontal and vertical placement of the tennis court, respectively. The Matlab program reconstructed the ball placement by transforming the ball placement from the captured frames to real-world locations. We obtained a time-series of ball placement for each player. The time-series of ball placement for the horizontal data and for the vertical data were classified with respect to each player. Detrended Fluctuation Analysis (DFA) was applied to every set of time-series data to determine the statistical self-affinity. **Results** There were overall 634 frames of ball placement for each player. After the serves and outs were excluded, the valid ball placements for player 1 was 170 and for player 2 was 152. It was found that the horizontal ball placement showed a u-shape frequency histogram, which meant both players tended to send the ball mostly to the left and right. This shape corresponded to the basic idea of tennis strategy to force the opponent to cover more area on the court. There was a 36.6 cm difference in the average radial distance of ball placement from the center of the court. However, DFA results for both players were almost the same with the alpha value of 0.53 and 0.54. In horizontal ball placement, an 18.65 cm difference was shown and the alpha value was 0.53 for player 1 and 0.65 for player 2. The alpha value was 0.51 and 0.56 respectively, which showed a 38.36 cm difference in vertical ball placement. **Discussion** This study showed that professional tennis players seem to produce uncorrelated shots. DFA results were approximately 0.5, a criterion known as white noise. It is likely that the results are due to the high ability of each player. An exception was found for player 2 in horizontal ball placement possibly due to ranking differences. Future comparative research is necessary to analyze less skilled players. **References** Lames M. (2006). J Sports Med, 5, 556-560. Palut Y., Zanone P-G. (2005). J Sports Sci, 23(10), 1021-1032. Contact kim1314@purdue.edu

### BEING TOP LEVEL YOUTH IS NEITHER SUFFICIENT NOR NECESSARY TO BECOME A TOP LEVEL ATHLETE.

BOCCIA, G.1,2, MOISÉ, P.3, FRANCESCHI, A.3, TROVA, F.3, PANERO, D.3, LA TORRE, A.4, RAINOLDI, A.2, SCHENA, F.1,5, CARDINALE, M.6

1 CeRISM (Rovereto, Italy); 2 Motor Science Research Center (Torino, Italy); 3 SUIISM (Torino, Italy); 4 Department of Biomedical Sciences for Health; 5 Department of Neurological, Neuropsychological,

**Introduction.** The idea that early sport success, because of early sport specialization or early physical maturation, can be detrimental for long-term sport performance is still under debate (Moesch et al. 2011, Tønnessen et al. 2015). Limited information is available on many sports on the pathway to elite performance. The aims of this study were to investigate if the age of starting competition, the youth annual rate of change in performance, and the age of reaching personal best performance influenced reaching international level performances of high and long jumpers. We also wanted to investigate how many top level youth athletes became top level athletes and how many top level athletes were considered top level when performing in youth categories. **Methods.** The long and high jump rankings of the Italian Track and Field Federation were collected for each age category, i.e. from the age of 12 to career termination, and both genders from the year 1994 to 2014. The individuals of each discipline were ranked on the base of the z-score of their personal best performance. The annual rate of change in jumping performance, the age of beginning competitions, and the age when they reached their best performance were identified for each individual. Top athletes were identified as those with a z-score between 97 and 100. **Results.** The initial age of entering competitions of top level athlete was not different with respect to the rest of sample. Whereas the age at which the personal best performance was obtained was higher in top level athletes than in the rest of the sample. Top level athletes showed an overall higher rate of change in performance from the age of 14 to the age of 18 years when compared to all other individuals. Less than 45%, of young male and female top athletes were top level when young. Less than 40% of top level athletes at the age of 16 became top level adults. **Discussion.** These findings show that the duration of the athlete career influences the personal best performance. Moreover, most of the top level adult athlete were not top level at youth level and most of the top level youth did not maintained the same level of performance in adulthood. We suggest that young age performance do not predict the performance in adulthood because the length of the career is a key factor in the career athlete, however rapid improvements in elite performers are observed from 14 to 18 years of age suggesting that technical learning during puberty is fundamental to develop elite performers. **References** Moesch K, Elbe A, Hauge T, Wikman J (2011), Late specialization: the key to success in centimeters, grams, or seconds (cgs) sports, *Scand J Med Sci Sports*, 21: 282–290 Tønnessen E, Svendsen IS, Olsen IC, Guttormsen A, Haugen T. (2015) Performance Development in Adolescent Track and Field Athletes According to Age, Sex and Sport Discipline, *PLoS One* 4;10(6)

### THE VIENNA CPX-TOOL – A NEW ANALYSIS SOFTWARE FOR PERFORMANCE DIAGNOSTICS

ALLEMANN, H., SEILER, P., HAUSHARTER, M., WEBER, C., HEBER, S., POKAN, R.

*Institute of Sport Science Vienna*

**Introduction** Vienna CPX-tool is a new software intended for evaluation of cardiopulmonary exercise tests by estimating transitions (T) between 3 phases of energy supply, i.e. T1 and T2. We integrated 3 distinct calculation methods. Each allows estimation of threshold indicators (IND), i.e. lactate turn point 1 (LTP1), ventilatory threshold 1 (VT1) and respiratory equivalent for oxygen (VE/VO2) for T1 and LTP2, VT2, VE/VCO2, and heart rate turn point (H RTP) for T2. Since each T is based on a common physiological mechanism, we assume that an accurate calculation method results in a small range of power output estimates for each IND within each T. The aim of the present study was to compare the 3 methods regarding ranges. **Methods** 10 women and 19 men, mean age 25.3y, performed a bicycle step test until exhaustion with increments of 15 or 20 watt/min, respectively. HR, ventilation (VE), VO2, VCO2 were measured continuously, blood lactate concentration (LA) after each stage. Curves for HR, LA, VE, VE/VO2 and VE/VCO2 were analyzed by defining sections of each curve, to which each calculation method (Angle, A; Regression, R; Error variance, E) was applied. Sections were set between the start of the work and 75% of maximal power output (Pmax) for LTP1, VE/VO2, and VT1, between the respective first turn point (TP) and the maximal value of each parameter for LTP2, VT2, and VE/VCO2, and between 50% of Pmax and HRmax for H RTP. All TPs were computed by 3 methods: A: A point that can move within a predefined section is determined near the center of the calculation section. Two lines, originating in the start and end of the section with a common intersection at the movable point are created. The intersection of lines combination of lines with the highest angle at the intersection is selected, their intersection defines the TP. R: Starting near the center of the dataset, the calculation area is divided into two sections. Applying the least squares method two regression-lines are fitted to the divided areas and the error variance is calculated. This procedure is repeated until the combination of lines with the smallest error variance is identified. The intersection between the two lines marks the TP. E: Two lines are created as in method A. The calculated global error variance is used to identify the two lines with the best fit. The TP equals their common intersection point. **Statistics:** For each individual, % power output of Pmax was calculated for each IND, the range was calculated for T1 and T2. Range differences between 3 methods were tested by ANOVAs. **Results** No differences between methods were found. **Conclusion** Based on the present findings it is not possible to determine a qualitative difference between the 3 calculation methods. Contact herwig.alleman@univie.ac.at

### COACHING PRACTICE IN SPORT <5-11 YEARS>: A SYSTEMATIC REVIEW

HOOVER, D.1, HAYMAN, R.1, HALL, E.1

*Northumbria University*

**Introduction:** Sport coaching research displays a diverse range of findings, but as interest in the area builds momentum, a call for a logical, organised examination of the literature was required to provide a structured outline of research previously undertaken and any potential lines of enquiry necessary in order to provide a complete overview of sport coaching practice(5-11 years). Therefore, the aim of this paper was to systematically review, evaluate, appraise and synthesise all existing coaching practice literature within sport (5-11 years). The review was undertaken to inform policy and professional practice in sport coaching along with identifying further research opportunities in unexamined areas of coaching. **Methods:** Initial electronic database searches were directed by the use of specific key words extracted from the research question, which allowed for the main concepts of the review to be investigated. An inclusion and exclusion criteria was developed to aid the efficiency of the acceptance and rejection process. Six major electronic databases and 20 electronic journals were searched in order to identify relevant research. A three stage removal process was undertaken as part of the review and sifting process (Nicholls and Polman, 2007). During the initial phase of sifting, references were removed after reading their title. Abstracts of articles which had not yet been excluded were then read, with further rejections made at this secondary stage of sifting. A full paper review was then completed at this final tertiary stage of sifting and removal process, with the remaining papers being in-

cluded in the final systematic review. Results: After systematically reviewing the extant literature within coaching practice in sport (5-11 years), results indicate that the majority of research undertaken in the area is focused towards an elite setting, with the aim of said research to improve high performance. Furthermore, the research methodology routinely implemented is of a quantitative nature with researchers tending to be from a positivist standpoint on the research paradigm. Discussion: For sport coaching understanding to advance, researchers need to address some of the methodological and contextual inadequacies currently residing within the literature. Giving consideration from a participatory, grassroots environment would provide the profession of sport coaching with a more complete and holistic body of academic work to guide progress. Therefore, findings from the systematic review will be discussed with a focus on their implications for coaches and coach education in grassroots sport. Future studies may wish to examine the underpinning philosophy, values and beliefs of grassroots coaches, with additional consideration given to the practical delivery methods of grassroots coaches supported through systematic observations of grassroots coach delivery. References: Nicholls, A. R., and Polman, R. C. J. (2007) Coping in sport: A systematic review. *Journal of Sports Sciences*. 25(1), p.11-31. Contact: David Hooper: david.hooper@northumbria.ac.uk

## Mini-Orals

### MO-SH06 Sport Management

#### SPORT RELATED ORGANIZATIONS : IMPROVING THE COMPETITIVENESS OF CAREER AND TALENT MANAGEMENT STRATEGIES

CHAUDHURI, S.

*University of Physical Education*

In the 21st century the issue of career of a sport related organization is becoming an utmost priority due to several reasons. First of all in our rapidly changing dynamic environment it is increasingly difficult for our young generation members to create and develop properly their precise career strategy concept and Hungary is no exception in this context. Secondly the methodology of analysing and utilizing life cycle lessons using a sport mindset philosophy is also a great challenge for HR specialists. Thirdly war for talent in sport related organizations has specific processes and features that deserve more attention from relevant research individuals especially in a globalizing environment. It is understood by the author of this paper that national competitiveness consists of competitiveness of all kind of sectors and industries including sport related industries organizations as follows : • Sport Manufacturing and Sport Retailing Organizations • Sport Professionals Supplement and Sport Complementary Products Organizations • Organizations who either strongly support and/or sponsor sport or have very attractive employee sport benefits • Sport organizations and associations An industry in return has its members striving to obtain and maintain a competitive advantage for as long as possible. Identification and efficient and effective utilization of unique resources and core competencies, transformation of them for a young person using individual talent coaching and Personal Branding methodology has to be ensured for aligning with organizational image and long term job satisfaction. The paper is tending to provide a comparative assessment of efforts made in Hungary in this area to comply with the challenge of in-depth analysis of four above listed area development trends and major key challenges for making sport related organizations an even more substantial contributor to national competitiveness. Evidence will be provided to demonstrate the key challenges and trends to be taken into consideration by any employer sport related organizations willing successfully identify how to reach appropriate job expectations formulated by its stakeholders.

#### INTEGRATING PEOPLE WITH DISABILITIES IN MAINSTREAM SPORT: A COMPARATIVE ANALYSIS OF ATHLETICS AND SWIMMING

CHRISTIAENS, M.

*Coventry University*

Introduction In the UK there is an estimate of 10 million people with disabilities. Only around 17.2% of them are active in sport compared to 39.6 of people without disabilities, showing a huge disparity between the two groups. In fact this gap is bigger than the gap related to gender, social class, ethnicity or sexuality. Yet, 65% of people with disabilities is interested in becoming more active and 20% is interested in becoming active (Sport England, 2015). With these positive attitudes towards sport and the huge interest in becoming active, it leaves to wonder what is going wrong. Disability sport has been an under-researched area in both sport and disability studies (Huang, 2005) which is only being addressed in the last couple of years. Therefore, this study is aimed at addressing the existing research gap focusing on disability sport participation, more specific in relation to the recent change in policy with a new focus on integrating people with disabilities in mainstream sport clubs. This study uses a comparative design to look at how grassroots sport clubs are incorporating disability policy within their club strategy. Methods This study will compare grassroots sport clubs in Athletics and Swimming. These sports are chosen for their relative big participation rate in the total population, while differing a lot on the amount of people with disabilities participating in them. Swimming has a high participation rate amongst people with disabilities while athletics has a very small participation rate (Sport England, 2015). This study uses a mixed method approach. Quantitative data is collected through an online survey, in order to map the grassroots sport clubs in the West-Midlands (County of the UK) and collect preliminary data. This data will be used to make a selection for a qualitative study. The qualitative study is aimed at gaining an understanding in how grassroots sport clubs implement disability sport policy and if these strategies are efficient. Interviews will take place with multiple stakeholders in the sport clubs. Involving Sport England, board members, coaches and both participants and non-participants. Discussion While the data collection is going to take place in the next months, the expectations are that different sport clubs approach the new policy requirements in different ways. It will be interesting to see how strategies of a sport with high participation rates, swimming clubs, compare to a sport with low participation rates, athletic clubs. Secondly it will be very interesting to see how different clubs within the same sport approach the policy in different ways and how this effects participation rates. References Huang, C. (2005). *Discourses of Disability Sport?: Experiences of Elite Male and Female Athletes in Britain and Taiwan*. Sport England. (2015). *Active People Survey 9*. London. Contact Matej Christiaens: Christ43@coventry.ac.uk

**EFFECTIVE FACTORS ON WOMEN'S PROMOTIONAL IN SPORT MANAGEMENT IN IRAN**

EHSANI, M.

*Tarbiat Modares University*

**Introduction:** This paper examines women's position in Iran based sports organizations throughout the country. It is argued that the so-called-neutral promotion process is biased against female candidates and in the end, serves the purpose of reinforcing a male-dominated top management (Aitchison, 2003; McKay, 1996; Shinew & Arnold, 1998). **Methods:** The data were collected through self-administered questionnaire ( $\alpha=.86$ ) in 2009. The findings of the study reveal several key items in evaluating candidates for promotion. **Results:** The variables of higher education, organizational commitment, political skills, family support, ICT skills, psychological factors and sport management skills ranked the upper intermediate level for the female managers, but organizational environment stood at the lower level. **Discussion:** In spite of these factors, women are absent from senior leadership positions and their powerlessness in hierarchy of Iranian sport organization is evidently shown. It is suggested that sport organizations bring about some changes aimed at supporting the women managers in fulfilling their needs.

**THE EFFECT OF PHYSICAL ENVIRONMENT AND EMOTIONAL INTELLIGENCE ON PARTICIPATION LEISURE TIME PHYSICAL ACTIVITY**

KHANGHOLI, S.

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**Introduction** Physical environment refers to characteristics of both natural environment (weather, climate, geography) and built environment (community resources, access, information) which may influence people's engagement in PA (Baranowski, 2002). Emotional intelligence has also been defined as: "The ability to perceive and express emotion, assimilate emotion in thought, understand and reason with emotion, and regulate emotion in the self and others" (Mayer, 2000). Leisure-time physical activity (LTPA) refers to "Leisure-time physical activity is exercise, sports, recreation, or hobbies (Centers for Disease Control and Prevention [CDC], n.d.a). **Methods** The research is regarded as an application one and the methods of data collection is descriptive and correlation, the population on this study included athletic participation in leisure time in Tehran city municipalities regions. Sample size is based on formula for calculating the morgan and kerji table sample size 152 females and men completed the questionnaire physical environment physical activity leisure time (CDC, 2006) and emotional intelligence (Bar-On, 2000). The data was analyzed based on multiple regression with the significance level set at 0.05. **Results** Results indicated that remarkable relationship between the total volume of physical environment and emotional intelligence for athletic participation in LTPA. Physical environment and Emotional intelligence were the independent variables while LTPA was the dependent one. The analysis indicated that only emotional intelligence was correlated ( $R=0.74$ ). liner regression analysis was used to calculate and to examine the effects of the covariates on the associations between physical environment and emotional intelligence to LTPA. those who increased their physical environment from inactive to vigorously active had a significantly compared with the persistently inactive ( $RR=0.80$ ). **Discussion** Physical environmental correlates of Emotional Intelligence in Tehran city municipalities and investigate environmental moderators of LTPA associations. several researchers have suggested the linear relationship between physical environment and emotional intelligence tend to be mediated by perceived value, which has been empirically supported as an important mediator in the various domains. The current study was designed to fill this void by examining the structural relationships of physical environment and Emotional Intelligence factors in relation to LTPA attendance, while examining the mediating influence of perceived value. **References** Bar-On, R. (2000), "Emotional and social intelligence: insights from the emotional quotient inventory", Jossey-Bass, San Francisco, CA, pp. 363-88. Centers for Disease Control and Prevention. (n.d.a). Physical Activity for Everyone: Physical Activity Terms. Retrieved November 16, 2006 from <http://www.cdc.gov/nccdphp/dnpa/physical/terms/index.htm>.

**USE TECHNOLOGY ACCEPTANCE MODEL TO EXPLORE THE TRAINING EFFECTIVENESS OF GPS SPORTS WATCH**

WU, S.Y., CHOW, H.W.

*National Cheng Kung University*

In recent years, there has been an increase in the popularity of outdoor exercise. More and more people have begun to enjoy sports like running, triathlons, and trail running. As a result of the boom in wearable technology in the health and fitness area, both recreational and professional athletes have started wearing GPS sport watches, looking to continually monitor their physical activity training and adjust intensities to improve the efficiency of their training. In spite of this trend, the factors of adopting GPS sport watches remain largely unexplored. Hence, this study employed the Technology Acceptance Model (TAM), and added social influence factor as an antecedent variable to examine the factors in influencing the intention behaviors of using GPS sport watches, and ultimately, achieving better training effectiveness. 341 users who had used GPS sport watches in Taiwan responded to a web-based questionnaire. Descriptive statistics, multiple choice analysis, independent t-test, one-way ANOVA, and Structural Equation Modeling (SEM) were used for data analysis. The results were as follows: 1. The majority of users were college-educated men between the ages of 21-40, with regular exercise habits; 2. Users preferred features including accuracy of distance measuring, battery lifetime, watch durability, and heart rate measurement. Additionally, users had an almost universal expectation to be able to track their performance via the GPS sports watch to improve the effectiveness of training; 3. On average, respondents rated higher than the midpoint of 5-points Likert scale in all of the following constructs: "Social Influence (SI)", "Perceived Usefulness (PU)", "Perceived Ease of Use (PEOU)", "Attitude toward Using (AU)", "Behavior Intention (BI)", and "Training Effectiveness (TE)"; 4. There are significant differences between participants who are in training groups or not, in terms of their responses in SI, PU, PEOU, and BI. There are also differences among the times of use per week in terms of SI, PEOU, and BI. 5. The data supports the proposed TAM model with good goodness of fit. The result shows that nearly all of the variables have significant positive effect, except SI to AU and PU to BI. According to the results above, it can promote the recommendations for GPS sports watch manufacturers and future research directions.

**ANALYSIS OF CHAOS THEORY MANAGEMENT AT ISLAMIC REPUBLIC OF IRAN YOUTH AND SPORT MINISTRY**

ZARGAR, T., HEDAYATI, M.

*south Tehran branch, Islamic azad university*

The main purpose of this study was to analysis and measurement of chaos theory management at Islamic republic of Iran youth and sport ministry. The method of this study was descriptive-analytic that was conducted survey research. The population of this study con-



sisted of all different sections officials of youth and sport ministry (N=105) and sample was selected by Cochran table and the method of sampling was simple random sampling (n=83). Measurement scale was self-construct 40 item ( $\alpha=0.86$ ) with 5 point likert. The validity of this questionnaire was confirmed by 15 physical education professors and the reliability of chaos management questionnaire ( $\alpha=0.86$ ). In order to data analysis kolomogrove-smirnov, pearson correlation coefficient, one sample t test, one way ANOVA and Test-Tukey was used in  $P \leq 0.05$ . The results indicate that there is significant difference between expected mean with experimental mean of chaos management of officials of youth and sport ministry and its subscales. Also, there is significant difference between butterfly effects according to educational certification. Moreover, there was significant difference between Bachelor of Science degrees with master of art. At least, given to low level of chaos management and its subscales among youth and sport ministry officials it suggests that with holding special meetings on ministry emphasized on significant of chaos management on youth and sport ministry.

## THE EVALUATION OF SERVICE QUALITY OF RECREATIONAL ANIMATION ACTIVITIES

ÇEVİK, H., SIMSEK, K.Y.

*Anadolu University, Faculty of Sport Science*

**Introduction** The well-organized recreational animation activities play such a significant role in clients' repeating their buying behaviors and also they lead the clients to prefer the same enterprise again for their prospective travels to enjoy recreational activities. Therefore, it is of great importance to be aware of the quality of the service rendered. The purpose of this research is to assess the service quality of the recreational animations held in five-star hotels. **Methods** The population of the research is composed of the tourists that stay in the five-star hotels which are located in Antalya. The sample population is selected using the convenience sampling method and includes in total 603 participants. "Scale of Service Quality in Recreational Sport" (SSQRS), developed by Ko and Pastore (2005), has been used as the data collection tool of the research. Descriptive statistics, T-test analysis and One Way ANOVA analysis have been benefited so as to analyze the data. **Results** The sample population of study consisted of 324 (53.7%) female and 279 (46.3%) male. 177 (29.4%) Turkish citizen, 159 (26.4%) German citizen, 136 (22.6%) Russian citizen and 131 (21.7%) other countries citizen were included in study. It was detected that the participants attended study ranged mostly between 28-34 (%25.7) age. The most of participants (%57) had undergraduate level. The widest participation in terms of occupation was by self-employed (17.2%). Individuals with an income between 1001 \$ -2000 \$ (17.9%) ensured the widest participation in terms of income levels. Additionally, it was seen that there were significant differences according to demographic characteristics of sample group in all dimensions that affected the service quality. **Discussion** It has been observed that the participants with high income have a high average from the aspects of program quality, physical environment, satisfaction and access to information. Moreover, it has been found out that the participants of the group of younger age have a high average from the aspects of result, satisfaction and access to information. Also it has been determined that the graduates have a high average about the results obtained from the recreational animation activities as do the participants of the profession group of administrators from the aspects of program and as also do the students from the aspects of physical environment, satisfaction and access to information. Finally the assessment of recreational animation activities according to nationalities shows that the Turkish nationals have a low average in all dimensions. **Keywords:** Service Quality, Recreation, Animation **References:** Ko Y. J. and Pastore D. L. (2005). A Hierarchical Model of Service Quality for the Recreational Sport Industry, *Sport Marketing Quarterly*, 14, 84-97.

## THE RELATIONSHIP BETWEEN PERCEIVED SERVICE QUALITY AND LOYALTY: RECREATIONAL SPORTS FACILITIES ORIENTED RESEARCH

BAYRAM, A., MERCANOGLU, A.O., TURGUTKAYA, K., KOSE, H.

*Anadolu University, Faculty of Sport Sciences*

**Introduction** Service quality and customer loyalty is regarded as an important factor in terms of recreational sports facilities. The aim of this study is to uncover the relationship between the service quality and loyalty of recreational sports facility users. This study can be a guide to companies in terms of recreational consumer behaviours. **Methods** Survey used in this study was performed on 205 customers in five different sports facilities in Eskisehir. The scale, which was developed by Zeithaml et al. (1996) used in this study. **Results** It can be said that there is a direct correlation between quality of service and customer loyalty. Exploratory factor analysis has revealed two sub-dimensions. The scale consists of 13 items and its reliability coefficient value (Cronbach's Alpha) is 0.855. The values over 0.70, can be applicable (Nunnally, 1978). An item that had less than 0.50 factor value was removed from the scale. **Discussion** The original study consists of a total of 4 sub-dimensions. Those sub dimensions are "word of mouth communication", "purchase intentions", "price sensitivity" and "complaining behavior". However, in our study, 2 sub-dimensions have emerged. The cultural diversity and the properties of the universe are thought to be the cause of this situation. While the items of "Word of mouth communication" and "purchase intentions" sub-dimensions are concentrated in one sub dimension; the items of "price sensitivity" and "complaint behaviour" sub-dimensions are concentrated in another sub-dimension. **References** Nunnally, J. (1978). *Psychometric Theory* (Second edition). New York: McGraw Hill. Zeithaml, V. A., Berry, L. L. & Parasuraman, A. (1996). The behavioral consequences of service quality. *The Journal of Marketing*, 60(2), 31-46.

## REFORM OF GOVERNANCE STRUCTURE OF SMALL SIZE FA REACTING TO GOVERNANCE CHALLENGES OF XXI CENTURY

EIMONTAS, E., VALANTINE, I., STASKEVICIU-BUTIENE, I.

*Lithuanian Sports University*

Shifting political-social-economical-cultural poles within Europe and beyond require sporting bodies to consider whether existing inclusive policies, diversity strategies and levels of representation across all groups remain appropriate and reflective of their participants and society in general. Stakeholders of sport have a greater interest to participate in the future direction and policy making activities of sports governing bodies and to have their views heard and appropriately reflected in the decisions of those bodies. The purpose of this survey was to propose governance framework for the sport organization, whereas at the heart of compiling the proactive model is stakeholders' management improving governance and effectiveness of the organization through representation of stakeholders and their involvement in decision making. **Findings:** governance has direct relationship with performance since it is very important how efficiently the decisions in the sport organization are taken, there is a governance problem in the Lithuanian Football Federation (LFF) since the organization doesn't have a proper governance structure to tackle with contemporary challenges achieving organizational objectives through co-opting with all stakeholders. Though the LFF main goal is to preserve eco-system whereas its members and stakeholders could perform

their activities, usually the LFF acts as the main actor instead of coordinator; in sport expected outcomes are defined by much more multi-faceted objectives and performance indicators, sometimes having nothing to do with financial performance of the organization – higher levels of participation, sporting results of the national team, success for clubs, grassroots development, etc.; though there are practices of informal stakeholders' cooperation through external mechanisms among the sport organization, when reforming the governance structures of small size sport organization inclusion of the stakeholders in the governance structures shall be evolutionary step by step because of uncertainty and opposition; the proposal for external mechanisms was mentioned by majority of the respondents when instead of speaking about stakeholders' involvement into the official structures of the sport organization, there should be adverse involvement pursued; the governance in the sport organization is shifting from the classic unilateral vertical channels of authority of the pyramidal network towards new lateral forms of networked governance; international sport organizations should be important players in the development of practices and the governance structures and implementation of governance networks in their member associations; the governments will play more and more important role in the sports, therefore the inclusion of it into the governance structures are beneficial for the sport organizations.

#### **DETERMINING AND EVALUATING DIMENSIONS OF CUSTOMER RELATIONSHIP MANAGEMENT IN SPORTS FACILITIES: SAMPLE OF ESKİŞEHİR**

MERCANOĞLU, A., BAYRAM, A., TURGUTKAYA, K., KOSE, H.

*Anadolu University Faculty of Sport Sciences*

**Introduction** It can be said that Customer Relationship Management (CRM) ,which has emerged through the efforts of organizations that want to gain their potential customers, has an important role for sports facilities. Therefore, the aim of this study was to determine and evaluate dimensions of CRM in sports facilities. **Methods** In order to determine dimensions of CRM approach that perceived by sports facility customers in our country, the scale which was developed by De Wulf et al. (2001) applied to the sports facility customers. The research group consists of 198 sport facility customers in total who were chosen with convenience sampling method. Exploratory factor analysis was used to determine factor loads. **Results** As a result of exploratory factor analysis six dimensions were revealed. These dimensions are named as relationship quality, customer orientation, communication by mail/sms, activities, preferential treatment, continuity. Three items was removed because of their factor load values (< 0,50). **Discussion** It can be said that due to cultural and industry differences, there are two important differences between original scale's dimensions and our study results. The first one, most of items which belongs to "trust", "relationship commitment", "relationship quality and relationship satisfaction" dimensions are grouped under "relationship quality" dimension. The second one, items which belongs to "interpersonal communication" and "perceived relationship investment" dimensions are grouped under "customer orientation" dimension. **References** De Wulf, K., Odekerken-Schröder, G., & Iacobucci, D. (2001). Investments in Consumer Relationships: A Cross-Country and Cross-Industry Exploration. *Journal of Marketing*, 65(4), 33-50.

**15:00 - 16:30**

### **Invited symposia**

#### **IS-PM01 Taking care of the respiratory health of elite athletes**

##### **MECHANISTIC BASIS OF 'ASTHMA' IN ATHLETES**

KIPPELEN, P.

*Brunel University London*

Asthma is the most common chronic medical condition in elite athletes, with a prevalence of 8% (Fitch, 2012). Exercise is a potent trigger of asthma attacks, and the transient airway narrowing brought about by (strenuous) exercise is commonly referred to as exercise-induced bronchoconstriction (EIB). The aim of this presentation is to discuss the various mechanisms potentially implicated in the short- and long-term development of asthma / EIB in elite athletes. While local, airway osmotic and thermal stress associated with exercise-hyperpnoea are key determinants to EIB (Anderson & Daviskas, 2000), the role of whole-body dehydration in precipitating airway narrowing post-exercise is unknown. Novel data suggest a detrimental effect of mild-to-moderate exercise-induced dehydration on resting lung function (with possible gas trapping and small airway collapse) in athletes, but no significant effect of mild fluid losses (~2% of body weight) on bronchial responsiveness. Further, while repeated-injury repair of the airway epithelium induced by acute osmotic and / or mechanical stress during exercise-hyperpnoea is thought to contribute to the pathogenesis of asthma / EIB in elite athletes (Anderson & Kippelen, 2005), our understanding of the role of other contributing factors – such as (over-)use of nutritional supplements – is limited. Our preliminary data highlight the potential for the widely used ergogenic supplement, creatine monohydrate, to increase lung inflammation and airway responsiveness in youth, elite, football players (particularly, in those with atopy). Further work is now warranted to confirm these preliminary findings and to explore the mechanisms through which creatine, when associated with intensive physical training, might up-regulate airway inflammation in the human lung. In summary, it is important to recognise that asthma / EIB is a widespread, serious, but manageable condition in elite athletes. Based on our current understanding of the pathophysiology of asthma / EIB in athletes, appropriate pharmacological and non-pharmacological prevention strategies should routinely be implemented to minimise the impact of these respiratory disorders on athletes' health and performance. **References** Anderson SD, Daviskas E. (2000). *J Allergy Clin Immunol*, 106(3), 453-9. Anderson SD, Kippelen P. (2005). *Curr Allergy Asthma Rep*, 5(2), 116-22. Fitch KD. (2012). *Br J Sports Med*, 46(6), 413-6.

**THE PROS AND THE CONS OF ENGAGING IN COMPETITIVE SWIMMING: A LUNG HEALTH PERSPECTIVE**

BOUGAULT, V.

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Swimming is a sport usually considered as non asthmogenic. The warm and humid atmosphere of indoor swimming pools limits the airway dehydration associated with the high ventilatory demand of this endurance-based activity, therefore reducing the risk for exercise-induced bronchoconstriction (EIB)<sup>1,2</sup>. When asthma is well managed, asthmatic athletes perform as well as their non-asthmatic peers, and famous Olympians (including swimmers) are well-known asthmatics. However, amongst non-asthmatic endurance athletes, swimmers are the ones who develop more frequently asthma-related disorders during their career. Repeated airway inflammation and epithelial damage during strenuous and repeated training sessions are thought to be mainly responsible for airway hyper-responsiveness in elite swimmers<sup>1,2</sup>. Many recent studies also highlight an increased incidence of asthma in lifeguards and in children regularly exposed to the atmosphere of chlorinated swimming pools<sup>1,2</sup>. Thus, regular exposure to chlorine by-products could be a contributing factor to the high prevalence of asthma-related disorders in elite swimmers. The current dilemma is to establish whether swimming is a 'safe' activity for those who compete at top level, and to devise appropriate prevention strategies to protect the respiratory health for all those who swim<sup>1,2</sup>. 1. Bougault V, Boulet LP. Airways disorders and the swimming pool. *Immunol Allergy Clin North Am* 2013;33(3):395-408 2. Bougault V, Boulet LP. Is there a potential link between indoor chlorinated pool environment and airway remodeling/inflammation in swimmers? *Expert Rev Respir Med* 2012;6(5):469-71

**INHALERS FOR AIRWAY HEALTH OR ERGOGENIC AID?**

DICKINSON, J.

*University of Kent*

Athletes are more susceptible to asthma and exercise induced bronchospasm (EIB) than non-athletes (Dickinson et al., 2011). However, the treatment of athletes with asthma/EIB is not always consistent or optimal. Athletes with asthma/EIB who train and compete using sub-optimal inhaler therapy are susceptible to airway remodeling, worsening of symptoms, increased reliance of rescue medication and increased severity of their condition (Karjalainen et al., 2000). Secure diagnosis and appropriate management will ensure airway health is optimised in athletes with asthma/EIB (Parsons et al., 2013). Since 2010, the World Anti-Doping Agency (WADA) has removed the requirement for an athlete with asthma/AHR to obtain a Therapeutic Use Exemption Certificate in order to use some inhaled  $\beta_2$ -Agonists (IBAs). There is a danger that unscrupulous athletes may use IBAs to seek a competitive advantage. IBAs does not appear to enhance endurance performance (Pluim et al., 2011). However, emerging evidence suggests sprint and power performance may be enhanced from using IBAs (Kalsen et al., 2016). This session is relevant for sports medicine professionals and sport and exercise scientists. Delegates will gain an understanding of the best practice in the treatment athletes with asthma/EIB. Delegates will learn how IBAs may impacts on the performance of athletes. References: Dickinson J, McConnell A, Whyte G. *Br J Sports Med.* 45, 1126-31. Karjalainen E, Laitinen A, Sue-Chu M, Altraja A, Bjerrmer L, Laitinen L. (2000). *Am J Respir Crit Care Med.* 161, 2086-91. Kalsen A, Hostrup M, Söderlund K, Karlsson S, Backer V, Bangsbo J. (2016). *Med Sci Sports Exerc.* 48, 39-48. Parsons J, Hallstrand T, Mastrorade J, Kaminsky D, Rundell K, Hull J, Storms W, Weiler J, Cheek F, Wilson K, Anderson S. (2013). *Am J Respir Crit Care Med.* 187, 1016-27. Pluim B, de Hon O, Staal J, Limpens J, Kuipers H, Overbeek S, Zwinderman A, Scholten R. (2011). *Sports Med.* 41, 39-57. Contact: J.W.Dickinson@kent.ac.uk

**Oral presentations****OP-PM02 ASPETAR Presentations: Football****BETROOT JUICE SUPPLEMENTATION IMPROVES EXERCISE PERFORMANCE IN SOCCER PLAYERS**

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Introduction: Dietary nitrate supplementation has previously been shown to enhance exercise performance in moderately-trained endurance athletes. Recent work also suggests increases in repeated sprint and/or intermittent high-intensity exercise performance following nitrate supplementation, relevant for team-sports. We assessed the effects of 6 days of nitrate supplementation on high-intensity intermittent type exercise performance in trained soccer players. Methods: Thirty-two trained soccer players (23±1 y; 2nd and 3rd Dutch amateur league) participated in a double-blind, randomized, placebo-controlled cross-over experiment. Following a familiarization trial, all subjects participated in 2 separate test-days in which intermittent exercise performance was assessed using the Yo-Yo intermittent recovery level 1 test (Yo-Yo IR1). Test days were preceded by 6-days of concentrated nitrate-rich beetroot juice ingestion (140 mL; providing ~800mg nitrate/day; BRJ), or a nitrate-depleted beetroot juice (PLA), with the last supplemental bolus being ingested 3 h prior to performing the Yo-Yo IR1 test. A single blood sample was collected ~2.5 h after ingestion of the last supplemental bolus to determine pre-exercise nitrate and nitrite concentrations. Supplementation periods were separated by 1 week washout. The primary outcome was distance covered in the Yo-Yo IR1 test. Additionally, heart rate (HR) was measured continuously throughout the test, and ratings of perceived exertion (RPE) were assessed using the Borg-20 scale. All data were analyzed using paired samples t-tests. Plasma and saliva nitrate and nitrite concentrations represent preliminary data from n=24. Data are presented as mean ± SEM. Results: Plasma nitrate and nitrite concentrations were significantly increased following 6 days of BRJ supplementation (836±44  $\mu$ M and 581±45 nM) when compared to the PLA trial (72±5  $\mu$ M and 165±14 nM; both  $P<0.001$ ). Distance covered in the Yo-Yo IR1 test was 3.4±1.3% greater with BRJ (1623±48 m) when compared to PLA (1574±47 m;  $P=0.027$ ). Mean HR was significantly lower with BRJ vs PLA (172±2 vs 175±2;  $P=0.014$ ). Peak HR (190±1 vs 191±1), and RPE (17.3±0.4 vs 17.6±0.3) did not differ between BRJ and PLA. Conclusion: Six days of beetroot juice supplementation increases plasma nitrate and nitrite concentrations and improves performance during an intermittent type exercise task in soccer players. Contact: jean.nyakayiru@maastrichtuniversity.nl This study was financially supported by a grant from the Dutch Technology Foundation STW

### **"FIFA 11+ KIDS" A WARM-UP PROGRAM TO PREVENT INJURIES IN CHILDREN'S FOOTBALL: CLUSTER RANDOMISED CONTROLLED TRIAL**

RÖSSLER, R.1, BIZZINI, M.2, DVORAK, J.2,3, CHOMIAK, J.4, AUS DER FÜNTEN, K.5, VERHAGEN, E.6, LICHTENSTEIN, E.1, BEAUDOUIN, F.5, JUNGE, A.2,7, FAUDE, O.1

*University of Basel*

1: University of Basel (Switzerland), 2: F-MARC and Schulthess Clinic (Zürich, Switzerland), 3: FIFA (Zürich, Switzerland), 4: Charles University (Prague, Czech Republic), 5: Saarland University (Saarbrücken, Germany), 6: University of Amsterdam (The Netherlands), 7: Medical School Hamburg (Germany) Introduction The prevention of football injuries should start at a young age (Rössler et al., 2014). Based on epidemiological data (Rössler et al., 2016b), the injury prevention program FIFA 11+ Kids was developed (Rössler et al., 2016a). The objective of the present study was to assess the effectiveness of FIFA 11+ Kids with regard to injury prevention. Methods Children's football teams (under-11 and under-13 age groups) from Switzerland, Czech Republic, The Netherlands, and Germany were recruited. Clubs were randomised to an intervention (INT) and a control group (CON), and followed for one season. INT performed FIFA 11+ Kids during their warm-up, while CON warmed-up as usually. Data was collected using an internet-based registration platform. Time-to-injury data were analysed, and hazard ratios (HR) calculated using extended Cox models to account for correlations on team- and intra-person-level. Results In total, 3,895 player seasons and 292,749 hours of football exposure were recorded. Mean age of players was 10.8 (SD 1.4) years. During the study period 374 (INT=139; CON=235) injuries occurred. Overall injury rate in INT was reduced by 48% compared to CON (HR 0.52; 95%-CI 0.32–0.86),  $P=0.01$ ). Further reductions of injury rates were found with regard to match (49%, (HR 0.51; 0.27–0.94),  $P=0.03$ ), to training (42%, (HR 0.58; 0.38–0.89),  $P=0.01$ ), to severe (74%, (HR 0.26; 0.10–0.64),  $P=0.003$ ) and to lower extremity injuries (55%, (HR 0.45; 0.24–0.84),  $P=0.01$ ). Discussion FIFA 11+ Kids is effective in reducing injuries in children's football. Considerable effects were found for overall, match, training, lower extremity, and specifically severe injuries. The present overall injury reduction is comparable to studies in older youth football players (Rössler et al., 2014). The reduction of injury incidence might be due to improved motor performance (Rössler et al., 2016a). A broad implementation may help to reduce injuries and to support the health benefits of playing football in the long term. The authors gratefully acknowledge the financial support of FIFA. References Rössler, R., Donath, L., Bizzini, M., & Faude, O. (2016a). J Sports Sci 34(6), 549-556. Rössler, R., Donath, L., Verhagen, E., Junge, A., Schweizer, T., & Faude, O. (2014). Sports Med, 44(12), 1733-1748. Rössler, R., Junge, A., Chomiak, J., Dvorak, J., & Faude, O. (2016b). Am J Sports Med 44(2), 309-317. Contact roland.roessler@unibas.ch

### **REFLECTIONS FROM A FEMALE SPORT PSYCHOLOGIST WORKING IN ELITE LEVEL PROFESSIONAL FOOTBALL**

FRANCESCA, C., NESTI, M.S., TOD, D., LITTLEWOOD, M.A.

*Liverpool John Moores University*

Introduction The introduction of the Elite Player Performance Plan (EPPP) by the English Premier League in 2011 has resulted in more opportunities for sport psychology practitioners within Academy football. It is anticipated that more female sport psychology practitioners will join the sport and deliver psychological support at youth levels. However, few practitioners are currently writing about their experiences, and the challenges they have faced within this culture. The aim of the study was to outline a range of experiences that shaped the identity of a female sport psychology practitioner working in elite level professional football. Methods An ethnographic study was conducted over a 24-month period (3-4 days per week) within an elite level professional football club. The first author's role within the club was a practitioner-researcher, delivering sport psychology support to Academy footballers and support staff. Data was collected via participant observation, and field interviews (Hammersley & Atkinson, 1995). Data is presented in a series of progressive vignettes based upon critical moments that shaped the researcher's development as a neophyte sport psychology practitioner. Results and Discussion The findings from this study fall within the following themes; "Where it all began", "11 months on; The same old story", and finally "Learning to cope". The first two themes outline challenges that the practitioner faced in developing a relationship with a senior member of staff in a culture where power, dominance, and control are paramount. A number of encounters left the practitioner questioning her belonging at the club, and more importantly her identity and future as a sport psychology practitioner. The final theme "Learning to cope" outlines how after 12 months the practitioner started to navigate her way through these challenges. An existential perspective is used to frame the experiences. The practitioner's feelings of isolation were related to a lack of understanding, and an estrangement of meaning from the situations encountered. However, existentialists take a positive stance on this, and believe that recognition of the feelings associated with isolation are a pre-requisite for inner growth, and attaining greater self-knowledge (Kierkegaard, 1983). It was through reflection, frequent supervisory meetings and professional training that the practitioner began to feel more comfortable with her experiences, and began to understand the individual's behaviour. References Hammersley, M., & Atkinson, P. (1995). Ethnography: Principles in Practice, 2nd ed. London: Routledge Kierkegaard, S. (1983). Fear and trembling; repetition, Princeton University Press, Princeton, NJ.

### **MENTAL FATIGUE IMPAIRS SOCCER-SPECIFIC PERFORMANCE**

SMITH, M.1,2, MARCORA, S.3, LENOIR, M.2, BADIN, O.1, MERLINI, M.3, DEPREZ, D.2, ZEUVTS, L.2, COUTTS, A.1

1: UTS (Australia), 2: UGent (Belgium), 3: University of Kent (UK)

Introduction: Anecdotal reports from soccer players and coaches suggest that mental fatigue impairs soccer performance. However experimental investigations of this claim are limited. Therefore, two randomised, crossover investigations were conducted to assess the impact of mental fatigue on soccer-specific physical, technical, and decision-making performance. Methods: Players completed a 30-min Stroop task (mental fatigue treatment), or 30 min of an emotionally neutral control, prior to tests of soccer-specific performance. Study 1 assessed the impact of mental fatigue on physical and technical performance of 20 well-trained soccer players during 15-min, 5 vs. 5 small-sided games (SSGs). Physical performance was assessed using 15-Hz GPS units, and technical performance was assessed using video-based notational analysis. Heart rate (HR) and ratings of perceived exertion (RPE; CR10) were also recorded during the SSGs. Study 2 utilised videos of simulated play to assess the impact of mental fatigue on soccer-specific decision-making, and visual search behaviour in 12 well-trained soccer players. Decision-making skill was assessed using response time and accuracy, while visual search behaviour was assessed via search rate, fixation location, and fixation order. A progressive magnitude-based approach was used to assess chances of differences between conditions being trivial or true (greater than the smallest worthwhile change;  $0.2 \times$  the between-subjects SD). Results: Players reported higher levels of mental fatigue following the Stroop task than the control treatment in both studies, while no clear differences in motivation existed. Mental fatigue had unclear effects on most physical performance variables in Study 1, despite a possibly lower HR (mental fatigue =  $85 \pm 5\%$ HRmax; control =  $86 \pm 4\%$ HRmax; ES = -0.28), and likely higher RPE in the mental fatigue



condition (mental fatigue =  $6.8 \pm 1.4$ ; control =  $6.2 \pm 1.6$ ; ES = 0.39). In contrast, mental fatigue impaired both offensive and defensive technical performance during the SSGs (positive involvements: mental fatigue =  $70 \pm 10\%$ ; control =  $63 \pm 9\%$ ; ES = -0.73). In Study 2, mental fatigue very likely reduced soccer-specific decision-making accuracy (mental fatigue =  $81 \pm 6\%$ ; control =  $86 \pm 4\%$ ; ES = -0.89) and likely increased response time (mental fatigue =  $768 \pm 134$  ms; control =  $685 \pm 156$  ms; ES = 0.49), despite minimal differences in visual search behaviour. Discussion: These findings support anecdotal reports that mental fatigue impairs soccer-specific performance. Soccer clubs may benefit from assessing pre-match routines, to ensure players are not mentally fatigued prior to competition, and are advised to identify and implement strategies that may attenuate the negative impact of mental fatigue on performance. In this respect, coaches could utilise short SSGs to train technical performance under mentally fatigued conditions, without compromising physical training loads. Contact Mitchell.Smith@uts.edu.au

### THE DETERMINATION OF ENERGY COSTS DURING SOCCER MATCHES: COMPARATIVE ANALYSIS BETWEEN MEASURED AND CALCULATED ENERGY EXPENDITURE

VENZKE, J., NARDIELLO, D., PLATEN, P.

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Introduction: The metabolic demands of soccer and other team sport players have been a subject of research for many years. However, there is no method for estimating the energy costs (EC) during official matches. A new mathematical approach<sup>1</sup> can be used to calculate metabolic loads during a match. Using this method it might be possible to determine EC from velocity and acceleration data measured by global positioning system (GPS) or comparable technology. The aim of the study was to validate the new mathematical approach for the determination of metabolic demands by comparing the results of the mathematical analysis against the direct measurement with spirometry (SM) during a soccer match. Methods: 22 healthy soccer players from the 5th German League agreed to participate in a simulated soccer match with a playing time of 90 min and a regular halftime break (15 min). 8 of the subjects ( $24.4 \pm 2.1$  y,  $183.3 \pm 6.9$  cm,  $82.6 \pm 8.0$  kg) wore a portable GPS system (GPI-Sports, 5 Hz) for the determination of accelerations and decelerations and velocities, and additionally a portable SM system. GPS and SM data were recorded simultaneously to compare direct vs. indirect determination of EC. The match was separated into four quarters to acquire an accurate analysis. Data was analyzed by means of a paired t-test and Pearson's chi-squared test. Results: EC determined by the mathematical approach underestimated directly determined EC by approximately 25% and was significantly lower compared to the directly determined EC ( $1030 \pm 287$  vs.  $779 \pm 171$  kcal,  $2p < 0.05$  for directly measured and calculated EC, respectively). The correlation between the calculated and directly measured EC was highly significant for the total game ( $R = 0.88$ ), the two halves ( $R_{1st} = 0.85$ ,  $R_{2nd} = 0.96$ ), and the last two quarters ( $R_{3rd} = 0.97$ ,  $R_{4th} = 0.91$ ) ( $2p < 0.01$ ). Discussion: Data showed that the determination of EC of a soccer match based on acceleration and velocity data using a new mathematical approach seems to be possible and valid however the results still underestimate the real energy costs. Correction factors are required for an even better approximation to the real EC, including corrections for movements with the ball, passing the ball, shots, jumps, and taking into account different ground conditions. Further studies will result in nearly exact estimation of EC of soccer matches and will help to optimize training loads. References: 1. di Prampero, P. E., Fusi, S., Sepulcri, L., Morin, J. B., Belli, A. & Antonutto, G. (2005). Sprint running: a new energetic approach. *The Journal of Experimental Biology*, 208, 2809-2816. Contact: jan.venzke@rub.de

## Invited symposia

### IS-PM02 Nutritional supplements to improve health and performance

#### FUNDAMENTAL AND EMERGING CONCEPTS IN THE REDOX REGULATION OF EXERCISE RESPONSES AND ADAPTATIONS

NIKOLAIDIS, M.

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Although substantial progress on the understanding of the molecular functions of reactive oxygen, nitrogen and sulfur species ("reactive species") has been attained in vitro, this has rarely been translated in vivo. The equivocal role of reactive species in exercise adaptations is an example showing the inadequacy of current redox biology research to shed light on fundamental biological processes in vivo. In fact, despite intense research efforts, it is still uncertain whether and how reactive species regulate exercise-induced responses and adaptations. This is mainly due to the extreme complexity of in vivo biology. Contrary to the complexity and specificity of the redox network, the most common approach to establish the role of reactive species in exercise responses and adaptations is the measurement of oxidative stress biomarkers in blood or muscle. However, the use of such generic biomarkers does not provide mechanistic information (Margaritelis et al. 2016). Another frequent methodological choice is to exogenously administer pleiotropic compounds with purported generic antioxidant properties (principally vitamin C and E), aiming to decrease global reactive species levels and, thus, to attenuate exercise-induced oxidative stress. However, there is a paucity of evidence supporting the notion that antioxidant supplementation interferes with exercise-induced redox signaling via a redox-dependent "scavenging" mechanism. To describe as accurately as possible the biological role of reactive species, our group has proposed six fundamental principles that should be considered to mechanistically link reactive species production to exercise responses or adaptations: 1) identify and quantify the reactive species, 2) determine the potential signaling properties of the reactive species, 3) detect the sources of reactive species, 4) locate the domain modified and verify the (ir)reversibility of post-translational modifications, 5) establish causality between redox and physiological measurements, 6) use selective and targeted antioxidants (Margaritelis et al. 2015). Fulfilling these principles in their entirety requires an idealized human experimental setting, which is certainly a utopia. However, I believe that an account of the complexity of redox reactions in future research will reveal that redox processes are behind most (if not all) exercise responses and adaptations. I foresee that exercise redox biology will be one of the true frontiers in the exercise physiology research for the 21st century. References Margaritelis NV, Cobley JN, Paschalis V, Veskoukis AS, Theodorou AA, Kyparos A, Nikolaidis MG (2015). *Cell Signal*, 28(4), 256-271. Margaritelis NV, Cobley JN, Paschalis V, Veskoukis AS, Theodorou AA, Kyparos A, Nikolaidis MG (2016). *Free Radic Biol Med*, (in press).

## A FISHY STORY THAT KEEPS REPEATING : OMEGA-3 DERIVED LIPID MEDIATORS, DO THEY HAVE A BENEFICIAL ROLE FOR THE PATIENT AND THE PERFORMER ?

LINDLEY, M.R.

*Loughborough University*

A variety of fatty acids exists in the bloodstream and in the cells and tissues of humans with some being endogenous (non-essential) alongside some important exogenous fatty acids (essential – dietary). Fatty acids can be energy sources or membrane constituents and have biological activities that influence cell and tissue metabolism, function, and responsiveness to hormonal and other signals. Biological activities can be grouped as regulation of ; membrane structure and function, intracellular signalling pathways, transcription factor activity, and gene expression; alongside the production of bioactive lipid mediators. Through these effects, fatty acids influence health, well-being, and disease risk and possibly response to exercise and training. Although traditionally most interest in the health impact of fatty acids related to cardiovascular disease, it is now clear that fatty acids influence a range of other diseases, including metabolic diseases such as type 2 diabetes, inflammatory diseases in general and cancer specifically. Eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) are omega-3 (n-3) fatty acids found in oily fish and fish oil supplements. EPA gives rise to eicosanoids that often have lower biological potency than those produced from arachidonic acid (AA) while both EPA and DHA give rise to new families of anti-inflammatory and inflammation resolving mediators called resolvins, protectins and maresins. Identification and structural elucidation of these new families of bioactive mediators in resolution has opened the possibility of diverse patho-physiologic actions in several processes including infection, inflammatory pain, tissue regeneration, neuroprotection-neurodegenerative disorders, wound healing, and others. This presentation will take us on a journey from dietary supplementation through tissue incorporation and into biological action as linked to both disease and sporting performance.

## POLYPHENOLS: PANACEA OR PARIAH FOR HUMAN HEALTH AND PERFORMANCE

BOWTELL, J.

*Exeter University*

Epidemiological evidence demonstrates the many health benefits associated with fruit and vegetable consumption including reduced risk of and mortality from cardiovascular disease, and this is attributable at least in part to their phytochemical content. Polyphenols containing at least one phenolic ring and 2 or more hydroxyl groups can be classified into 5 main families. The most plentiful and widely expressed in plants are the flavonoids which include sub-families such as anthocyanins (cherries and berries), and flavanols (cocoa). These substances have been shown to: (i) inhibit key reactive oxygen species producing enzymes such as NADPH oxidase, (ii) improve endogenous anti-oxidant capacity perhaps via signalling through nuclear factor erythroid 2-related factor (Nrf2), (iii) inhibit cyclo-oxygenase 1 and 2, also the target of non-steroidal anti-inflammatory drugs, (iv) enhance endothelial dependent vasodilatation and (v) stimulate mitochondrial biogenesis in skeletal muscle. It is plausible therefore that polyphenol consumption may protect against age-related decline in cardiovascular, musculoskeletal and cognitive function, as well as interacting with exercise training adaptation, but data from polyphenol supplementation studies with human participants are relatively sparse. Muscle damage subsequent to intense exercise is caused partly by the mechanical forces to which the muscle is exposed, but reactive species and inflammatory processes are also suggested to be important contributors to the damage. We and others have shown that fruit-derived polyphenol supplementation enhances recovery from muscle damage, but very few studies have investigated the consequences for training adaptation. For older adults, resistance to the anabolic effects of protein and exercise is a key factor in sarcopenia. As well as physical inactivity, low grade inflammation and oxidative stress may contribute to this important problem that leads to loss of function and capacity for independent living. We will present our data examining whether fruit-derived polyphenols can influence the anabolic response in the elderly. Exposure of the vasculature to ROS and RNS is suggested to contribute to endothelial dysfunction, and acute and chronic consumption of fruit-derived polyphenols have been shown to improve peripheral vascular function possibly via improved nitric oxide bioavailability. We have recently shown that chronic blueberry consumption is able to increase resting state brain perfusion as well as improving task related brain activation in healthy older adults, offering the potential to support improved cognitive function. Cherries and berries may truly provide a tasty panacea for healthy aging.

## Invited symposia

### IS-PM03 Oxygen Uptake Kinetics in Performance, Health and Disease

#### VO2 KINETICS: CONTROL AND RELATIONSHIP TO PERFORMANCE

JONES, A.M.

*Exeter University*

The kinetics of pulmonary O<sub>2</sub> uptake following the onset of exercise provides important insights into the integrated adjustment of the pulmonary-cardiovascular-muscle metabolic systems to meet an increased energy demand. While the control of VO<sub>2</sub> kinetics is complex and continues to be investigated, the rate of adjustment of mitochondrial oxidative phosphorylation is functionally linked to the rate of cytosolic high-energy phosphate hydrolysis, such that the principal limitation appears to be an intrinsic inertia of intracellular processes. In other situations, such as when type II fibres are recruited during high-intensity exercise or there are cardiovascular impediments, substrate supply (in the form of O<sub>2</sub>) may further limit the VO<sub>2</sub> on-kinetics. During moderate-intensity exercise, VO<sub>2</sub> typically attains a steady state within 2-4 minutes; however, during heavy- or severe-intensity exercise, VO<sub>2</sub> continues to rise with time despite a constant external power output. This greater O<sub>2</sub> cost of exercise, reflected in the 'VO<sub>2</sub> slow component' phenomenon, signifies a loss of skeletal muscle efficiency. The VO<sub>2</sub> profile during exercise has important implications for the development of fatigue and exercise intolerance. For example, the magnitude of the O<sub>2</sub> deficit that is incurred during the first 1-2 minutes of exercise, and which is a function both of the VO<sub>2</sub> time constant and amplitude, will determine the extent to which substrate-level phosphorylation is activated with implications for high-energy phosphate depletion and hydrogen ion accumulation. Also, the trajectory of the VO<sub>2</sub> slow component during higher-intensity constant-work-rate exercise will dictate the time to exercise intolerance because exhaustion becomes imminent after the maximum VO<sub>2</sub> has been attained. Understanding VO<sub>2</sub> kinetics and its relationship to fatigue development enables sport scientists to consider

interventions which might enhance the VO<sub>2</sub> kinetic profile (i.e., speed the initial response or attenuate the subsequent slow component) and thus improve sports or exercise performance. This presentation will consider several such interventions including training, prior exercise, pacing and nutritional supplementation. Contact a.m.jones@exeter.ac.uk

### VO<sub>2</sub> KINETICS IN HEALTH VERSUS HEALTHY AGING AND DISEASE

POOLE, D.C., JONES, A.M., MUSCH, T.I.

*Kansas State University*

Slow VO<sub>2</sub> kinetics, emblematic of loose metabolic control, "sows the seeds" for exercise intolerance by accelerating depletion of finite high energy phosphates and intramuscular glycogen reserves. There is compelling support for VO<sub>2</sub> kinetics in young healthy individuals being limited by mitochondrial inertia rather than VO<sub>2</sub> delivery per se. However, exercise that recruits more fast twitch muscle fibres and/or cardiovascular dysfunction consequent to aging and also diseases such as heart failure, diabetes or emphysema can predicate O<sub>2</sub> delivery-limited VO<sub>2</sub> kinetics (Poole and Jones, 2012; Hirai et al. 2015). For muscles that are O<sub>2</sub> delivery-limited the local O<sub>2</sub> delivery (QO<sub>2</sub>)-to- VO<sub>2</sub> ratio assumes a key point of metabolic control as this sets the microvascular O<sub>2</sub> partial pressure (PmvO<sub>2</sub>) and thus the potential for blood-myocyte O<sub>2</sub> flux. At least in animal muscles during contractions PmvO<sub>2</sub> is far lower in fast twitch muscles than in their slow twitch counterparts and is lowered in mixed fibre-type muscles by aging, heart failure and diabetes (rev. Poole et al. 2012). Exercise training and other therapeutic interventions such as sildenafil/tadalafil (Viagra/Cialis) that act to promote vasodilation (via nitric oxide dependent or independent means) elevate muscle PmvO<sub>2</sub>, speed O<sub>2</sub> kinetics and increase exercise tolerance (Sperandio et al. 2011; Hirai et al. 2015). Accordingly, therapeutic interventions that effectively increase QO<sub>2</sub> in exercising muscles would at first glance seem to be overwhelmingly beneficial. Unfortunately, the reality is more complex. Within and among exercising muscles there is a considerable heterogeneity of QO<sub>2</sub>s, O<sub>2</sub> s and QO<sub>2</sub>: O<sub>2</sub> (PmvO<sub>2</sub>) ratios (Koga et al. 2014). Whereas elevating QO<sub>2</sub> and thus PmvO<sub>2</sub> in one region may have beneficial metabolic effects in that region, if the "extra" QO<sub>2</sub> creates a QO<sub>2</sub> deficit elsewhere or, alternatively, demands an overall greater cardiac output that jeopardizes cardiac integrity the end result would be counterproductive to exercise tolerance. The frontier and substantial potential of this rapidly-moving field will be explored especially as it relates to improving exercise tolerance and quality of life in aging and patient populations. References Hirai DM, Musch TI, Poole DC. (2015). American Journal of Physiology, Heart and Circulatory Physiology 309, H1419-1439. Koga S, Rossiter HB, Heinonen I, Musch TI, Poole DC. (2014). Medicine and Science in Sports and Exercise, 46, 860-876. Poole DC, Jones AM. (2012). Comprehensive Physiology, 2, 933-996. Sperandio PA, Oliveira MF, Rodrigues MK, Berton DC, Treptow E, Nery LE, Almeida DR, Neder JA. (2012). American Journal of Physiology, Heart and Circulatory Physiology, 303, H1474-1480.

### VO<sub>2</sub> KINETICS IN DIFFERENT MODES OF EXERCISE

SOUSA, A.1,2, VILAS-BOAS, J.P.1,2, FERNANDES, R.J.1,2

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Introduction The rate at which a subject can "switch on" their aerobic energy system to fulfil the requirements for exercise performance can determine if the subject will fatigue less rapidly and be better able to sustain the demands of that particular task. Thus, oxygen uptake (VO<sub>2</sub>) kinetics can be considered to involve the study of the physiological mechanisms responsible for the dynamic VO<sub>2</sub> response to exercise, determining the instantaneous aerobic and anaerobic energy transfer, the mixture and amount of substrate utilized, and the tolerable duration of exercise (Jones & Burnley, 2009). One of the key considerations when measuring VO<sub>2</sub> kinetics is that the VO<sub>2</sub> response to exercise can be altered considerably when different ergometers or modes of exercise are used. The first study that compared the VO<sub>2</sub> kinetics in different exercise modes demonstrated that the half time (time necessary to achieve 50% of the total VO<sub>2</sub> response) for the on-transient phase was longer at the same absolute metabolic requirement for arm cranking compared to cycling, although it was similar at the same relative exercise intensity (Cerretelli et al., 1977). Since this first study, the majority of research has been conducted using cycle ergometry and treadmill running and within the heavy and severe exercise intensity domains, the time constant is shorter and the VO<sub>2</sub> slow component less pronounced in running compared with cycling (Hill et al., 2003). This different profile suggests that VO<sub>2</sub> kinetics may be influenced not only by the central and peripheral structural/ metabolic attributes, but also by the muscle contraction regimen and the ensuing muscle fibre recruitment profile. Notwithstanding the above, two other modes of exercise that have been achieving prominent places within VO<sub>2</sub> kinetics research are swimming and rowing. In fact, recent research has shown that swimming is characterized by a slower VO<sub>2</sub> response compared with other cyclic sports (Sousa et al., 2015), suggesting that the horizontal body position adopted could also be responsible for important differences found in the VO<sub>2</sub> kinetics. Therefore, the characterization of each mode of exercise modality's physiological profile may convey valuable information relating to its specific performance enhancement. The purpose of this presentation is to provide an analysis of the principal VO<sub>2</sub> kinetics differences between exercise modes both during exercise and subsequent recovery. References Jones A, Burnley M. (2009). International Journal of Sports Physiology and Performance, 4(4), 524-532. Cerretelli P, Shindell J, Pendergast D, Prampero P, Rennie D. (1977). Respiration Physiology, 30(1), 81-97. Hill DW, Halcomb JN, Stevens EC. (2003). European Journal of Applied Physiology, 89(6), 612-8. Sousa A, Figueiredo P, Zamparo P, Pyne D, Vilas-Boas JP, Fernandes RJ. (2015). Medicine and Science in Sports and Exercise, 47(8), 1705-1713. Contact asousa@fade.up.pt

## Invited symposia

### IS-BN01 TECHNOLOGY AND MODELLING IN GAME SPORTS

#### THE FUTURE OF WEARABLE TECHNOLOGY FOR GAME ANALYSIS

ABT, G.

*The University of Hull*

Although 'wearable' technology has been around for decades (Polar Innovations, n.d.), only recently has the combination of adequate battery power, pervasive wireless networks, and miniaturisation of electronic components, allowed wearable technology to reach mainstream use. The current poster-child of wearable technology for game analysis is the Global Positioning System (GPS). GPS provides coaches and sport scientists with information on player location and its derivatives - speed and direction. Current GPS systems also include heart rate monitoring, together with triaxial accelerometers and gyroscopes, which are increasingly being used to measure rapid

changes in direction and speed (Aughey, 2011). Despite wide adoption of GPS, we have only just begun to explore the potential of wearable technology for game analysis. For example, we now have the capability to measure a wider range of physiological data, including temperature, hydration status, heart rate variability, and even blood lactate. These measures can be obtained through new methods of data acquisition such as flexible skin-mounted sensors (MC10, n.d.), electronic circuits sewn into fabric (OMsignal, n.d.), electromyography (Leo, n.d.), or near-infrared spectroscopy (BSX Insight, n.d.). All of this data is available in real-time and connected to the cloud for storage and sharing via wireless networks. Vast amounts of data collected from this array of wearable technology will increasingly allow the use of multivariate approaches to analysis as used in machine learning and data mining. However, it will be the fusion of these data (Weaving et al., 2014; Liu et al., 2012) that will provide unique insights into not only the stress placed on players during training and competition, but also the interactions between the physical, technical, and tactical aspects of a game. References Aughey, R.J. (2011). *Int. J. Sports Physiol. Perform.* 6:295–310. BSX Insight. (n.d.). Retrieved from <https://www.bsxinsight.com>. Leo. (n.d.). Retrieved from <http://leohelps.com>. Liu, S et al. (2012). *IEEE Transactions on Bio-Medical Engineering*, 59(3), 687–696. MC10. (n.d.). Retrieved from <http://www.mc10inc.com>. OMsinal. (n.d.). Retrieved from <http://www.omsinal.com>. Polar Innovations. (n.d.). Retrieved from [http://www.polar.com/en/about\\_polar/who\\_we\\_are/innovations](http://www.polar.com/en/about_polar/who_we_are/innovations). Weaving, D et al. (2014). *Int. J. Sports Physiol. Perform.* 9(6), 905–912.

## PRACTICAL IMPACT OF MODERN PERFORMANCE ANALYSIS IN FOOTBALL

LAMES, M.

*Faculty of Sports and Health Science*

The advent of new technologies and the interest of media in enhanced reports have advanced football to the most analysed sports in Europe. This development was accompanied by the hope for improvements in football practice as well as competition analysis. Meanwhile, some critical opinions gave rise to a 'practical impact debate' with controversial positions. A basic reason for the failure of performance analysis research to provide hints for practical improvement is the applied research strategy. There are fundamental differences between the applied basic research and applied research, that would in fact be needed to generate practical impact. Some basic requirements for a practice oriented research program in performance analysis are: • Adaptation of qualitative methods to arrive at sound interpretations of player behaviour. • Integration of background information (tactics, preparation, opponent, situation) for assessing the quality of actions. • Interpretation of results from basic research only as background information for practical analyses. • Development of a new generation of game analyses that make use of the new data available and aim at assessing constructs on a higher tactical or physiological level oriented at the information needs of practice. • Investigation of football from the aspect of emergency and contingency for a better understanding of its nature.

## GAME ANALYSIS IN THE ERA OF BIG DATA: A SYNTHESIS APPROACH

DUARTE, R.

*Faculdade de Motricidade Humana, Universidade de Lisboa*

In the last 15 years, we entered in a period of accelerated access to large amount of data (Barris & Button, 2008). Today, tracked positional data and multiple-event notation systems are undoubtedly available at professional club setting. Performance analysis, like most scientific disciplines, lives in the era of 'big data' (Howe et al., 2008). As such, one important consequence is that performance analysts are struggling with large amount of data. This implies a re-definition of the more appropriate methods and tools to use and, consequently, the way analysts are educated to deal with them (Donovan, 2008). Thus, despite the need to have sophisticated technologies compiling all the statistical information from match performance, there is also a need to develop 'synthetic' methods and tools to enhance the usability of such 'big data' (e.g., Lames & McGarry, 2007). According to the 2011 McKinsey Global Institute report (Manyika et al., 2011), this need is particularly important when practitioners are interested to extract meaningful information from large amount of data sets and not only on how to store it in long-term. Here, we review and propose some modelling and visualization tools allowing to objectively quantifying the individual, group and team performance in game sports. The modelling tools that will be under our scope are social networks analysis, cluster phase analysis and dominant region diagrams. Also, we will introduce the multiplexity concept once team players forge-and-broke different kind of networked relationships (e.g., passing relations, switching positioning relations, positioning stability relations, etc., Hanneman & Riddle, 2005). REFERENCES Barris, S., & Button, C. (2008). A review of vision-based motion analysis in sport. *Sports Medicine*, 38, 1025-1043. Donovan, S. (2008). Big data: teaching must evolve to keep up with advances. *Nature*, 455, 461. Hanneman, R. A. & Riddle, M. (2005). Introduction to social network methods. Riverside, CA: University of California, Riverside (published in digital form at <http://faculty.ucr.edu/~hanneman/>) Howe, D., Costanzo, M., Fey, P.... Rhee, S. Y. (2008). Big data: The future of biocuration. *Nature*, 455(7209), 47–50. Lames, M. & McGarry, T. (2007) On the search for reliable performance indicators in game sports. *International Journal of Performance Analysis in Sport*, 7(1), 1-18. Manyika, J., Chui, M., Brown, B.... Byers, A. H. (2011). Big data: The next frontier for innovation, competition, and productivity. McKinsey Global Institute Report, McKinsey & Company 2011 (published in digital form at [http://www.mckinsey.com/insights/business\\_technology/big\\_data\\_the\\_next\\_frontier\\_for\\_innovation](http://www.mckinsey.com/insights/business_technology/big_data_the_next_frontier_for_innovation))

## Invited symposia

### IS-BN02 BIOMECHANICAL FUNDAMENTALS, ADAPTATIONS AND IMPAIRMENTS OF LOWER LIMB FUNCTION

#### MUSCLE AND TENDON MECHANICS FOR EFFICIENT MOVEMENT AND CONTROL

LICHTWARK, G.

*The University of Queensland*

Muscles are responsible for generating the mechanical work that is required for humans and other animals to move. However, one of the key factors that influences muscle performance is not actually associated with the contractile tissue itself, but instead in the elastic connective tissues that transmit force from the muscle to the skeleton and act to absorb and generate mechanical power for efficient locomotion. I will discuss the factors that contribute to energy consumption in muscle and describe how tendon compliance is tuned to



enhance efficiency in walking and running in a range of different muscles in the lower limb, even in muscles that do not support body weight (e.g. tibialis anterior, tibialis posterior). I will also provide evidence of the protective effect that tendons can have in limiting muscle strain during eccentric muscle actions. Innovative methods for measuring and understanding muscle-tendon interaction during dynamic movements, including musculoskeletal modelling and ultrasound image processing, will be described with insight into how they might be used to assess muscle and tendon function. Finally, I will discuss the implications for changing tendon compliance and how this influences muscle force development, energetic cost of performing contractions and the subsequent control of movement.

### **MUSCLE AND TENDON ADAPTATIONS TO TRAINING: A FUNCTIONAL PERSPECTIVE**

SEYNNES, O.

*Norwegian School of Sport Sciences*

The effectiveness and efficiency of ambulatory activities depends on the interaction between the architecture of lower limb muscles and the viscoelastic properties of connective tissue/ tendons to which they are connected. Training studies indicate that both parameters are altered following a period of exercise (1, 2), although the mechanisms underpinning some of these adaptations remain elusive. An increase in pennation angle is often associated with muscle hypertrophy following resistance training, and is assimilated to the necessary accommodation of additional in parallel sarcomeres. However, direct evidence of this assumption is currently missing. Furthermore, animal studies have shown that muscle fibre plasticity can occur lengthwise, via the addition of serial sarcomeres. Yet, reports of exercise-induced changes in fascicle length are conflicting, with some studies showing fascicular lengthening under certain training modalities (e.g. eccentric contractions), while others did not. Tendons display metabolic and structural adaptations following resistive training. In most cases, these changes are accompanied by an increase in stiffness and/or Young's modulus. Scarce data also indicate a decrease in hysteresis. However, the time course and relative contribution of material and structural changes to mechanical behaviour differ considerably between studies, and information is lacking regarding adaptive patterns of tendinous tissue. In this presentation, I will review some aspects of training-induced changes in muscle and tendon and discuss their functional significance. References: 1. Franchi MV, Atherton PJ, Reeves ND, Flück M, Williams J, Mitchell WK, Selby A, Beltran Valls RM, Narici MV. Architectural, functional and molecular responses to concentric and eccentric loading in human skeletal muscle. *Acta Physiol* 210: 642–654, 2014. 2. Wiesinger H-P, Kösters A, Müller E, Seynnes OR. Effects of Increased Loading on In Vivo Tendon Properties: A Systematic Review. *Med Sci Sports Exerc* 47: 1885–1895, 2015.

### **IMPAIRED LOWER LIMB FUNCTION: WHAT'S WRONG IN ATHLETES WITH CHRONIC ANKLE INSTABILITY?**

GEHRING, D.

*University of Freiburg*

A main feature of human locomotion is to protect the musculoskeletal system against harmful overloading. If those neuromuscular and structural/anatomical protective mechanisms fail, injuries are very likely. One of the most frequent examples of sports injuries is an ankle sprain, which leads very often to the development of chronic ankle instability (CAI). It is thought that the concept of CAI encompasses both, mechanical ankle instability, i.e., an impaired structural protection, as well as an impaired function of the neuromuscular system to control the ankle during daily and sportive activities. I will discuss that CAI and especially its neuromuscular impairments are not completely understood yet. Results are diverse, for instance indicating an impaired postural stability and inverter strength without differences in ankle range of motion or muscle reflex latencies compared to healthy controls. Hence, this talk will focus on most recent research approaches, which aim to evaluate ankle joint control in functional dynamic situations trying to assess both feedforward and feedback control mechanisms. Therefore, complex game-like situations are biomechanically analysed. In addition, ankle sprain mechanisms are imitated to assess features of neuromuscular joint control in individuals with CAI and its sub-entities. This talk will indicate how these approaches may help us to better understand the problem of CAI.

## **Invited symposia**

### **IS-SH01 THE FAN CAN: THE MEDIA AND FOOTBALL SUPPORTER COMMUNITIES AS ENABLERS OF MULTICULTURAL ENVIRONMENTS**

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#### **FEMALE FANS OF MEN'S FOOTBALL - SOCIALISATION, MOTIVATION AND CIRCUMSTANCES OF LIFE**

PFISTER, G.

*University of Copenhagen*

Football is an invention by men for men, and today, the majority of players and fans are men. There is an abundance of literature on football and fandom; however, gender is mostly not an issue in these publications. Research about female football supporters and fans is very limited. Based on gender concepts, socialization theories as well as on approaches to circumstances of life, this contribution addresses women and their (lack of) interest in men's football. The main questions refer to the numbers of female supporters and their patterns of football consumption. The sources of information are user data of mass media, results of a survey about football fans in a number of European countries (conducted by members of the FREE project) and the results of an interview study with female fans. A specific focus of this article is on the minority of female supporters who attend football games. How do they become fans, adapt to a 'man's world' and integrate football in their everyday lives? What are their roles in the 'male environment' of the game and its fans? The results of a survey and the statements of interviewees revealed that female fans have to cope with a measure of sexism, and that they often adopt the men's perspectives in order to be accepted as 'authentic fans'. Other women reacted on men's domination in the football stadium by founding women only fan groups that seem to allow them to find their own way to be women and fans.

**SOCIAL RESILIENCE: SPORT AS A PLACE FOR AUTONOMOUS ORGANIZING AND SELF-LEARNING**

KROVEL, R.

*Oslo and Akershus University College, Norway*

Much recent social research has tried to understand social and community resilience. Community resilience will here be broadly defined as the ability of a community to respond to crisis by drawing on local resources of all types to help themselves. Autonomous organizing and self-learning seem to be crucial aspects of resilient communities. This paper will reflect on the role of sport in producing resilient communities in a time of mass migration, mass tourism, hyper consumption and global flows of information and images. It summarizes four investigations into fan activism and fan re-construction of imagined communities in Norway and what it means to belong to these communities. It will also try to interpret new forms of organizing and self-learning in comparison with earlier forms described in the literature on Norwegian sports and social organization. The four cases highlight important aspects of the collective social agency these fans have in times of mass migration, mass tourism, global flows of images and information and hyper consumption. The cases demonstrate that communities of fans can become collective agents for social change and social resilience through autonomous organization and self-learning. Nonetheless, a few paradoxes need to be explored further. First, Norwegian membership of fan organizations for clubs such as Liverpool and Manchester by far exceeds membership of local supporter organizations at home. The meanings of this will be explored by drawing on theories and concepts such as "De-territorialization" (Deleuze and Guattari), "Cloakroom identities" (Bauman) and the fan as "Flâneur" (Giulianotti). Another concern is related to the interplay between online communication and social interaction with other members of the local community. Based on these cases, it seems as face to face interaction and communication plays a key role when social identities and imagined communities are being transformed to include for example immigrants, Muslims and gay men as valued members. When online communication is detached from other forms of social interaction and communication, identity politics have been observed to spiral into extreme forms of identity based politics, such as racism and homophobia. A third paradox is related to the imbalance between membership in fan clubs and the clubs themselves. Norwegian historians focus on clubs and organizations not only as sites that produce identities, feelings of belonging, imagined communities etc., but also as spaces of learning. An organization is a place where the members teach themselves how to organize, cooperate and to participate as potentially equal members with shared rights and responsibilities. Seen from the perspective of community resilience, these new forms of global fandom faces local communities with a number of challenges regarding certain aspects of autonomous organizing and self-learning. These challenges will be discussed further in the paper.

**SUPPORTER CULTURE – FOR WHOM? WOMEN'S PERCEPTION OF FOOTBALL ARENA CULTURE IN SWEDEN**

RADMANN, A.

*Malmö University*

Football supporter culture has been studied and analysed since the 1960s from historical, economic, sociological, cultural and psychological perspectives. Important questions within the field have been who the football supporters are, what influences them, how they can be understood, whether they are violent or well behaved, and what kind of identities are developed within the football supporter culture on a local, regional, national or international level. Most studies on football supporters have focused on men and on men's supporter culture and research on female fandom is lacking. This study has a different focus, as female supporters in a Swedish context will be studied. The aim is to map out and analyse female supporters' views of their situation in Swedish football supporter culture. Of special interest is the question of whether female supporters express the same ideas on gender specific codes within the supporter culture as the male supporters. Method: Interviews with 18 female supporters from Swedish clubs are analysed. The interviews last between one to two hours and are recorded and transcribed. Life stories from four females presented in two different books on supporter culture are used too. The theoretical framework is based on Erving Goffman's dramaturgical perspective, and Judith Butler's notion of performative gender. Results: In the interviews and the life stories of the female supporters, three themes emerge in women's description of their football fandom: restrictions, respect and freedom.

**Invited symposia****IS-SH02 INTERCULTURALITY IN SPORTS – DIFFERENT APPROACHES, EFFECTS AND DILEMMAS****EVALUATING AN INTERCULTURAL EDUCATION PROGRAM FOR PHYSICAL EDUCATION**

GIESS-STUEBER, P., GRIMMINGER, E., MÖHWALD, A.

*University of Freiburg, TU Dortmund University*

Experiences of strangeness become inevitable in socially and ethnically differentiated societies. Based on a sociological, social constructivist and socio-psychological theoretical framework didactical guidelines for physical education were developed with the aim to promote the handling of strangeness in a constructive way (Gieß-Stüber, 2008). This didactical concept was implemented in two different settings to evaluate on the one hand the impact of the concept on relevant socio-cognitive structures for the handling of strangeness, and on the other hand to evaluate how the concept is accepted by target groups, i.e. students. The first evaluation aim was pursued by a quasi-experimental eight weeks intervention study in physical education classes with N=121 students (mean age 11.70 years; SD=.59). Questionnaires evaluated the development of the socio-cognitive structures; video records focused the intervention process. The second evaluation aim was realized in a local sport for development project: a mixed-method study in football groups for girls in residential areas with a dominant rate of families at social risk and with migration background. The integration of all empirical findings elucidate that the didactical concept of intercultural education in PE must be reformulated and focused on specific target groups. Gieß-Stüber, P. (2008). Reflexive interculturality and interaction with strangeness in sport and through play. P. Gieß-Stüber & D. Blecking (eds.), Sport – Integration – Europe. Widening Horizons of Intercultural Education (pp. 228-242). Baltmannsweiler: Schneider.

**ASSESSING INTERCULTURAL PROCESSES AND OUTCOMES IN THE SPORT FOR DEVELOPMENT AND PEACE FIELD**

RATO BARRIO, M.

*Universidad Politécnica de Madrid*

The promotion of intercultural relations has become a frequent objective in the field of Sport for Development and Peace (SDP); however, we lack coherent theoretical fundamentals and specific indicators for measuring intercultural processes and outcomes in the Global South, and as a consequence there is little evidence about the effects of sport in this context. Therefore, a theoretical framework will be presented, which was operationalized and tested in a sport programme (PIDE) in the post-war context of Guatemala with data from 100 participants in four intervention groups and a control group with 557 youths. The results of the PIDE show positive effects in the 4 mentioned intervention groups regarding the affective, cognitive and behavioural elements of tolerance towards diversity and the categories defined for the three phases of the intercultural process (decentring, comprehension and negotiation). Methodological issues and challenges of this programme as well as of other similar SDP initiatives are critically discussed. Finally theoretical and practical recommendations are drawn for further SDP initiatives and the assessment of intercultural processes and outcomes.

**THE INTERCULTURAL PERSPECTIVE OF PHYSICAL EDUCATION: GOALS, DIDACTIC STRATEGIES, AND SOCIAL OUTCOMES IN THE ELEMENTARY SCHOOL**

DERRI, V., KELLIS, I.

*Democritus University of Thrace*

The rapid and diverse changes that our world is experiencing challenge the traditional societal and educational policies. Education should be directed to promote understanding, tolerance and positive relations for all students, through certain policies, if it is to make a significant contribution to a peaceful and fruitful society. To this end, Intercultural Education (IE) is considered a key premise. The core values of IE, such as respect and responsibility not only are prerequisites for the implementation of Physical Education (PE) but also form its emotional/social goals which are expected to be achieved through movement activities. Therefore, the current presentation attempts to show a) the relation between IE and PE goals and didactic strategies; b) the intercultural PE initiatives in Greece; c) the impact of an Intercultural PE program on elementary school students' social and emotional skill learning. Results are discussed in terms of the existence of similarities between IE and PE, and the positive effects of the IPE intervention on student social and emotional development.

**Invited symposia**

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**IS-EX01 ECSS - ACSM EXCHANGE SYMPOSIUM: Preparing for the Olympics - an European and American viewpoint**

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**SPORT SCIENCE AND INNOVATION AT THE NETHERLANDS OLYMPIC COMMITTEE**

MAASE, K.

*NOC\*NSF (Netherlands Olympic Committee)*

Former elite distance runner Kamiel Maase is performance manager sport science & innovation at the Netherlands Olympic Committee (NOC\*NSF). In this role, he contributes to bridging the well-known gap between science and sports on a daily basis. A solid foundation has been built over the past seven years. His work involves, of course, interaction with both coaches and academics. But he interacts with businesses as well. His network has expanded and numerous projects – some highly academic, others very practical – have been carried out. With the 2016 Rio Olympics approaching, coaches and athletes demand evidence-based, practical advice as well as concrete innovations supporting performance. Kamiel explains how NOC\*NSF approaches applied sport science and innovation, and will present specific examples of projects, both long-term and short-term, on the Road to Rio. The presentation is part of the ACSM-ECSS exchange symposium. Randy Wilber (US Olympic Committee) will represent the United States. The presentations will allow comparisons between the US and European approach to be made. The audience is invited to actively contribute to the discussion and ask questions.

**USE OF SPORT SCIENCE BY OLYMPIC ATHLETES FOR MEDAL PERFORMANCE IN RIO 2016**

WILBER, R.

*United States Olympic Committee*

Team USA has produced relatively strong performance results in the Olympic Games since the inception of the modern Olympics in 1896. Team USA is comprised of several national governing bodies (NGBs), which provide both the administrative structure and performance-support structure for elite athletes and coaches within that particular NGB, or sport. USA Swimming and USA Track & Field are historically the two most successful NGBs in Olympic sport for Team USA. These two NGBs alone have consistently won approximately 60 percent of the total medals won by Team USA at any given Olympic Games, and this trend is expected to continue at the RIO 2016 Olympics. The overall strategy of USA Swimming and USA Track & Field in preparation for RIO 2016 is to “defend” medals in traditionally successful events, and to “go on offense” in events where returning Team USA athletes placed 4th through 8th in LONDON 2012, or in events that are relatively new (e.g., 10km swimming). This presentation will focus on select Olympic athletes from USA Swimming and USA Track & Field, and their implementation of various components of sport science in preparation for RIO 2016. Highlighted within this presentation will be examples of specific “Olympic performance initiatives” utilized over the past four years with medal-potential athletes from USA Swimming and USA Track & Field.

## Oral presentations

### OP-PM13 Muscle Strength

#### BLOOD FLOW RESTRICTION RESISTANCE EXERCISE PERFORMED SUB-MAXIMALLY OR UNTIL VOLUNTARY FAILURE INDUCES SIMILAR INCREASES IN MUSCLE SIZE AND STRENGTH

SUNDNES, J., BJØRNSSEN, T., BRANKOVIC, R., STÅLESEN, H., BERNTSEN, S., PAULSEN, G., WERNBOM, M., RAASTAD, T.  
*University of Agder*

**Introduction** Blood flow restriction resistance exercise (BFRRE) using loads as low as 20% of 1 repetition maximum (1RM) can induce rapid increases in muscle size and strength (Nielsen et al., 2012). No study has investigated the importance of conducting BFRRE to voluntary failure; therefore the present study aimed to compare the effect of a failure protocol (FA) vs. a submaximal protocol (SU) on changes in muscle size and strength during BFRRE. **Methods** Seventeen untrained men (18-45yrs, participating in < 2 leg-strength-sessions per week the last six months), had their legs randomized to one of two BFRRE protocols: one leg performed four sets to voluntary failure, whereas the submaximal leg aimed for four sets with 30-, 15-, 15- and 15 repetitions. The intervention consisted of two periods including seven BFRRE sessions within five days (separated with 10 days rest) using unilateral knee extension at 20% of 1RM (30 s rest between sets). The pressure cuff stayed on during all four sets and was inflated to 100 mmHg (13.5 cm pressure zone). Muscle size was measured as muscle-thickness (m. rectus femoris, m. vastus lateralis and m. vastus intermedius) and cross-sectional area (CSA) (m. rectus femoris) with ultrasound imaging. Ultrasound and 1RM (knee extension machine), measurements were conducted before, during and after the intervention; seventeen days after last BFRRE session for ultrasound and twenty-four days after for 1 RM. **Results** Muscle thickness of m. rectus femoris increased significantly in both FA ( $10.5 \pm 5.8\%$ ;  $p < 0.001$ ) and SU ( $10.0 \pm 5.7\%$ ;  $p < 0.001$ ) compared to baseline. FA increased the muscle thickness of m. vastus lateralis ( $5.9 \pm 4.5\%$ ;  $p < 0.001$ ), while only a tendency was observed in the SU group ( $6.6 \pm 4.8\%$ ;  $p = 0.07$ ). No significant increases in m.vastus intermedius were found in FA and SU. CSA of m. rectus femoris increased significantly in both groups compared to baseline (FA:  $7.9 \pm 7.6\%$ ;  $p < 0.001$  and SU:  $9.1 \pm 10.8\%$ ;  $p = 0.003$ ). We did not observe any group differences in the changes of muscle thickness or CSA. Maximal strength (1 RM) increased significantly in both groups (FA:  $9 \pm 8\%$ ;  $p < 0.001$  and SU:  $11 \pm 7\%$ ;  $p < 0.001$ ) compared to baseline. We found no group differences, except a tendency (FA:  $-5 \pm 8\%$  and SU:  $-1 \pm 8\%$ ,  $P = 0.07$ ) within the 10 days of rest. Participants described SU as less demanding and more feasible compared to FA. **Discussion** We did not observe any difference between the two BFRRE protocols, considering improvements in muscle size or maximal strength; both groups had a similar improvement in muscle size and strength compared to baseline. Importantly, the participants described SU as less demanding relative to FA. Therefore, it may not be necessary to conduct BFRRE to voluntary failure in order to achieve optimal gains in muscle size and muscle strength. **References** Nielsen et al., (2012) J Physiol 590: 4351-4361. Contact joakimsundnes@hotmail.com

#### THE EFFECT OF HEAVY AND LIGHT RESISTANCE TRAINING ON SKELETAL MUSCLE STRENGTH AND FUNCTION IN ELDERLY INDIVIDUALS

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**Background:** Skeletal muscle mass decreases with up to 1-2% per year from around the age of 50 and the muscle strength even more. This bodily deterioration often leads to functional impairment and dependency or home care. The aim of this study was to investigate the impact of intensity and settings of resistance exercise training on the efficacy to counteract this age-related decline in elderly subjects. **Methods:** A total of 45 subjects was randomized to 12 weeks of center-based progressive heavy resistance training (RT) (HRTW), home based light rubber band RT (LITW) or no training (WHEY) of the legs with  $n=15$  in each group. All subjects consumed 20g of whey protein twice daily: one at morning and one at lunch. Before and after intervention knee extension peak torque and power, 30s chair-stand, 400m gait speed, MRI-based quadriceps muscle cross sectional area (CSA) and body-composition (DXA) were assessed. Current data are on 32 subjects. Final tests are scheduled for March 2016. **Results:** Two-way RM ANOVAs were applied with Holm-Sidak post-hoc test when interaction was detected. Mean age of completed subjects was  $70 \pm 4$  (SD) years. Intention-to-treat analysis revealed that HRTW ( $n=11$ ) increased peak isokinetic and isometric strength  $12.7 \pm 13.6$  (SEM) Nm (8%) and  $19.7 \pm 15.6$  Nm (11%), respectively ( $P < 0.05$ ). LITW ( $n=12$ ) and WHEY ( $n=9$ ) did not change. There was a time-effect on leg fat free mass ( $P < 0.05$ ) with an increase of  $369 \pm 120$  (SEM) g. Thigh power, gait speed and 30s chair-stand was unchanged. Quadriceps CSA and compliance have not been analyzed at time of submission of this abstract. **Conclusion:** Twelve weeks of RT with heavy but not light loads increased strength but not function in elderly individuals above 65 years. Heavy-loading RT is superior to light-loading RT and can be implemented if feasible.

#### THE EFFECT OF NATIVE WHEY- VERSUS MILK-PROTEIN SUPPLEMENTATION ON MUSCLE SIGNALLING AND HYPERTROPHY DURING STRENGTH TRAINING IN ELDERLY

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**Introduction** Reduced muscle mass and strength with increasing age is a challenge to daily function in many elderly. Resistance exercise and intake of high quality protein has the potential to stimulate muscle protein synthesis (MPS) and thereby counteract the muscle loss. The increased MPS is driven by an increased activity in anabolic signalling proteins (1). In addition to strength training, the amino acid leucine is suggested as a trigger of the signalling networks driving MPS (2). **AIM:** to investigate if a native whey supplement, known to rapidly increase blood leucine concentrations, enhances anabolic signalling more than milk, and whether this translates into increased hypertrophy and strength during an 11-week strength-training program in elderly men and women. **Methods** Thirty elderly participants ( $\sigma=18$ ,  $\eta=12$ ) with a mean age of 74 years were randomized into two groups, receiving 20 g of protein twice per day either as native whey or 1% milk. Both groups performed heavy load strength training three times per week for 11 weeks. Changes in lean mass, m. vastus lateralis thickness and strength, were measured by DXA, ultrasound and 1RM leg press, respectively. Biopsies were collected from m. vastus lateralis in a subgroup of 21 participants, before and 2 h after the first and last workout, to look at acute responses (p70S6K, 4E-BP1 and eEF-2) and training adaptations (muscle fibre area). **Results** Lean mass (milk:  $5.0 \pm 2.6\%$ , native whey:  $3.8 \pm 2.5\%$ ), m. vastus lateralis thickness (milk:  $7.2 \pm 5.7\%$ , native whey:  $6.1 \pm 4.7\%$ ), muscle fibre area (milk:  $15 \pm 26\%$ , native whey:  $13 \pm 21\%$ ) and 1RM in leg press (milk:



29±14%, native whey: 36±16%) increased significantly in both groups with no differences between groups. The ratio of phosphorylated to total p70S6K increased significantly in both groups at all time points and was greater in the Native Whey group compared to the milk group after the training intervention (21-fold vs. 9-fold). There were no significant changes in 4E-BP1 or eEF-2 phosphorylation. Discussion The strength training intervention was effective in increasing muscle mass and strength in the elderly participants, but there were no differences between groups. In the untrained state supplementing with native whey and milk produced the same activation of p70S6K. However, in the trained state native whey produced a greater activation of p70S6K than milk, indicating an adaptive response. Activation of p70S6K was not correlated with gains in muscle mass or strength during the training intervention. References 1. D. L. Mayhew et al., J. Appl. Physiol. 107, 1655–1662 (2009). 2. J. E. Tang, D. R. Moore, G. W. Kujbida, M. A. Tarnopolsky, S. M. Phillips, J. Appl. Physiol. 107, 987–992 (2009). Contact: Havard.hamarsland@nih.no

## THE EFFECT OF GYMNASTIC TRAINING ON MUSCLE STRENGTH AND ACTIVATION DURING ISOMETRIC ELBOW AND SHOULDER FLEXION/EXTENSION

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**Introduction** The aim of the study was to demonstrate the differences between non-athletes and gymnasts at the pre- and post-pubertal age in the development of the peak torque and ensuing flexion/extension ratios at the elbow and the glenohumeral joints well as an to assess the relevance for the above activities of the co-existing co-activation of selected muscles. **Methods** The study involved 18 gymnasts and non-athletes aged 8-9 years as well as 12 gymnasts and 16 non-athletes aged 18-25 years. Measurements of the isometric peak torque (PKTQ) have been taken with a use of a dynamometer Biodex System 4 for flexion and extension at the elbow and the glenohumeral joints. To determine the neurophysiological characteristics of the strength capabilities the method of surface electromyography was applied with a use of the Noraxon's TeleMyo DTS in order to calculate the co-activation index. **Results** In the group of older gymnasts the PKTQ ratio of the arm flexors to extensors was the lowest (0.72) and significantly differed from the other tested groups. This result was influenced by 30% higher PKTQ values ( $p < 0.01$ ) of the arm extensors and their activity in flexion lower by 18% ( $p < 0.05$ ). **Discussion** Apart from proving the effects of long-term gymnastic training, the results give information about the imbalance between the agonist and the antagonist of the arm, which can predispose to more frequent injuries, as emphasized by Ruivo et al. (2012), Cools et al. (2005), who studied professional athletes from other sports disciplines. Interesting are also results on the elbow joint among gymnasts in whom closer proportions the extensors strength to flexors was primarily associated with an increase in the extensors strength. Non-training persons, in turn, at the background of ontogenetic development, headed towards the advantage of the strength of elbow flexors. This problem is undoubtedly worth greater attention in future research. **Conclusion** A disproportionately greater development of strength capabilities of extensor muscles in relation to arm flexors among experienced gymnasts can provide valuable information for physiotherapists and coaches on individuation of athletes' special preparation – essential in teaching many complex gymnastic exercises, as well as in the prevention of injuries. **References** Ruivo R, Pizarat-CorreiaandP, Carita AL. (2012). Isokinetics and Exercise Science, 20, 41-45. Cools A, Witvrouw E, Mahieu N, Danneels L. (2005). Journal of Athletic Training, (40)2, 104-110. Contact mieszkowski@ukw.edu.pl

## THE EFFECT OF SPINAL MOBILIZATION ON LOWER LIMB STRENGTH

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**Background:** There is limited evidence regarding the effects of spinal mobilization on the reduction of extremity muscle inhibition in asymptomatic subjects. In addition, the potential of the possible strength gain by spinal mobilization to be reflected in functional performance has yet to be investigated. **Purpose:** The purpose of our study was to investigate whether passive lumbar spine mobilization on L2/3 can improve hip flexion strength and performance in single-leg triple hop (SLTH) test in asymptomatic young adults. **Methods:** Our study adopted a pretest-posttest sham group design. Twenty-four participants (M=12; F=12), aged from 19 to 26, being positive in hip flexor 'break' test, which indicated hip muscle weakness could be caused by neuromuscular inhibition, were recruited. They were randomly allocated into treatment group (passive lumbar rotation at L2/3) or sham group (passive hip joint mobilization). Isometric hip flexor torque (Nm) and SLTH distance (cm) were measured before and after intervention. **Results:** After intervention, the treatment group illustrated a significantly higher (+3.41% ± 5.44%) ( $p=0.02$ ) positive percentage change in torque than the sham group (-2.36% ± 5.81%). Both the treatment and the sham groups showed significant increase in SLTH distance ( $p=0.040$  and  $0.044$  respectively). **Conclusions:** The study results showed a potential effect of passive lumbar rotational mobilization on decreasing hip flexor inhibition. However, improvement in SLTH performance could neither be differentiated as the effect from treatment, nor placebo or learning effects. **Implications:** Our study provided an insight that lumbar rotational mobilization could be a possible way to manage hip flexor inhibition, thus to regain/ increase hip muscle strength. Hip flexor inhibition can be presented without back pain. Therapists are therefore advised to include the screening of hip flexor inhibition during assessment when patients encountering lower limb conditions even without back pain. **Funding acknowledgements:** The authors reported no funding or conflicts of interest in this study.

## EFFECTS OF FOUR WEEKS OF UNILATERAL ISOMETRIC LOW INTENSITY STRENGTH TRAINING, WITH AND WITHOUT BLOOD FLOW RESTRICTION, ON MVC, CROSS SECTIONAL AREA, THE V-WAVE AND H-REFLEX OF THE SOLEUS MUSCLE

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**Introduction.** Low Intensity Blood Flow Restriction Training has been proven to be an effective method to increase strength together with muscle mass (Lonneke et al., 2011; Takarada et al., 2000). However, it remains unknown if this type of training promotes similar neural adaptations to those found after traditional strength training, such as increased volitional wave (V-wave) and Hoffman reflex (H-reflex) (Aaggard et al., 2001). Therefore, the aim of the present study was to test the effects of four weeks of unilateral isometric low intensity strength training, with and without blood flow restriction, on maximal voluntary contraction (MVC), cross sectional area, the volitional wave and the Hoffman reflex of the soleus muscle. **Methods.** Twenty two healthy males were voluntarily involved in this study. Subjects were randomly distributed in three different groups, a control group (CON; n=8), a low intensity blood flow restriction resistance training (LL\_BFRT; n=7) and a low intensity training resistance training (LL\_RT; n=7) groups. Both experimental groups completed four sets of unilateral isometric low intensity (25% of MVC) resistance training three times a week during four weeks. The load, repetitions and sets were

exactly the same in both groups. However, an inflatable cuff was applied to occlude blood flow on the dominant leg of the LI\_BFRT subjects during each training session. Results. The results showed that MVC increased 33% ( $p < 0.001$ ) and 22% ( $p < 0.01$ ) in the training leg of both LI\_BFRT and LI\_RT groups, respectively. The soleus thickness increased 9.5% ( $p < 0.001$ ) and 6.5% ( $p < 0.01$ ) in the training leg of both LI\_BFRT and LI\_RT groups, respectively. However, neither MVC nor thickness changed in any of the legs tested in the CON group. Moreover, V-wave and H-reflex remained unchanged in all the groups studied when tested in both trained or control leg. Discussion and conclusion. Our data are in accordance with previous studies showing that EMG or voluntary activation does not change when a LI\_RT, with or without blood flow restriction, is applied (Kubo et al., 2006; Moore et al., 2004). It seems that strength gains are related with changes occurred in the cross sectional area, at least, when the training period is no longer than four weeks. It is interesting to note that to the best of our knowledge this is the first study confirming that these types of trainings protocols do not elicit adaptations in the neural drive or motoneuronal function. References. Kubo et al. (2006). J Appl Biomech, 22(2), 112-119. Loenneke et al. (2011). Eur J Appl Physiol, 112(5), 1849-1859. Moore et al. (2004). Eur J Appl Physiol, 92(4-5), 399-406. Takarada et al. (2000). J Appl Physiol (1985), 88(6), 2097-2106.

## Oral presentations

### OP-PM12 Sports Medicine: Injury - Tendons

#### THE CHALLENGE OF DIAGNOSING PLANTARIS TENDON INVOLVEMENT IN MIDPORTION ACHILLES TENDINOPATHY – A STUDY USING US+CD, UTC AND CLINICAL ASSESSMENT

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**Introduction** Chronic painful midportion Achilles tendinopathy is a troublesome condition that frequently affects professional and recreational athletes in running and jumping disciplines. Recently, it has been shown that in patients who did not respond to common treatments such as eccentric training, a thickened plantaris tendon being positioned close to and seemingly compressing onto the medial side of the Achilles tendon ("plantaris tendon involvement") was often found (Alfredson, 2011). Surgical removal of the plantaris tendon has resulted in promising outcome. However, little is known about how to diagnose this condition. The aim of this study was therefore to evaluate whether imaging tools and clinical assessment can predict plantaris tendon involvement. **Methods** Twenty-three tendons in 18 patients (14 men, mean age: 37 years and 4 women: 44 years) with midportion Achilles tendinopathy were surgically treated with plantaris tendon removal and additional scraping procedure (Alfredson, 2011). Clinical assessment, Ultrasound + Colour Doppler (US+CD) examination and Ultrasound Tissue Characterisation (UTC) were performed and compared with the macroscopic findings during surgery. **Results** At surgery, all 23 cases had a plantaris tendon positioned close to the medial side of the Achilles tendon. Clinical assessment revealed localised medial activity-related pain in 20/23 tendons and focal medial tendon tenderness in 20/23 tendons. For US+CD, 20/23 tendons had a tendon-like structure interpreted to be the plantaris tendon and 23/23 had localised high blood flow in close relation to the medial side of the Achilles. For UTC, 23/23 tendons had disorganised (type 3 and 4) echopixels located in the medial area of the Achilles tendon indicating possible plantaris tendon involvement. **Discussion** In conclusion, in patients with midportion Achilles tendinopathy, medial tenderness and activity related medial pain might indicate plantaris tendon involvement. US+CD can directly visualise the plantaris tendon in a high proportion of the patients, and UTC seems to have potential to indirectly detect a plantaris tendon located close to the medial Achilles tendon. The results of this study provide important information on how to diagnose a plantaris-associated Achilles tendinopathy and can thus help clinicians and therapists to adapt the rehabilitation program. **References** Alfredson, H. (2007). Br J Sports Med, 45, 1023-5. Christoph.spang@umu.se

#### THE IMPORTANCE OF THE TNF SYSTEM IN OVERUSED/DAMAGED MUSCLE AND TENDON

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*Anatomy*

**Introduction:** TNF alpha is known to be involved in various aspects of damage and inflammation, as well as restitution, in different tissues. There is, however, little knowledge of the importance of TNF alpha in overused/damaged muscle and tendon. This is a drawback as TNF alpha may have many important functions in conditions with reorganization and damage and as pain in response to damage and overuse for muscle and tendon are troublesome situations. **Materials & Methods:** Muscle tissue from overused rabbit muscle was examined. The rabbits had been exposed to overuse concerning their soleus muscle via the use of an experimental procedure that has been developed in the laboratory and which has been used for evaluation of the importance of other signal substances than TNF alpha. Material from human tissue was also examined; material obtained from operations for Achilles tendinopathy (tendinosis). The material corresponded to tissues from the plantaris tendon, which has been found to be highly influenced when being located very close to the Achilles tendon in this situation. The material also corresponded to tissue from the peritendinous region, a region known to have an importance in the tendinosis situation. Immunofluorescence and antibodies towards TNF alpha and the TNF receptors I and II (TNFRI and TNFRII) were applied. **Results:** The TNF-alpha is expressed in white blood cells in the connective tissue, as in some extent in the fibroblasts in overused/damaged rabbit muscle tissue. The TNF receptors are present in white blood cells, fibroblasts, muscle fibres and muscle cell nuclei, blood vessels, neuromuscular junctions and nerve fascicles. In some cell types, TNF receptor expression were present in both healthy and damaged muscle tissue in compare with other cell types where expression extended the more damaged/overused the muscles were. The muscle fibres expressing TNF receptors were either of a degenerating or regenerating stadium. Concerning the human situation it was found that tenocytes in the plantaris tendons exhibited TNF alpha as well as TNF receptor immunoreactivities. Furthermore, the numerous cells occurring in the loose peritendinous tissue frequently exhibited immunoreactions for TNF alpha and TNF receptor. In addition, TNF receptor immunoreactivity was markedly seen for the walls of the blood vessels that were frequently present in tendon tissue and in the loose peritendinous tissue. **Discussion:** The findings show that the TNF system is likely to play an important role in the processes that occur in a muscle that is markedly overused and in tendon tissue as well as peritendinous tissue in the Achilles tendinosis situation. TNF alpha may via effects on its receptors cause tissue damage by inflammatory and cell death mechanisms as well as regeneration by myogenesis mechanisms.

**FUNCTIONAL PERFORMANCE DEFICITS SIX MONTH AFTER ANTERIOR CRUCIATE LIGAMENT RECONSTRUCTION**

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**Introduction** Consequences of an ACL rupture are a loss of function and stability in the knee (Rudolph et al., 2000). Reconstruction and subsequent rehabilitation are common approaches to regain function and stability. However, the rehabilitation process does not assure full knee stability and return to sports on pre-injury sports-level (Lentz et al., 2009). The aim of this study was to evaluate the function of the knee after ACL injury in a multifaceted test battery throughout the rehabilitation process with focus on the leg symmetry index (LSI). This should help to find criteria for a safe return in pre-injury sports and sports-level. **Methods** 20 patients with unilateral tear of the ACL were tested at T1 six weeks after injury; T2 six weeks, T3 three and T4 six month after reconstruction. A control group was matched in respect to age, body height, mass and the activity level and was tested once. Subjects had to self-evaluate themselves with the Tegner-Activity-Score (TAS) and the Knee Injury and Osteoarthritis Outcome Score (KOOS) at all test sessions. The subjects performed bilateral counter movement jumps, one-leg jumps for distance and isometric force tests in 90° and 110° knee flexion and extension. In the jumps, heights and distances along with take-off and landing impulses were calculated. In the isometric force tests, peak forces, peak rate of force development (RFD) and peak RFD in the first 200 ms of contraction were calculated. Thereof the LSIs were calculated by dividing the results of the injured leg by the result of the uninjured leg in the ACL group and non-dominant divided by the dominant leg in the control group. To determinate differences over the four test sessions one-way ANOVAs with repeated measures were conducted. The results of T4 of the ACL group were compared to the results of the control group with a t-test for independent samples. **Results** In all analyzed parameters decreases of the LSIs from T1 to T2 ( $p < .05$ ) were found. From T2 to T4 the LSIs increased towards a balanced level. However, the ACL patients, showed in comparison to healthy controls, lower LSIs six month after reconstruction ( $p < .05$ ). Additional, ACL patients do self-evaluate their activity level six month after reconstruction lower than the pre-injury level was ( $p < .05$ ). **Discussion** The lower LSIs six months after ACL reconstruction and the low self-evaluation leads to the conclusion that a general return to pre-injury sports level six month after reconstruction seems often too early. Therefore the functional status should be evaluated throughout the rehabilitation process to monitor the development of the leg symmetry over time after ACL injury. **References** Lentz, TA, Tilman, SM, Indelicato, PA, Moser, MW, George, SZ, Chmielewski, TL. (2009). Sports Health, 1 (1), 47-53. Rudolph, KS, Axe, MJ, Snyder-Mackler, L. (2000). Knee Surg Sport Tr A, 8, 262-269. Contact [frieder.krafft@kit.edu](mailto:frieder.krafft@kit.edu)

**TIME COURSE OF COSTAMERE PROTEIN CONCENTRATIONS AFTER ROTATOR CUFF TENDON RELEASE IN SHEEP**

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**INTRODUCTION** Tears of rotator cuff tendons are a frequent cause of shoulder complaints in athletes (Lazarides et al., 2015). If not repaired early, they lead to atrophy and fatty infiltration of the affected muscle. Early treatment with nandrolone mitigates this process in sheep (Gerber et al., 2015). Costamere components were investigated previously in the events of unloading through tendon release (TR) (Klossner et al., 2013) and adipocyte differentiation (Li and Xie, 2007). The aim of the present study was to assess the effects of simulated rotator cuff tendon tear and nandrolone treatment on costamere components in sheep. **METHODS** The tendon of the m. infraspinatus was surgically released in 18 female Swiss Alpine sheep. The animals were assigned to two groups defining a time course (TR2, age: 16.6 (0.0) months, N = 6; TR16, age: 23.2 (1.2) months, N = 6) and to a third group receiving weekly injections of nandrolone decanoate (TR16+NAN, age: 23.8 (1.2) months, N = 6). Muscle biopsies were collected prior to TR (all groups), and two weeks (TR2) or 16 weeks (TR16, TR16+NAN) after TR. Costamere protein concentrations/total protein were assessed through Western blotting with the contralateral muscle as control. Experiments were performed according to the Swiss law of animal welfare (TSch455) and approved by local authorities. All data are presented as mean (SD). Differences between and within groups were detected with a general linear model with repeated measures and LSD post-hoc test (SPSS, IBM). Statistical significance was defined as  $P < 0.05$ . **RESULTS** The concentration of the C-terminal 190kDa proteolytic fragment of talin significantly increased with 16 weeks of TR (2.2 fold,  $P < 0.001$ ), but not with 2 weeks ( $P = 0.44$ ). Full length talin protein concentration did not change. Nandrolone administration prevented the cleavage of talin and the increase of intramuscular fat content. Focal adhesion kinase, gamma- and meta-vinculin protein concentrations remained unaffected. **DISCUSSION** The differences in talin fragment abundance indicate alterations in costamere turnover, which seem to be part of the nandrolone-mediated pathway that reduces the degeneration of the rotator cuff muscle. **REFERENCES** Gerber C, Meyer DC, Flück M, Benn MC, von Rechenberg B, Wieser K (2015). Am J Sports Med 43(10):2393-400 Klossner S, Li R, Ruoss S, Durieux AC, Flück M (2013). Am J Physiol Regul Integr Comp Physiol. 305(6):R647-57 Lazarides AL, Alentorn-Geli E, Choi JH, Stuart JJ, Lo IK, Garrigues GE, Taylor DC (2015). J Shoulder Elbow Surg 24(11):1834-43 Li J, Xie D (2007). J Biochem Biophys Res Commun 357(3):648-54 CONTACT [sruoss@research.balgrist.ch](mailto:sruoss@research.balgrist.ch)

**Oral presentations****OP-SH10 Psychology: Motivation 1****PREDICTORS OF ANTISOCIAL ATTITUDES AND DOPING INTENTIONS IN SPORT: THE ROLE OF COACH INTERPERSONAL STYLE AND ATHLETES' PSYCHOLOGICAL NEEDS**

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**Introduction** Our statistical review of the literature (Ntoumanis et al., 2014) showed that relatively little research on doping in sport has examined the contributing role of social environments. Recent research (e.g., Bartholomew et al., 2011) has utilized the self-determination theory framework (Deci & Ryan, 2002) to show how adaptive and maladaptive coach motivational strategies predict a number of indices of athlete psychological and physical functioning (e.g., disordered eating, burnout, depression). However, it is unknown how coach adaptive and maladaptive motivational strategies relate to athletes' intention and engagement in doping behavior. Hence, our study draws from self-determination theory to address this gap in the literature. **Methods** Data collection took place in Australia and Greece at the beginning of the sport season. In Australia 211 athletes (140 males) from a variety of sports completed the survey (Mage = 22.69 years; SDage = 5.721). In Greece 237 athletes (146 males) provided responses (Mage = 21.99 years; SD = 3.9). The majority of athletes

were competing at a state or national level. Athletes completed a questionnaire pack containing a number of validated questionnaires. All procedures were carried out in accordance with APA ethics guidelines. Results Structural equation modeling analysis provided support for a model in which perceptions of autonomy supportive coaching environment positively predicted athletes' perceptions of psychological need satisfaction. Controlling coach environments were predictors of experiences of thwarted/frustrated needs. Thwarted needs were positive predictors of moral disengagement, antisocial attitudes and intention to dope. The opposite pattern of results was observed for need satisfaction and these outcomes. A number of country differences in these findings emerged. Discussion Results from this study can inform interventions that aim to provide coach anti-doping education from a self-determination perspective, in terms of creating optimal coaching environments that support athletes' psychological needs. References Bartholomew, K., Ntoumanis, N., Ryan, R., Bosch, J., & Thøgersen-Ntoumani, C. (2011). *Pers Soc Psychol B*, 37, 1459–1473. Ntoumanis, N., Ng, J.Y.Y., Barkoukis, V., & Backhouse, S. (2014). *Sports Med*, 44, 1603–1624. Deci, E. L., & Ryan, R. M. (2002). *Handbook of self-determination research*. Rochester, NY: University of Rochester Press.

### THE IMPORTANCE OF ACHIEVEMENT GOAL ORIENTATION WHEN LEARNING A NOVEL, AND INCREASINGLY COMPLEXED, SKILL

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Purpose of the study Previous studies have shown that high ego orientation might lead to maladaptive strategies in achievement situations like organized sport (Roberts, 2012). There are, however, few studies investigating the relationship between goal orientation and learning new skills. The purpose of this study was to investigate if the degree of ego- and task orientation is connected to the ability of learning a novel skill. Another purpose was to investigate if there would be different outcomes when manipulating the complexity of the skill. Methods University students (N=40, 37.5% female) took part in a training study as part of an introductory course in Sport Science. Participants were introduced to Sport Stacking, and taught the increasingly complexed tasks of stacking the 3-3-3, the 3-6-3, and the Cycle-stack. None of the participants had tried Sport Stacking before. Skills in each task were tested at baseline by allowing each participant ten tries at each stack, and logging the last three times as a measure of outcome. Participants then took part in a five-week supervised training program, before conducting a final test of their skills. The outcome measure of learning is the difference between baseline and final test. To measure ego- and task orientation of the participants, the Perception of Success Questionnaire (POSQ; Roberts, Treasure & Balague, 1989), was administered. Results A series of independent t-tests were conducted in order to check for differences between male and female participants on central study variables. There were no differences on achievement goals or Sport Stacking skills. Correlation analysis was used to check for a connection between ego- and task orientation and Sport Stacking skills, showing no significant relationship between task orientation and Sport Stacking skills. There was however, a significant negative relationship between ego-orientation and the most complexed skill (the Cycle-stack) ( $r = -.50$ ,  $p < .05$ ). Discussion Results in the present study indicate that, when learning a novel skill, there needs to be a certain complexity involved before goal orientation matters. When the skill becomes relatively complexed, having a strong ego orientation appears to have a negative relationship with the learning outcome. Thus, results in the present study indicate that having a strong ego orientation leads to maladaptive strategies for learning novel skills. References Roberts, G.C. (2012). Motivation in sport and exercise form an achievement goal theory perspective. In Roberts, G. C. & Treasure, D. C. (eds). *Advances in motivation in sport and exercise*. Champaign: Human Kinetics Roberts, G. C., Treasure, D. C., & Balague, G. (1998). Achievement goals in sport: The development and validation of the Perceptions of Success Questionnaire. *Journal of Sport Sciences*, 16, 337–347.

### AUTONOMOUS MOTIVATION AND SELF REGULATED LEARNING: DETERMINING FACTORS OF PERFORMANCE IN SNOWBOARD AND FREESKIING

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Snowboard and freeskiing seem to represent a somewhat different training-culture compared to 'traditional' winter sports. Due to the absence of a typical coach utilizing customary coaching-strategies including provision of structure, instructions and feedback as tools for performance enhancement, these riders are required to take greater responsibility and control of their own learning processes. The aim of the present study was to investigate the existence of self-regulated learning (SRL - e.g. Toering, et al., 2009) and autonomous motivation (AM) (Self-determination Theory; Ryan & Deci, 2002) within this culture, and how these variables relate to development and skill level. Methods Forty-three snowboarders and freeskiers aged 15-23 years ( $M = 17.5$ ,  $SD = 1.8$ ), completed two questionnaires related to motivation (Behavioural Regulation in Sport Questionnaire – BRSQ; Lonsdale, et al., 2008) and SRL (Self-regulated learning questionnaire – SRLQ; Toering et al., 2013) during the on-snow season. BRSQ was distributed at the beginning (T1), mid (T2) and at the end of the season (T3). SRLQ was distributed at T2 and T3. The riders' current skill level, and seasonal development, which is a cumulative score of technical-skill, tactical- (deliberateness), mental- (involvement) and physical (strength, agility) abilities, was rated by their coaches at T3. Results AM at T1, T2 and T3 was found to positively correlate with SRL at T3. Both SRL at T2 and T3 correlated positively with skill level. Regression analyses indicate that AM at T1 may predict coach-rated development ( $B = 0.65$ ,  $p = 0.03$ ,  $R^2 = 0.12$ ), but not skill level. In turn, SRL at T2 was found to have a positive effect on skill level ( $B = 1.15$ ,  $p = 0.05$ ,  $R^2 = 0.14$ ), but not coach-rated development. Discussion Snowboarders and freeskiers display a high degree of AM, and in large part self-regulate their learning and development. Although not explicitly identified in the present study, the positive relation between AM and SRL, in combination with the separate effects of AM and SRL on development and skill level, indicate that SRL function as a mediating variable between motivation and skill level. The present results signify the importance of a training environment that facilitates autonomy and self-regulation in these sports. References Lonsdale C, Hodge K, & Rose EA. (2008). *J Sport Exercise Psy*, 30(3), 323–55. Ryan RM & Deci, EL. (2002). *Handbook of self-determination research*, 3-33. Rochester, NY US: University of Rochester Press. Toering T, Elfenrink-Gemser MT, Jordet G, & Visscher C. (2009). *J Sport Sci*, 27, (14), 1509–1517. Toering T, Jordet G, & Ripegutu A. (2013). *J Sport Sci*, 31(13), 1412–20. Contact marius.sommer@psy.umu.se

### OVERTAKING BEHAVIOUR IN ELITE AND SUB-ELITE 1500M SHORT TRACK SPEED SKATERS

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Introduction Pacing can be seen as a continuous decision-making process related to how and when to invest your energy (Smits et al, 2014). Previous studies explored pacing behaviour as well as tactical positioning in short track speed skating competitions, and indicated



that tactical positioning in the final stages of the race was highly related to finishing position in 1500m races (Konings et al, 2016). As a next step in understanding pacing and tactics in head to head competition in short-track speed skating, the present study explored overtaking behaviour of elite and sub-elite short track speed skaters in 1500m races. Methods Intermediate positional rankings of 1500m races (13,5 laps) were collected per lap from short track speed skating World Cups, European and World Championships over the seasons 11/12 until 14/15 (N=7157 individual races). Short track speed skaters with a top 10 World Cup ranking were classified as elite speed skaters (ELITE; N=35 athletes, 716 individual races), while short track speed skaters with a World Cup ranking between 20-30th place were classified as sub-elite short track speed skaters (SUB; N=34 athletes, 392 individual races). The mean number of overtakings, being overtaken and total changing of positions (sum of overtaking and being overtaken) were calculated using the intermediate positions. Differences between elite and sub-elite short track speed skaters in overtaking frequency per lap were determined using independent T-tests ( $P<0.05$ ). Results ELITE overtook their opponents less frequently in lap 1 compared to SUB (ELITE=  $0.2\pm0.2$ ; SUB=  $0.4\pm0.2$ ,  $P=0.001$ ). In contrast, ELITE showed a higher number of overtakings in lap 10 (ELITE=  $0.2\pm0.1$ ; SUB=  $0.1\pm0.1$ ,  $P<0.001$ ) and lap 12 (ELITE=  $0.2\pm0.1$ ; SUB=  $0.1\pm0.1$ ,  $P=0.002$ ) compared to SUB. ELITE were overtaken more frequently than SUB in lap 1 (ELITE=  $0.5\pm0.2$ ; SUB=  $0.4\pm0.2$ ,  $P=0.004$ ), but less frequently in lap 11 (ELITE=  $0.1\pm0.1$ ; SUB=  $0.1\pm0.1$ ,  $P<0.001$ ), lap 12 (ELITE=  $0.1\pm0.1$ ; SUB=  $0.1\pm0.1$ ,  $P=0.046$ ) and lap 13 (ELITE=  $0.1\pm0.1$ ; SUB=  $0.1\pm0.1$ ,  $P=0.022$ ). Finally, no differences were found in the total changing of positions between ELITE and SUB. Conclusion The present study showed that elite short track speed skaters distinguished themselves from sub-elite short track speed skaters by demonstrating on average both a higher number of overtakings as well as being overtaken less frequently by their opponents in the final, decisive part of the race. References Smits BLM, Pepping G-J, Hettinga FJ (2014) Sports Med, 44(6), 763-75. Konings MJ, Noorbergen OS, Parry D, Hettinga FJ (2016) Int J Sports Physiol Perform, 11(1), 122-129. Contact fjhett@essex.ac.uk

### THE POSITIONING BEHIND ONE'S FORERUNNER IN THE FINAL STAGES OF THE RACE DISTINGUISHES ELITE AND SUB-ELITE SHORT TRACK SPEED SKATERS

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Introduction Pacing can be seen as a continuous decision-making process related to how and when to invest your energy (Smits et al., 2014). Previous research explored the pacing strategies of short track speed skaters and emphasized the importance of tactical positioning (Konings et al., 2016). In addition, the positioning behind one's forerunner might be crucial in order to provide oneself the opportunity to overtake the forerunner. The present study explored how elite and sub-elite short track speed skaters positioned themselves behind their forerunner. Methods Lap times and intermediate positions of 1500m races were collected from short track speed skating World Cups, European and World Championships over the seasons 11/12 until 14/15 (N=7157 individual races). Short track skaters were classified by proficiency: skaters with a top 10 World Cup ranking were classified as elite (ELITE; N=35 athletes, 716 individual races), while skaters with a World Cup ranking between 20-30th place were classified as sub-elite (SUB; N=34 athletes, 392 individual races). The positioning behind one's forerunner was determined by calculating the time the forerunner preceded the participant in every lap. Differences between elite and sub-elite riders in the positioning behind one's forerunner were determined using independent t-tests ( $p<0.05$ ). Results SUB positioned themselves closer behind their forerunner in the first three laps compared to ELITE (Lap 1: SUB=  $0.13\pm0.07$  sec vs. ELITE=  $0.15\pm0.08$  sec,  $P=0.001$ ; Lap 2: SUB=  $0.13\pm0.06$  sec vs. ELITE=  $0.14\pm0.08$  sec,  $P=0.021$ ; Lap 3: SUB=  $0.12\pm0.05$  sec vs. ELITE=  $0.13\pm0.08$  sec,  $P=0.006$ ). In contrast, ELITE positioned themselves closer behind their forerunner in the last four laps (Lap 11: ELITE=  $0.10\pm0.07$  sec vs. SUB=  $0.14\pm0.12$  sec,  $P<0.001$ ; Lap 12: ELITE=  $0.11\pm0.09$  sec vs. SUB=  $0.18\pm0.20$  sec,  $P<0.001$ ; Lap 13: ELITE=  $0.15\pm0.15$  sec vs. SUB=  $0.27\pm0.31$  sec,  $P<0.001$ ; Lap 14: ELITE=  $0.21\pm0.31$  sec vs. SUB=  $0.47\pm0.66$  sec,  $P<0.001$ ). Discussion Elite short track skaters appeared to be able to position themselves closer behind their forerunner compared to sub-elite skaters during the final, decisive stages of the race. Our findings emphasize the importance of tactical positioning in short track speed skating competitions, and propose the positioning behind one's forerunner in the final, decisive stages of the race as a distinguishing factor between elite and sub-elite short track speed skaters. References Smits BLM, Pepping G-J, Hettinga FJ (2014) Sports Med, 44(6), 763-775. Konings MJ, Noorbergen OS, Parry D, Hettinga FJ (2016) Int J Sports Physiol Perform, 11(1), 122-129. Contact fjhett@essex.ac.uk

## Oral presentations

### OP-PM05 Brain & Cognitive Function

#### EFFECTS OF EXERCISE-INDUCED HYPOHYDRATION ON BRAIN STRUCTURE AND FUNCTION IN ENDURANCE-TRAINED ATHLETES USING MRI

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Affiliations 1National University of Singapore 2Agency for Science, Technology Research, Singapore. 3DSO National Laboratories, Singapore Introduction Hypohydration exceeding 2% body mass is known to impair endurance performance (Sawka et al., 2001; Cheuvront et al., 2010). It is hypothesized that the central nervous system, specifically the brain, is negatively affected by hypohydration, leading to an impairment in endurance capacity. To date, few brain imaging studies have investigated the functional impact of exercise-induced hypohydration and this precipitates the main objective of this study. Methods Ten endurance-trained sportsmen (mean $\pm$ sd: age  $23.3\pm1.1$  years; body fat  $10.5\pm2.4\%$ ;  $VO_{2peak}$   $65.6\pm5.0$  ml  $kg^{-1}$   $min^{-1}$ ) were dehydrated to  $-3\%$  body mass by running on a treadmill at  $65\%$   $VO_{2peak}$  in a  $25^{\circ}C$  environment, before drinking to replace 100% or 0% of fluid losses in two separate randomized, counterbalanced trials. Participants underwent MRI scans at baseline and post-fluid replacement for assessment of brain volume and fMRI imaging during a plantar flexion task. Endurance capacity was assessed by running to exhaustion at  $75\%$   $VO_{2peak}$ . Core temperature, heart rate and endurance timings were assessed using paired sample T-test with  $p<0.05$  considered significant. Results Results from the endurance run showed similar heart rates between the euhydrated (EU) and hypohydrated (HH) trials at time of exhaustion (EU:  $171\pm10$  bpm, HH:  $172\pm9$  bpm;  $p=0.184$ ). Core temperature before the start of endurance run were similar between conditions (EU:  $36.7\pm0.2^{\circ}C$ , HH:  $36.7\pm0.3^{\circ}C$ ;  $p=0.836$ ). The absolute change in core temperature in the endurance run were similar between trials (EU:  $2.7\pm0.2^{\circ}C$ , HH:  $2.7\pm0.3^{\circ}C$ ;  $p=0.939$ ). However, the rate of increase in core temperature was higher in hypohydrated subjects (EU:  $0.06^{\circ}C$   $min^{-1}$ , HH:  $0.07^{\circ}C$   $min^{-1}$ ;  $p=0.006$ ). Endurance capacity was reduced with hypohydration (EU:  $45.2\pm9.3$  min, HH:  $38.4\pm10.7$  min;  $p=0.033$ ). Fold changes in total

brain volume were lower in HH trials than EU trials (EU: 1.007, HH: 0.993;  $p=0.003$ ). BOLD (blood-oxygen-level dependent) activation in the precentral gyrus (motor), postcentral gyrus (somatosensory) and supplementary motor area (SMA) during the plantar flexion task were similar between conditions (PreCG:  $p=0.314$ , PostCG:  $p=0.332$ , SMA:  $p=0.677$ ). Conclusion Our findings demonstrate that the cardiovascular system is remarkably defended in endurance-trained athletes despite loss of body fluids. Total brain volume is reduced with hypohydration but notably the functional activity of the brain is well-preserved in these endurance athletes. The decline in endurance capacity could possibly be due to other factors such as the greater heat strain accumulated in hypohydrated individuals. References: Sawka et al. (2001). *Comp. Biochem. Physiol. A*. 128 (4), 679-690. Cheuvront et al. (2010). *J. Appl. Physiol.* 109, 1989-1995. Contact: a0067132@u.nus.edu / tan.xiangren@gmail.com

## CEREBRAL OXYGENATION DURING CORTICAL ACTIVATION: THE EFFECT OF THREE EXERCISE TRAINING MODALITIES

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**Introduction** Research on the influence of exercise training on cerebral oxygenation patterns is inconsistent and not well understood. Physical training induces structural brain changes as well as functional changes in neural networks essential for cognitive processing. It is, however, uncertain how the changes relate to cognitive performance and it remains to be established if these patterns are training mode dependent. The primary aim of this study was to determine if the exercise training mode has a differential effect on older individuals' cerebral oxygenation during cortical activation. **Methods** Sixty seven inactive individuals (55 to 75 years) volunteered for this intervention study. Participants were allocated to a resistance training (RT) group ( $n=22$ ), high-intensity interval training (HIIT) group ( $n=13$ ), moderate continuous training (MCT) group ( $n=13$ ) and a control (CON) group ( $n=19$ ). Each training group performed three supervised exercise sessions per week for a period of 16 weeks. Near-infrared spectroscopy (NIRS) was used to measure cerebral oxygenation during a simple and complex cognitive task. Data were analysed using mixed model repeated measures ANOVA and  $P < 0.05$  was considered statistically significant. Cohen's effect sizes were calculated to compare the magnitude of differences in outcome variables between the groups. Results CON showed higher relative O<sub>2</sub>Hb values during the simple and complex Stroop tasks during post-test (ES = 0.76 and 0.62, respectively;  $P < 0.05$ ). MCT showed a decrease in O<sub>2</sub>Hb on the simple (ES = 0.48;  $P > 0.05$ ) and complex (ES = 0.50;  $P > 0.05$ ) tasks. The HIIT groups' O<sub>2</sub>Hb on the simple task decreased from pre-test (ES = 0.45;  $P > 0.05$ ). MCT showed an increase in HHb on the simple (ES = 0.89;  $P < 0.05$ ) and complex (ES = 1.14;  $P < 0.05$ ) cognitive tasks. HIIT exhibited a smaller decrease in the concentration of HHb compared to pre-test measurements on the simple (ES = 0.67;  $P > 0.05$ ) and complex tasks (ES = 0.49;  $P > 0.05$ ). The RT group did not show any significant changes in their activation patterns during the simple or complex task when comparing pre- and post-test values (ES < 0.3;  $P > 0.05$ ). **Discussion** Sixteen weeks of high-intensity interval training and moderate continuous aerobic training improved task-efficient cerebral oxygenation and oxygen utilization during cortical activation in older individuals more than resistance training. These findings may reflect the different neural-cognitive mechanisms involved with different modes of exercise training. It has been suggested that aerobic training is linked to elevated levels of BDNF, while resistance training produces increased levels of IGF-1. However, it is unclear whether these differences account for the varying responses in cerebral oxygenation observed in this study. et2@sun.ac.za

## A QUALITATIVE COMPARISON OF ELITE TAEKWONDO PLAYERS: DOES FIGHTING IN TRAINING ADEQUATELY SIMULATE THE COGNITIVE-EMOTIONAL CONSTRAINTS OF COMPETITION?

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**Introduction** The importance of designing training tasks that simulate the cognitive-emotional constraints and demands of competition has recently been highlighted (Headrick et al., 2014). Fighting is a key training task of combat sports, however no research has examined whether the constraints of this task adequately simulate the cognitive-emotional demands of competition. The aim of this study was to use the qualitative course-of-action methodology to explore how the cognitive-emotional responses of elite taekwondo athletes differ between fighting in competition and fighting in training. **Methods** Five international (world ranking  $11.2 \pm 2.2$ ; age  $26.8 \pm 4$  years) and three national level taekwondo players (world ranking  $165 \pm 97.9$ ; age  $18.3 \pm 1$  year) were video-taped completing a typical fight in competition and a typical fight in training. Following each fight, players participated in a video-facilitated self-confrontational interview where they were asked to comment on the perceptions, thoughts and feelings that influenced each action. Data were analysed using a course of action approach (Theureau, 2002). Each condition was analysed separately and then compared for differences. Firstly, comments relevant to an action were organised into discrete units, termed elementary units of meaning (EUM). Consecutive relatable EUMs were joined together into sequences, with common sequences then grouped together as themes. Themes unique to either the training or competition environment were identified. Results Results revealed the emergence of several themes unique to either competition or training fights. Unique competition themes: Ego goal orientation, aggression, mental effort, physiological arousal and anxiety. Unique training themes: Mastery focus, low stimulation and opponent familiarity. **Discussion** Findings highlight the contextualised nature of cognitive and emotive responses, which emerged from the interaction between the actor and environment. Our interpretation suggests that simply fighting in training does not produce cognitive-emotive responses representative of competition, perhaps due to players being familiar with their team mates and having different goals. Further work needs to empirically test the identified themes and consider how fighting in training can better simulate the constraints and demands of competition. References Headrick, J., Renshaw, I., Davids, K., Pinder, R., and Araujo, D., (2014). *Psych Sport Ex.* 16(1), 83-90. Theureau, J. 2002. Course of action centred design. In E. Hollnagel (Ed.), *Handbook of cognitive task design*, London, Lawrence Erlbaum Associates, 55-81. Contact Michael.Maloney@Ausport.gov.au

## THE EFFECTS OF A SINGLE BOUT OF EXERCISE ON MOTOR MEMORY INTERFERENCE IN THE TRAINED AND UNTRAINED HEMISPHERE

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**Aim** Increasing evidence suggests that cardiovascular exercise has positive effects on motor memory consolidation. In this study, we investigated whether a single session of high-intensity interval training mitigates the effects of practising an interfering motor task. Furthermore, learning and interference effects were assessed in the actively trained and untrained limb, as it is known that unilateral motor

learning can cause bilateral adaptations. **Methods** A total of 30 subjects were divided into three groups and equally distributed based on their fitness level determined during a graded VO2max test 1 week prior to the experiment. Subsequently, subjects performed a ballistic training comprised of 45 contractions aiming to increase their rate of force development. This was followed by a single session of high-intensity interval training (4x4min at 75% of the max workload obtained during the VO2max test) either before (Group1) or after (Group 2) practising an interfering accuracy task (visuomotor tracking). The control group (Group 3) did not participate in the HIIT, but rested instead. Performance in the ballistic task was tested before and after the ballistic training, after the exercise and practise of the accuracy task, and 24 hours later. **Results** After ballistic training, all groups showed comparable increases in performance in the trained ( $98.1 \pm 30.5\%$ ) and untrained limb ( $71.5 \pm 25.7\%$ ). Despite the practise of the accuracy task, Group 1 ( $-4.9 \pm 6.11\%$ ,  $p = 0.39$ ) maintained their ballistic task performance after the high-intensity interval training, whereas Groups 2 ( $-21.57 \pm 5.80\%$ ,  $p < 0.01$ ) and 3 ( $-13.69 \pm 5.28\%$ ,  $p = 0.01$ ) showed significant interference effects. After 24 hours, Group 1 still did not show any interference effects. Group 2 counteracted the interference, resulting in increased in ballistic task performance ( $+43.94 \pm 12.80\%$ ,  $p < 0.01$ ) so Group 1 ( $142.23 \pm 46.21\%$ ) and Group 2 ( $142.07 \pm 29.45\%$ ) had significantly higher overall ballistic learning rates compared to Group 3 ( $47.38 \pm 21.24\%$ ). The results were similar in the trained and untrained limb. **Conclusion** A single session of cardiovascular exercise can prevent motor interference in the trained and untrained hemisphere, irrespective of whether it is performed before or after the interfering motor task.

## RESTING EEG MICROSTATES CHANGES AFTER ACUTE EXERCISE

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**Introduction** Multichannel electroencephalography (EEG) recording during relaxed wakefulness is a promising neuroimaging technique to investigate spontaneous brain activity changes after exercise. EEG microstates analyses showed that the majority of signal can be explained by only four stable microstates (Lehmann et al., 2009). The temporal characteristics of the microstates have a neurophysiological relevance in humans. Thus, this study aims to identify the effect of physical exercises on microstates temporal features. **Methods** Twenty triathletes performed two successive exercises on a cycle ergometer: a 30 minutes moderate exercise at 60% of the maximal aerobic power, and a 10 kilometres time trial. Before (PRE), between (POST1) and after (POST2) the two sessions, spontaneous resting EEG was recorded by using 64 surface electrodes during 3 minutes. Muscular artefacts were manually excluded from the signal, and Independent Component Analysis was applied to remove eye-blinks and cardiac artefacts. The data were down-sampled to 128 Hz and bad electrodes were interpolated. The three initial datasets were concatenate into one file and submitted to a k-means clustering to identify the 4 dominant microstates by using Cartool software (Brunet et al., 2011). Those maps were back fitted to the initial datasets to compare microstates between conditions in term of mean duration (ms), relative time coverage (%), and frequency of occurrence (nb/s). **Results** The analyses revealed that the four cluster map solutions (named A, B, C, D) explain above 84% of the global topographic variance. ANOVAs indicated significant Time by Map interactions for the mean duration ( $F(6,114)=7.5$ ,  $p<0.001$ ) and the relative time coverage ( $F(6,114)=7.4$ ,  $p<0.001$ ) of map C only. Bonferroni post-hoc tests revealed that both variables increase at POST1 and POST2 compared to PRE. No significant effects were obtained for the frequency of occurrence. **Discussion** This is the first study that assesses the effect of an acute endurance exercise on EEG microstates features. Microstates C was previously shown to correspond to a specific network with main generators in the anterior cingulate and the insula cortices (Britz et al., 2010). These results are in line with the literature as these regions are involved in the integration of sensory feedback and emotional information. Thus, the increase duration and relative time coverage of microstate C could reflect the exercise-related afferent activity. **References** Britz, J., Van de Ville, D., & Michel, C. M. (2010). BOLD correlates of EEG topography reveal rapid resting-state network dynamics. *NeuroImage*, 52(4), 1162–1170. Brunet, D., Murray, M. M., & Michel, C. M. (2011). Spatiotemporal Analysis of Multichannel EEG: CARTOOL. *Computational Intelligence and Neuroscience*, 2011(1). Lehmann, D., Pascual-Marqui, R. D., & Michel, C. (2009). EEG microstates. *Scholarpedia*. Contact jerome.spring@unil.ch

## EXERCISE AND VIGILANCE: INFLUENCE OF CARDIOVASCULAR FITNESS AND SPORT PARTICIPATION.

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**Introduction** Vigilance or sustained attention is the capacity to maintain attention over time and react efficiently to relevant stimuli (Gunzelmann et al., 2010). The study of vigilance is highly important since optimal levels of this capacity are necessary in many day life activities such as attending to academic lessons (Trautmann & Zepf, 2012) or performing efficiently in certain sport settings (Voss et al., 2010, for a review). Indeed, the regular practice of exercise has been related to vigilance across the life span (e.g., Ballester et al., 2013; Luque-Casado et al., 2013). **Methods** Two studies have been carried out with different groups of children and adolescents differentiated in terms of their regular sports participation (athletes, football players and sedentary controls). Participants completed the Psychomotor Vigilance Task (PVT) to evaluate their vigilance performance. In a different session, participants performed the Leger Multi-stage fitness test to estimate their aerobic fitness level. **Results** Both children and adolescent football players showed better cardiovascular fitness than sedentary controls in the Léger test (all  $ps < .001$ ). In the first study, adolescent football players exhibited faster responses in the PVT than sedentary controls ( $F(1,71) = 17.27$ ,  $p < .001$ ,  $\eta^2_{\text{partial}} = .19$ ). In the second study, athletes showed faster RTs in the PVT than sedentary controls ( $p < .001$ ), and football players outperformed both athletes and sedentary controls (both  $ps < .001$ ). **Discussion** The major novel finding of our investigation points to a positive relationship between sport participation and vigilance performance during childhood and adolescence. We discuss our results in terms of the two different hypotheses ("cardiovascular fitness" and "cognitive component skills") put forward in the literature to explore the relationship between regular exercise and cognitive functioning. **References** Ballester R, Huertas F, Yuste FJ, Llorens F, Sanabria D. (2015). *PLoS ONE*, 10(4), e0123898. Getzmann S, Falkenstein M, Gajewski PD. (2013). *PLoS ONE*, 8(9), e74539. Gunzelmann G, Moore LR, Gluck KA, Van Dongen HPA, Dinges DF(2010). Cognitive Fatigue: Multidisciplinary perspectives on current research and future applications. American Psychological Association, Washington. Luque-Casado A, Zabala M, Morales E, Mateo-March M, Sanabria D(2013). *PLoS ONE*, 8(2), e56935. Trautmann M, Zepf, FD. (2012). *PLoS ONE*, 7(3), e32279. Voss MW, Kramer AF, Basak C, Prakash RS, Roberts B. (2010). *Appl Cogn Psychol*, 24(6), 812–826. Contact rafael.ballester@ucv.es

## Oral presentations

### OP-BN04 Exercise in Elderly: Balance & Running

#### BALANCE TRAINING INDUCES HIGHLY TASK-SPECIFIC NEURAL PLASTICITY

GIBOIN, L.S.1, KRAMER, A.1, HASSA, T.2, SCHÖNFELD, A.3, DETTMERS, C.2, GRUBER, M.1

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**Introduction** There is growing evidence that improvements in performance after short-term balance training occur only in the trained task (Giboin, Gruber, & Kramer, 2015), and it has been suggested that this task-specificity has a neuronal origin. However, task-specific neural plasticity after balance training has not been demonstrated yet. In the present study we tested the hypothesis that learning to walk and balance on a slack-line induces specific neural adaptations only for this task. **Methods** We measured the amplitude of H-reflexes in the soleus muscle (SOL) during a trained (slackline) and an untrained balance task (tilt-board) before and after six weeks of slackline training (3 times 30 min per week) in a training group (N=15) as well as in a control group (N=13), which did not train. We established comparable conditions between the tasks and for the pre and post measurements by giving the stimulation during the preparatory phase of the balance task, i.e. just before the foot of the subject touched the balance device. Background EMG of the SOL and tibialis anterior muscle (TA) and the angle of the right knee and ankle were measured at stimulation to ensure comparable conditions. To assess the effect of training on a behavioural level, the number of steps on the slackline and the duration of equilibrium on the tilt-board were measured before and after the training. **Results** Three ways ANOVA with mixed design showed: i) a task ( $p < 0.01$ ), time ( $p < 0.01$ ) and group\*time effect ( $p < 0.001$ ) on performance. Post hoc tests showed that the increase in performance occurred only for the training group and only for the trained task (slackline,  $p < 0.001$ ). ii) No effect of time for the background EMGs nor the knee and ankle angles at the time of stimulation was detected, indicating comparable conditions for the stimulations pre and post training. A two ways ANOVA with mixed design showed an effect of training on the amplitude of the H post expressed in percentage of the amplitude of the H pre training (task effect,  $p < 0.05$ ). Post hoc paired T tests showed that the H reflex was reduced only in the training group during the slackline task ( $p < 0.05$ ). **Conclusion** In line with previous studies we found an increased performance only in the trained task. Only during the trained task we observed a modulation of the H-reflex without any differences in the ankle and knee angles and the background EMGs for the pre vs. the post training measurements. Thus, we assume that the modulation of the H-reflex most probably reflect training-induced neural plasticity. We suggest that the training of a specific balance task, here walking on a slackline, induces plasticity at spinal level, which might, at least in part, explain the specificity of the improvement observed on the behavioural level. Giboin, L. S., Gruber, M., & Kramer, A. (2015). Task-specificity of balance training. *Hum Mov Sci*, 44, 22-31. doi:10.1016/j.humov.2015.08.012

#### BEHAVIORAL AND NEUROPHYSIOLOGICAL RESPONSIVENESS OF OLDER ADULTS TO BALANCE TRAINING

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Normal aging involves structural and functional deteriorations in all systems relevant for postural control leading to impairments in postural stability. It has been shown that balance training can counteract these impairments. However, only very few studies have investigated the neural correlates of such behavioral adaptations in older adults. The available literature suggests that older adults show an increase in spinal reflex excitability and a decrease in corticospinal excitability after balance training. The present study aimed to shed more light on neural adaptations in response to balance training in older adults. To this end, we measured spinal and cortical excitability and postural stability in older adults (65-80 years) before and after 5 weeks of balance training (training group, TG) or habitual activity (control group, CG). An H-reflex recruitment curve was recorded from m. soleus during upright standing to evaluate changes in spinal reflex excitability. To investigate changes in the excitability of direct (monosynaptic) corticospinal pathways, we conditioned the H-reflex by TMS during a fast backward translation of the support surface. Behavioral results, showed significant interactions of session and group in the more challenging one-legged tasks which were due to the TG performing better and the CG performing worse in the post-session. The H-reflex was significantly reduced in the post-session. This effect was mainly due to the CG although the interaction of session and group did not reach significance ( $p = 0.09$ ). Conditioning of the H-reflex led to an early facilitation in all subjects. Although the facilitation was slightly decreased in the TG and slightly increased in the CG after training, there was no significant session or group effect. Our results confirm that older adults' postural stability can be improved by training. Although neural adaptations failed to reach significance in this study, the adaptations in the TG relative to the ones in the CG follow the trend of existing studies showing greater spinal and reduced corticospinal excitability after training. This could be interpreted as a reversion of age-related changes in these neural pathways. Interestingly, in this study, the effects were often not primarily due to the TG showing large adaptations but to the CG showing inverse effects. This was true for behavioral as well as for neural adaptations. In this regard, the results are consistent. However, the reasons for the changes in the CG remain unclear. It seems that neural adaptations occur at a slower rate in older adults than in young. It can thus be speculated that the training period of this study was too short to induce significant changes, even more since existing studies had longer intervention periods. Contact: jan.ruffieux@unifr.ch

#### SPRINT ACCELERATION MECHANICS IN MASTER ATHLETES: A PILOT STUDY.

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**Introduction** Even in well-trained individuals, sprint performance decreases with age, the best performances being usually reached between 20 and 30 yrs (Arampatzis et al., 2011; Rittweger et al., 2009). Although this inevitable decrease in performance has been related to decreases in muscular force, velocity and power capabilities, these have not been measured in the specific context of all-out sprinting (Korhonen et al., 2006; Korhonen et al., 2009). The aim of this pilot study was to investigate the sprint acceleration mechanical outputs of Master sprinters to better understand the mechanical underpinnings of the age-related decrease in sprint performance. **Methods** The study took place during an international Masters competition. Horizontal ground reaction force, velocity, mechanical power outputs and mechanical effectiveness of force application were measured during a 30-m sprint acceleration (Samozino et al., 2015) in twenty-eight



male sprinters (39 to 96 yrs). Age-related changes were presented and compared to elite young sprinters data (Rabita et al., 2015). Results Maximal force, velocity and power outputs decreased linearly with age (all  $r^2 > 0.71$ ;  $P < 0.001$ ), at an  $\approx 1\%$  per year rate. The maximal effectiveness of horizontal ground force application also decreased with age. However, its decrease with increasing velocity within the sprint acceleration was not age-dependent. The maximal power output of the oldest subject tested was about 9 times lower than that of younger world-class sprinters (3.57 vs. 32.1 W.kg<sup>-1</sup>). Discussion In addition to lower neuromuscular force, velocity and power outputs, Master sprinters had an impaired effectiveness of ground force application (i.e. less horizontal orientation), especially at the beginning of the sprint. These mechanical variables explain the linear decrease in sprint performance with age in trained Master athletes, and these results provide insights into effective training methods for this specific population. References Arampatzis A, Degens H, Baltzopoulos V, Rittweger J. (2011). *Exerc Sport Sci Rev*, 39, 18-22. Korhonen MT, Cristea A, Alen M, Hakkinen K, Sipila S, Mero A, Viitasalo JT, Larsson L, Suominen H. (2006). *J Appl Physiol*, 101, 906-917. Korhonen MT, Mero AA, Alen M, Sipila S, Hakkinen K, Liikavainio T, Viitasalo JT, Haverinen MT, Suominen H. (2009). *Med Sci Sports Exerc*, 41, 844-856. Rabita G, Dorel S, Slawinski J, Saez de villarreal E, Couturier A, Samozino P, Morin JB. (2015). *Scand J Med Sci Sports*, 25, 583-594. Rittweger J, di Prampero PE, Maffulli N, Narici MV. (2009). *Proc Biol Sci*, 276, 683-689. Samozino P, Rabita G, Dorel S, Slawinski J, Peyrot N, Saez de Villarreal E, Morin JB. (2015). *Scand J Med Sci Sports*, in press. Contact jean-benoit.morin@unice.fr

## MOVEMENT SPECIFIC REINVESTMENT, STEPPING BEHAVIOR AND VISUOMOTOR CONTROL DURING WALKING IN OLDER ADULTS WITHOUT HISTORY OF FALLING

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Introduction Reinvestment refers to the use of self-focused attention to consciously monitor and control movements during performance. Ironically, conscious effort often leads to performance breakdown. We have previously shown that older adults who had not fallen but displayed high propensity for movement specific reinvestment were more aware of their limb movements and less aware of the external environment during walking than those who displayed low propensity for reinvestment (Uiga et al., 2015). The aim of this study was to examine whether such inward focus of attention by high reinvestors in comparison to low reinvestors is characterised by differences in visuomotor control. We measured gait and gaze behavior of older adults with high or low propensity for reinvestment during walking. Methods Based on their scores on the Movement Specific Reinvestment Scale (Masters et al., 2005), older adults with no fall history were divided into high ( $n=25$ ) and low ( $n=26$ ) reinvestors. They were required to perform 30 walking trials on a 4.8-m pathway, in which they had to step on the middle of a target as accurately as possible and navigate between two obstacles. Participants' gait kinematics (stepping characteristics and stepping on target accuracy), gaze behavior (number and duration of fixations on the target and obstacles), and the time difference between saccadic offset from the target and the heel contact in the target were measured. Results Results show that high reinvestors displayed lower walking velocity ( $p=.05$ ), decreased stepping on target accuracy ( $p=.005$ ) and longer foot contact with the target ( $p=.031$ ) compared to low reinvestors. There were no significant differences in gaze behavior variables and saccadic offset from the target and heel contact with the target ( $p's > .05$ ). Discussion Our results suggest that older adults with high propensity for reinvestment display impaired gait behavior already before falling compared to older adults with low propensity for reinvestment. These gait differences were not accompanied by disparities in gaze behavior. Future research is recommended to identify other factors that could influence gait behavior of high reinvestors. References Masters, R.S.W., Eves, F.F., & Maxwell, J.P. (2005). Development of a movement specific reinvestment scale. In T. Morris, P. Terry, S. Gordon, S. Hanrahan, L. Ievleva, G. Kolt, & P. Tremayne (Eds.) *Proceedings of the ISSP 11th World Congress of Sport Psychology*, Sydney, Australia. Uiga, L., Capió, C.M., Wong, T.W.L., Wilson, M.R., & Masters, R.S.W. (2015). Movement specific reinvestment and allocation of attention by older adults during walking. *Cognitive Processing*, 16(S1), 421-424.

## REVERSAL OF AGE-RELATED "SLOWING" OF EEG POWER THROUGH VIDEOGAME-BASED TRAINING

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Introduction Age-related "slowing" of EEG power results in increased slow frequencies power and might reflect impaired cognitive processing and functional brain connectivity [1][2]. Motor skill training with videogame-based training (VGT) is hypothesized to ameliorate motor and cognitive deficits in older adults [3]. Neuro-electrical adaptations following VGT in older adults remain unclear. This study investigated and compared eight weeks VGT with conventional Balance training (BT) on EEG frequencies power, measured during a divided attention task. Methods 27 older adults ( $79 \pm 7$  years) were randomly assigned to VGT / BT, both lasting 8 weeks with three 30 min training sessions per week. Subjects performed a divided attention task involving auditory and visual stimuli (TAP, PSYTEST, Herzogenrath) pre and post intervention. EEG was measured with a portable device (Alpha-Active Ltd, Devon, UK) and two electrodes on the prefrontal cortex (channels: Fp1 & Fp2 / 10-20 system). EEG analysis of clustered Fp1-Fp2 was performed event-locking auditory and visual stimuli in 4s epochs (-1500 ms pre- and 2500 ms post-stimulus) analyzed separately. Relative Power (RP) of DELTA ( $\delta$ : 1 - 3.5 Hz), THETA ( $\theta$ : 3.5 - 7.5 Hz), LOWER ALPHA ( $\alpha$ LOW: 7.5 - 10 Hz), UPPER ALPHA ( $\alpha$ UP: 10 - 12.5 Hz) and BETA ( $\beta$ : 12.5 - 30 Hz) were calculated and normalized, along with all the possible Ratio (RP-Ratio) combinations. Statistical analysis was performed with Puri and Sen L ANOVA statistics for ranked data [4]. Results Both RP and RP-Ratio revealed significant interaction effects in favor of VGT, specifically in  $\theta$  RP ( $L = 6.23$ ,  $p = 0.007$ ) and  $\alpha$ LOW /  $\beta$  RP-Ratio ( $L = 6.27$ ,  $p = 0.006$ ). A significant main time effect for VGT was observable in these measures:  $\theta$  RP ( $L = 3.38$ ,  $p = 0.032$ );  $\alpha$ LOW /  $\beta$  RP-Ratio ( $L = 3.01$ ,  $p = 0.049$ ). Wilcoxon Signed Rank Test showed an intra-group pre-to-post difference with medium-to-large effect size after VGT;  $\theta$  RP and  $\alpha$ LOW /  $\beta$  RP-Ratio ( $p = 0.016$ ,  $r = -0.57$  &  $p = 0.031$ ,  $r = -0.53$ , respectively). Discussion Following VGT, individuals exhibited post-intervention decrease in slow waves ( $\theta$  RP) as well as reduced slow-to-fast frequencies ( $\alpha$ LOW /  $\beta$  RP-Ratio), that was more evident in this group compared to Balance. Results suggest that an 8 weeks VGT intervention may ameliorate age-related "slowing" of EEG power. Further research is warranted that assesses whether the changes underlie improvements in cognitive information processing and functional brain connectivity. References [1] Rossini et al. *Progr Neurobiology* 83: 375-400; [2] Ho et al. *Neurosci. Lett.* 507(1): 78-83, 2012 ; [3] Seidler et al. *Neurosci Biobehav Rev* 34(5): 721-33, 2010; [4] Thomas et al. *Res Q Exerc Sport* 70(1): 11-23, 1999.

## Oral presentations

### OP-SH03 Fanship, Media & Megaevents

#### SOCIALIZATION INTO FORMAL AND INFORMAL SPORTS AND THE ROLE OF SOCIAL BACKGROUND AND MEDIA USE OF ADOLESCENTS

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Sporting (in)activity of teenagers and young adults doesn't appear by chance, it is rather developed in socialization processes and influenced by the social background. The social background reflects socio-structural aspects that can determine sports engagement, e.g. gender, age, migrant background, cultural and social capital. According to interactional models of socialization, engagement in sports is also shaped in the productive processing of interior and exterior realities of individuals. The interior reality relates to physical and mental conditions that appear in individual orientations and competencies. Focusing on the socialization into sports the motives for physical activity and the self-concept of athletic skills are interior factors (Baur et al 2004). The exterior reality reflects the social and ecological context, in which individuals are imbedded, e.g. requirements, conditions and social opportunity structures. In terms of sports-socialization physical activities of family and friends, parental support, peers and (media-related) leisure activities can affect the sporting (in)activity of adolescents. Especially in the youth peers and media are important mediators and impact the personality development and leisure behavior (Hurrelmann 2002). This holds even more true for new and social media, because they offer diverse opportunities for interaction and peer-communication that strongly influence socialization processes. Therefore using new and social media seems to be part of the exterior reality. Research questions & Methods While the impact of the three dimensions on general sports engagement as well as the effects of socio-structural factors on sports-clubs-memberships is quite well investigated, a lack of studies about the impact on other sports-settings appears in the current state of research. But this focus seems to be worthwhile, since socialization needs and structural conditions of formal and informal sports activities differ. The aim of this study is to analyze whether the process of socialization into sports, thus the productive processing of interior and exterior realities and the social background, shapes not only the general activity but also the settings in which adolescents and young adults engage in sports. The empiricism is based on a secondary data analysis of a study about cultural-, sport- and media-orientated leisure activities of German adolescents aged from 13-24 years (Grgic & Züchner 2013). Multivariate analyses will be made to identify the influencing factors on formal and informal sports engagement and to determine the role of new and social media activities in this model. References Baur J, Burrmann U, Maaz K.(2004). ZSE, 24(1), 73–89. Grgic M, Züchner I (2013). Weinheim: Beltz. Hurrelmann K (2002). Weinheim: Beltz. Contact: b.braumueller@dshs-koeln.de

#### MEDIA DISCOURSE OVER FOREIGN COACHES

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*London South Bank University*

Theoretical perspectives on migration have highlighted the dichotomy between established and outsiders and this has recently been discussed in regards to sport. Some research has focused attention on the migration of sports players and their interactions abroad, but fewer studies have examined the recruitment and integration of foreign coaches in their host country. This study explores the perspectives of host and donor countries through their media discourse. A qualitative content analysis was used to investigate how foreign coaches were represented in the media. Multiple sources were cross-referenced to capture the media and public opinions prior to, during and after national and international sport events including Premier league 2013/2014, FIFA World Cup 2014, and 2012 Olympic Games. We found 257 media texts published between April 2012 and August 2014, in four different languages. The results showed the polarisation of the media discourse with foreign coaches either portrayed as instrumental for sport development and success, or stigmatised as unsuccessful mercenaries with no attachment to the host country. Another result showed that the host media discourse was at odds with the views by foreign coaches about migration which also appeared in the media. Taken together, these results highlight the importance of cultural awareness and media training especially for coaches dealing with the media of a host country.

#### MEGA SPORTING EVENTS AND CHILDREN RIGHTS: THE VARIETY OF MEDIA COVERAGE IN 2014 IN 22 COUNTRIES

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*Deutsche Sporthochschule Koeln*

This paper examines how written media covered Mega Sporting Events (MSEs) and their impact on children rights, and human rights writ large, in 2014. Though many academic publications and advocacy organisations have examined the human rights implications of MSEs, little work has been done exploring media reporting on these issues. In an initial, exploratory fashion, articles from sources in 22 different countries were counted and scanned, aiming at a quantitative and qualitative summary of print and online reporting in 2014. Based on initial findings, we can tentatively classify media awareness of human rights issues surrounding MSEs in each country as either high, nascent or minimal. The pattern of resulting differences can be explained by enabling and limiting factors of the respective media system. We use a set of indicators for freedom, development and societal engagement with human rights issues to explain media awareness in different countries. This leads to a grouping of countries into types of awareness. Overall, the results – exploratory as they are – can give a baseline for future comparison and evaluation, orientations for further research and potential guidance for advocacy activities.

16:45 - 18:00

## Plenary sessions

**PS-PL01 Crossing the limits of impairment – lessons from neuromuscular and cardiovascular function after spinal cord injury****LIFE-LONG ACTIVITY-DEPENDENT NEUROMUSCULAR PLASTICITY IN OPTIMIZING PERFORMANCE IN THE PRESENCE OF NEUROMOTOR DISORDERS**

EDGERTON, V.R., GERASIMENKO, Y., GAD, P., SAYENKO, D., TACCOLA, G., BURDICK, J., LIU, W.

*University of California, Los Angeles*

The robustness of the potential plasticity within the neuromuscular system and autonomic systems in human subjects with severe neuromotor deficiencies have been consistently underestimated for decades. Similarly, this underestimation has been particularly extreme in individuals that have endured these deficiencies for relatively long periods. There is increasing evidence that the level of function that can be regained in individuals four years following a traumatic or even progressive dysfunction in the sensorimotor system can be realized to a level that would be considered to be a significant improvement in the general quality of life. The lack of appreciation of this recovery potential can be traced to the absence of recognition of the impact of activity-dependent mechanisms to guide the functional recovery. There is lack of recognition of the degree to which the neural control of routine daily movements is executed largely by neural networks that function largely automatically. Further, this automaticity is now better understood given the degree of control of these networks based on the complex ensembles of sensory information that can be processed without conscious input to spinal networks. The degree to which the sensory input representing the timing and level of loadbearing on the lower limbs is an important source of input to the central nervous system in sustaining postural and locomotor control continues to be underestimated. Experiments will be described which demonstrate that after complete paralysis, the return of the experience of bipedal and quadrupedal loadbearing in response to lumbosacral stimulation can be used to function following spinal cord injury in humans. Full weight-bearing stepping in rats can be recovered in the presence of spinal epidural stimulation and pharmacological modulation largely involving serotonergic agonists. Data will be presented which demonstrates a progressive increase of the level of loadbearing on a daily basis in rats and humans can significantly enhance the level of recovery of standing potential and even voluntary control. The mechanisms of this recovery are gradually being formulated from the perspective of how spinal networks can be fine-tuned to facilitate a wide range of complex motor tasks. This fine tuning can be accomplished using a combination of neuromodulatory interventions, including multiple forms of electrical stimulation, sensory modulation and pharmacological modulation. The basic physiological concepts and proposed mechanisms underlying these results will be presented.

**CARDIOVASCULAR FUNCTION DURING EXERCISE - THE SPINAL CORD INJURY MODEL**

THEISEN, D.

*Luxembourg Institute of Health*

A complete lesion to the spinal cord implies loss of sensitive neural traffic from the periphery and of voluntary muscle mass in body regions innervated by nerves caudally to the lesion level. Furthermore, functions relying on the autonomous nervous system are affected in proportion to the spinal lesion level. In particular the cardiovascular function can be strongly impaired, with consequences for the regulation of blood pressure and body temperature. The limited active muscle mass available for exercise and the impaired cardiovascular adaptations result in dramatically reduced exercise capacity. Individuals with spinal cord injury have to rely on their upper body musculature for exercise, which limits their total oxidative capacity, maximal power output and mechanical efficiency. Blood redistribution during exercise is impaired in body regions with no autonomic nervous system control. As a result, venous return to the heart is reduced and cardiac stroke volume is limited. This increases the risk of exercise induced hypotension and induces a higher compensatory heart rate during submaximal exercise conditions. On the other hand, heart rate during maximal effort may be lower in individuals with spinal lesions above the level thoracic 6, due to impaired sympathetic drive to the heart. Individuals with complete cervical spinal lesions solely rely on parasympathetic withdrawal and circulating catecholamines to increase their heart rate, generally not exceeding 130 beats per minute. Limited neural feedback and impaired vasomotor and sudomotor function below the lesion induce greater heat storage during exercise. Strategies to promote venous return and to support body cooling have been suggested in the literature to improve exercise performance and reduce injury risk, especially for athletes with high spinal lesions. However, their applicability depends on the sport context. Recent research indicates that successful elite athletes with spinal cord injury may represent a subgroup with partially intact autonomous nervous system control, in spite of them being classified as individuals with "complete" lesions, based on motor and sensory tests. A partial preservation of autonomic function can significantly improve exercise tolerance in both athletes and non-athletes. Individuals with cervical or high thoracic lesions are at risk for autonomic dysreflexia. These acute episodes of hypertension result from a generalized sympathetic vasoconstriction below the lesion, itself a consequence of nociceptive stimulations in insensate body regions. Autonomic dysreflexia is a clinical emergency, but may be triggered by athletes to enhance their exercise performance. Its deliberate induction is considered a doping offense by the International Paralympic Committee.

# Thursday, July 7th, 2016

08:00 - 09:30

## Oral presentations

### OP-PM06 Nitrate & Diet Composition

#### DIETARY NITRATE AUGMENTS MUSCLE METABOLIC ADAPTATION TO HIGH-INTENSITY INTERVAL TRAINING

THOMPSON, C., BAILEY, S.J., BLACKWELL, J.R., FULFORD, J., WYLIE, L.J., BLACK, M.I., KELLY, J., MCDONAGH, S.T.J., CARTER, J., VANHATALO, A., JONES, A.M.

*Sport and Health Sciences, NIHR Exeter Clinical Research Facility, University of Exeter, Heavitree Road, Exeter, UK and Gatorade Sports Science Institute, PepsiCo R&D, Barrington IL, USA*

Short-term dietary nitrate supplementation may favourably impact the intrinsic properties of skeletal muscle. It is unclear whether longer periods of nitrate supplementation may more favourably alter the physiological response to exercise and improve exercise performance. Furthermore, the possible interaction of a high-nitrate dietary supplement, such as beetroot juice (BR), with the adaptations to exercise training is presently unknown. We therefore tested the hypothesis that chronic BR supplementation would augment skeletal muscle metabolic adaptations to high-intensity interval training (HIIT). Twenty-four men and 24 women completed a series of exercise tests before and following a 4 week period in which they were assigned to: 1) HIIT and no supplementation (HIIT); 2) HIIT and nitrate-depleted beetroot juice as a placebo (HIIT+PL); 3) HIIT and nitrate-rich beetroot juice (~13mmol nitrate/day; HIIT+BR); or 4) no training and nitrate-rich beetroot juice (NT+BR). During sub-maximal exercise,  $\dot{V}O_2$  was reduced by HIIT+BR and NT+BR but not HIIT or HIIT+PL. During incremental exercise,  $\dot{V}O_{2peak}$  was increased by HIIT and HIIT+BR but not HIIT+PL or NT+BR. Compared to pre-intervention, maximal citrate synthase activity was elevated in HIIT+BR only (Pre  $15.9 \pm 3.4$  vs Post  $18.1 \pm 2.0$   $\mu\text{mol}\cdot\text{g}^{-1}\cdot\text{min}^{-1}$ ;  $P<0.05$ ). Similarly, muscle [glycogen] was higher (Pre  $335 \pm 119$  vs Post  $441 \pm 144$   $\text{mmol}\cdot\text{kg}^{-1}$ ;  $P<0.05$ ), muscle pH was greater (Pre  $6.9 \pm 0.3$  vs Post  $7.1 \pm 0.2$ ;  $P<0.05$ ) and [lactate] was lower in muscle (Pre  $53 \pm 33$  vs Post  $33 \pm 26$   $\text{mmol}\cdot\text{kg}^{-1}$ ;  $P<0.05$ ) and blood (Pre  $5.0 \pm 0.8$  vs Post  $3.7 \pm 1.0$   $\text{mM}$ ;  $P<0.05$ ) at 3-min of severe-intensity exercise in HIIT+BR but not HIIT, HIIT+PL or NT+BR. However, the improvement in severe-intensity exercise performance was not different between training interventions. In conclusion, BR ingestion reduced the  $O_2$  cost of moderate-intensity exercise and increased peak WR during incremental exercise whereas HIIT improved  $\dot{V}O_{2peak}$ , peak WR, and severe-intensity exercise performance. Similar effects to HIIT alone and NT+BR were found when HIIT and BR were combined but, in addition, maximal CS activity was increased and muscle metabolic perturbation during severe-intensity exercise was reduced. These data indicate that the independent physiological stimuli provided by HIIT and BR may be additive. Dietary nitrate supplementation in the form of BR may potentiate muscle metabolic adaptations to HIIT.

#### AFTER EFFECTS OF A 3 WEEKS NO<sub>3</sub> SUPPLEMENTATION ON ENDURANCE AND SPRINT PERFORMANCE

MAASSEN, N.1,2, FINKEL, A.1,2, JACOB, C.1, RÖHRICH, M.2, LÜTZOW, M.2, BLAU, L.2, HANFF, E.3, TSIKAS, D.3, MAASSEN, M.1,2

*1 Leibniz University Hannover, 2 Medical School Hannover 3 Medical School Hannover*

**Introduction** Most studies investigating the effects of NO<sub>3</sub> supplementation were performed during the supplementation period. The aim of the present study was to look for after effects of such a supplementation and answer the question: are there influences on the development of performance? **Methods** 17 subjects took part in the placebo-controlled double-blind study (Nitrate: 9; Placebo (NaCl) 8). Maximum power in a preceding incremental test was not significantly different between the groups (N:  $4.83 \pm 0.9$   $\text{Watt}\cdot\text{kg}^{-1}$ , PLA:  $4.85 \pm 0.6$   $\text{Watt}\cdot\text{kg}^{-1}$ ). The subjects performed an intermittent training of high intensity (HIIT) on a cycle ergometer (Lode Excalibur) 3 times a week for 3 weeks (45x 30s at 100% - 10W and 30s of 10W, 45). The subjects supplemented either sodium-nitrate [8.5 mg/kg body weight/d] (N, n=9) or sodium-chloride [8.5 mg/kg body weight/d] (PLA n=8) daily. Besides the incremental test (IT) a double Wingate-Test (one minute break between both, (WT)) and an endurance test to exhaustion (ET) with 80% of maximum power reached in the incremental test were performed as pre- and post-tests. [NO<sub>3</sub>] and [NO<sub>2</sub>] were measured in the cubital venous plasma (GC-MS-Method, Tsikas et al. 2000). The post-tests were performed at least 2 days after the end of supplementation period, when [NO<sub>3</sub>] and [NO<sub>2</sub>] in plasma are supposed to have returned to normal values (Webb et al. 2008). Results [NO<sub>3</sub>] and [NO<sub>2</sub>] did not differ between the pre- tests and the tests performed 2 days after supplementation (S). At least 2 days after the supplementation period (S) in the first WT maximal power (+4.5%) and mean power (+4.2%) were increased in PLA ( $p<0.05$  for both) whereas there was no significant difference in N. Both groups improved maximal (+9%) and mean power (+7%) in the second WT ( $p<0.05$  for all) without any difference between the groups. However, the oxygen cost per Watt was significantly ( $p<0.05$ ) reduced in N (-11.5%). During the ET (4 days after S) the  $\dot{V}O_2$  was significantly lower. Even at exhaustion there was a 5% reduction in  $\dot{V}O_2$  ( $p<0.01$ ). In spite of that the endurance time was not significantly different. Maximum Power reached in the IT post-test was enhanced in both groups (+3.9% in PLA) and (+5.1% in N) being significant in N, only. Again, the increase in  $\dot{V}O_2/\text{Watt}$  was lower in N ( $p<0.05$ ). **Conclusion** A supplementation of NO<sub>3</sub> for 3 weeks elicits effects on performance lasting at least for 7 days. The persisting effects look similar to those expected when fast muscle fibers change to more oxidative fibers. M. Maassen was supported by Leibniz University: WiF II: 60460457 Contact: Norbert.Maassen@sportwiss.uni-hannover.de



## MONTMORENCY CHERRY SUPPLEMENTATION ATTENUATES VASCULAR DYSFUNCTION INDUCED BY PROLONGED OCCLUSION

ABOO BAKKAR, Z., FULFORD, J., GATES, P.E., BOND, B., JONES, A.M., BOWTELL, J.L.

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**Introduction** Higher flavonoid intake is associated with reduced risk of cardiovascular related diseases, whilst both acute and chronic fruit flavonoid supplementation improve brachial artery flow-mediated dilatation (FMD), a nitric oxide dependent marker of endothelium dependent vasodilatation. Repeated cycles of ischaemia reperfusion injury (IRI) contribute to endothelial dysfunction. Therefore, we investigated whether chronic supplementation with Montmorency cherry (MC) attenuated the suppression of brachial artery FMD induced by prolonged occlusion. **Method** In a double-blind, placebo-controlled, crossover design, 10 physically inactive middle aged men ( $54.0 \pm 4.6$  y;  $28.6 \pm 4.9$  kg.m<sup>-2</sup>) consumed MC capsules (235mg.d<sup>-1</sup> anthocyanins) and placebo (PL) for 4 weeks in pseudo-random order separated by 4 weeks washout. Pre and post supplementation FMD responses were measured at baseline and 15, 30, and 45 min after a 20 min forearm occlusion to induce IR. Blood samples were obtained from the occluded arm at the beginning of the procedure and immediately, 2, 4, 15, 30 and 45 minutes after the 20-minutes occlusion for the measurement of nitric oxides metabolites. Baseline plasma samples before and after each supplementation block were analysed for interleukin 6 (IL-6) and C-reactive protein (CRP). Data were analysed by repeated measures ANOVA and presented as mean $\pm$ SD. **Results** Prolonged occlusion resulted in significant reduction of FMD, 15 min post occlusion in both conditions (BL vs 15min; MC:  $-57.9 \pm 17.1\%$ ; PL:  $-48.1 \pm 23.8\%$ , time effect:  $P < 0.001$ ) and remained depressed after 45 min (BL vs 45 min MC:  $-4.8 \pm 39.3\%$ ; PL:  $-26.2 \pm 12.6\%$ , time effect:  $P = 0.035$ ). There was a tendency for greater recovery of FMD response with MC supplementation (condition x supplementation interaction:  $P = 0.080$ ) after 45 min. Area under the curve for shear also decreased after prolonged occlusion ( $P = 0.036$ ), and tended to recover better after MC supplementation (condition x time interaction:  $P = 0.094$ ). Plasma nitrate concentration decreased significantly in response to the prolonged occlusion (main time effect:  $P < 0.001$ ), with tendency for higher plasma nitrate concentration after MC supplementation (condition x supplement x time interaction:  $P = 0.076$ ) compared to placebo. Neither plasma CRP nor IL-6 concentrations were affected by cherry or placebo supplementation. **Conclusion** In conclusion, prolonged forearm occlusion impaired FMD for at least 45 min, and MC supplementation tended to improve FMD recovery in parallel with higher plasma nitrate concentration. These effects may contribute to the vascular health benefits associated with flavonoid intake. Contact zba201@exeter.ac.uk

## SOLUBLE MILK PROTEINS OR WHEY SUPPLEMENTATION COMBINED TO ELECTROSTIMULATION TRAINING: WHAT EFFECTS ON POWER PRODUCTION AND RECOVERY CAPACITIES ?

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**Introduction** Electrostimulation training (ES) has the potential to increase muscle power. However, this training modality exposes the recruited motor units to a large stress. This sometimes translates into recovery and training adaptation issues. However, it has been demonstrated in humans that a supplementation of soluble milk proteins (SMP) could reduce fatigability after a strength training session and during the training period. Therefore, SMP could promote recovery and adaptations to ES training, compared to other milk proteins. The purpose of this study was to verify this hypothesis. **Methods** This pilot, randomized and double-blinded study involved 36 moderately active young men ( $21.6 \pm 3.2$  y). They were allocated into 3 groups supplemented 5d/week, either with 15g of SMP or whey proteins (WH), or with a placebo (PLA). All groups underwent a 12-week ES training program of the knee extensor muscles. During the last 6 weeks, ES training was combined with sprint and plyometrics training. Maximal power (Pmax), serum creatine kinase activity [CK] and muscle soreness (DOMS) were evaluated before, immediately after and 30', 60', 24h and 48h after the first (S1), fourth (S4) and last ES training session (S24). Evoked contractile properties (twitch amplitude; Pt) and the maximal voluntary activation level (VA) were measured before training (T0), and after 6 (T1) and 12 weeks of training (T2). **Results** DOMS and [CK] did not differ between groups. On average [CK] was higher at S4 compared to S1 and S24 ( $P < 0.001$ ). Furthermore, DOMS decreased between S1 and S24 ( $P < 0.001$ ). However, Pmax increased in the SMP and WH groups between S1 and S24 ( $+12.5\%$ ,  $P < 0.001$  &  $+13.9\%$ ,  $P < 0.01$ , respectively). No change was observed in PLA. At S4, 30' after the training session the SMP group displayed a faster Pmax recovery compared to WH (569 vs. 474 W;  $P < 0.05$ ). At S24, the SMP had fully recovered 30' after the training session. This was not the case for WH and PLA. During the training program, the evolution of the NA did not differ between groups. However, the modification of Pt differed between groups: Pt increased between T0 et T2 in the SMP group ( $+16.4 \pm 8.9\%$ ;  $P < 0.001$ ), was not significantly modified in WH, and decreased between T1 and T2 in PLA ( $-9.3 \pm 4.9\%$ ;  $P < 0.05$ ). **Conclusion** These results suggest that SMP have the potential to promote the short term recovery of maximal power after an ES training session compared to WH. This improved recovery is associated with a better adaptation to training, which translates into improved contractile properties in SMP, but not in WH. Therefore, as compared to WH, SMP could be more efficient to improve muscle performance after a training program.

## DIET QUALITY AND MACRONUTRIENT INTAKE DURING A PRECOMPETITIVE TRAINING CAMP IN MALE AND FEMALE SPANISH WHEELCHAIR BASKETBALL PLAYERS

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**Do not insert authors here****Introduction:** Wheelchair basketball has evolved into a high performance sport over the last several years and small variations in performance can determine the difference between winning and losing (Perret, 2015). In addition to physical fitness, an optimized diet is important to enhance performance and recovery. In fact, there are only a few studies available describing nutrition practice in wheelchair basketball (Goosey-Tolfrey and Crosland, 2010). Therefore, an adequate macro- and micronutrient intake may influence this difference. **Methods:** During a five-day precompetitive training camp the Spanish male and female National Teams of wheelchair basketball have been evaluated regarding their nutritional intake via a nutritional protocol and body composition by anthropometric assessment (ISAK). The Software Dial AlceÆ was used for the analysis of diet composition and quality. **Results:** Twelve male (age  $29.4 \pm 6.8$  years; height  $180.7 \pm 5.1$  cm; weight  $78.2 \pm 16.7$  kg) and ten female (age  $22.1 \pm 6.3$  years; height  $154.3 \pm 18.5$  cm;  $57.9 \pm 16.2$  kg) wheelchair basketball players took part in the study. Analysis revealed a total energy intake of  $3194 \pm 504$  kcal/day and  $1916 \pm 404$  kcal/day ( $p < 0.001$ ;  $d = 3.03$ ) or  $42.3 \pm 10.3$  kcal/kg and  $36.2 \pm 15.3$  kcal/kg ( $p = 0.277$ ), for the male and female athletes, respectively. Carbohydrate intake was  $3.8 \pm 1.2$  g/kg for males and  $2.9 \pm 1.4$  g/kg for females ( $p = 0.109$ ) and protein intake was  $2.0 \pm 0.5$  g/kg  $1.5 \pm 0.6$  g/kg ( $p = 0.047$ ;  $d = 0.99$ ) respectively. When taking the quality index -out of 10- into account, the food groups fruits (males  $4.7 \pm 3$ ;

females  $3.2 \pm 2.8$ ;  $p=0.274$ ) and vegetables (males  $3.7 \pm 1.2$ ; females  $1.4 \pm 0.5$ ;  $p<0.001$ ;  $d=2.51$ ) were very low resulting in a high proportion of fat (males  $43.6 \pm 4.9\%$ ; females  $50.1 \pm 4.0\%$ ;  $p=0.003$ ;  $d=1.59$ ). Anthropometrics analysis showed a sum of all eight skinfolds thickness of  $135.9 \pm 51.3$  mm for males and  $153.9 \pm 62.1$  mm for females ( $p=0.466$ ). Discussion: Male wheelchair athletes showed slightly better results than female athletes regarding fruit and vegetable intake, which resulted in a higher overall diet quality. Nevertheless, it has to be highlighted, that except for breakfast, the main meals lunch and dinner were served as plates and not as a buffet. Previous studies showed that diet variety is very important to reach adequate macro- and micronutrient intake (Grams et al., 2016). Further research is needed to improve diet and body composition in these athletes. References: 1. Perret C. (2015). *Disabil Rehabil*, 27:1-9. 2. Goosey-Tolfrey VL, Crosland J. (2010). *APAQ*, 27, 47-59. 3. Grams L, Garrido-Pastor G, Villacieros J, Ferro A. (2016). *PlosOne* (In press)

## Oral presentations

### OP-PM07 Health & Fitness

#### METABOREFLEX AND PERFORMANCE IN ELITE FEMALE SOCCER: EFFECTS OF INSPIRATORY MUSCLE TRAINING

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**Introduction** Inspiratory muscle training (IMT) is an established way to improve strength (S) and endurance (E) of inspiratory muscles. It has been extensively studied and used as an important tool in sports performance, mainly for those aerobic in nature. The objectives of this study are to test the effects on metaboreflex and exercise performance in a professional athlete cohort. **Methods** Eighteen professional female soccer players were recruited and underwent a cardiopulmonary exercise test. Subjects were randomized to placebo (PG) and IMT (IMTG) groups. Subsequently, they underwent tests of lung function, S and E of inspiratory muscles, constant high-load exercise testing (CLET) and repeated-shuttle-sprint ability test (RSSA). Near-infrared spectroscopy assessed oxygenation ([oxyHb] and [tHb]) of respiratory (intercostals) and peripheral (vastus lateralis) muscles during CLET and blood samples were taken to analyze lactate concentration ([L]). After 6-weeks of IMT [30 inspiratory efforts, twice/day, 5 days/week, IMTG training at 50% of maximal inspiratory pressure with load adjustments every week], subjects were reevaluated. **Results** There were significant improvements observed in the IMTG following IMT: 1) gain of inspiratory muscles S ( $19.45 \pm 10.91\%$ ) and E ( $53.06 \pm 32.51\%$ ); 2) greater exercise tolerance ( $P<0.05$ ) and reduced [L] over time ( $P<0.05$ ) in CLET; 3) [oxyHb] of intercostals muscles was higher (from  $-8.66 \pm 4.96$  to  $-1.94 \pm 8.50$   $\mu\text{mol}/\text{cm}$ ) while [tHb] was also higher in the vastus lateralis (from  $2.21 \pm 5.60$  to  $5.56 \pm 7.21$   $\mu\text{mol}/\text{cm}$ ), and; 4) soccer performance inferred by RSSA was better after IMT ( $P<0.05$ ). **Discussion** Recent evidence shows that IMT could affect lactate recovery, indicating that respiratory muscles are capable of lactate clearance, reducing [H+] and metabolites (Brown et al., 2009). This could explain the increased exercise tolerance and improved athletic performance (Nicks et al. 2009). Likewise, blunted metaboreflex' responses were observed post-IMT only in the IMTG, indicating an increase of [oxyHb] and [tHb] in respiratory and peripheral muscles, respectively, in accordance with previous study (Witt et al., 2007). We conclude that IMT is an important and effective strategy to enhance exercise performance in professional women soccer players. **References** Brown PI, Sharpe GR, Johnson MA. (2009) *Med Sci Sport Exerc*, 42(6), 1103-12. Nicks CR, Morgan DW, Fuller DK, Caputo JL. (2009) *Int J Sports Med*, 30(1), 16-21. Witt JD, Guenette JA, Rupert JL, McKenzie DC, Sheel AW. (2007) *J Physiol*, 584(3), 1019-28. Contact E-mail: barchiza@gmail.com Financial support: FAPESP (2014/10145-9) and CNPq (487385/2013-6)

#### THE EFFECT OF AGE ON PULMONARY AND MUSCLE OXYGENATION KINETICS FOLLOWING HIGH-INTENSITY INTERVAL EXERCISE

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**Introduction** Physiological measures of pulmonary and muscle oxygenation follow an exponential trends following exercise until reaching baseline values. A steeper exponential trend suggests faster post-exercise recovery. To date, no study has investigated the effect of age on off-transient pulmonary and muscle oxygenation kinetics following high-intensity interval exercise (HIIE) typical of training undertaken by both competitive endurance and sprint cyclists. Therefore, this study examined the effect of age on the off-transient pulmonary and muscle oxygenation kinetics in well-trained masters and young cyclists following HIIE. **Methods** Pulmonary ( $\text{VO}_2$ ) and muscle oxygenation (Total Oxygenation Index [TOI]) and change in deoxyhemoglobin concentration ( $\Delta[\text{HHb}]$ ) were monitored continuously in well-trained masters ( $n = 9$ , age:  $55.6 \pm 5.0$  yr) and young ( $n = 8$ , age:  $25.9 \pm 3.0$  yr) cyclists during HIIE and recovery. The HIIE consisted of 6 x 30 second intervals at 175% maximal aerobic power with 4.5 minutes rest between intervals. Following the HIIE, 20 minutes of passive supine rest was undertaken. The off-transient responses of  $\text{VO}_2$ , TOI and  $\Delta[\text{HHb}]$  from the cessation of the HIIE were then modelled using a mono-exponential function. **Results** The time constant ( $\tau$ ) of the  $\text{VO}_2$  response ( $\tau\text{VO}_2$ ) was significantly longer in the masters (mean  $\pm$  SD;  $217.49 \pm 44.43$  s) compared to young ( $169.69 \pm 35.73$  s) cyclists ( $P = 0.029$ ). The amplitude of the  $\text{VO}_2$  response was also lower in masters ( $d = 0.69$ , moderate), although not significant ( $P = 0.18$ ). A trend for a slowed  $\tau\text{TOI}$  was found in the masters cyclists, however this was not found to be significant ( $P = 0.40$ ,  $d = 0.42$ , small). Significant correlations were observed between  $\tau\text{TOI}$ , and both  $\tau\text{VO}_2$  ( $r = 0.49$ ,  $P = 0.049$ ) and  $\tau[\text{HHb}]$  ( $r = 0.75$ ,  $P < 0.001$ ), and a non-significant moderate relationship was found between age and  $\tau\text{VO}_2$  ( $r = 0.48$ ,  $P = 0.05$ ). **Discussion** The significantly slowed  $\tau\text{VO}_2$  suggests that masters athletes exhibit longer time for metabolic recovery following HIIE. Additionally, although no significant age-related differences for muscle re-oxygenation kinetics were observed a trend for a slower  $\tau\text{TOI}$  during the recovery phase was found. The slowed pulmonary and muscle oxygenation kinetics may have a negative effect on repeat sprint performance in masters athletes and greater recovery periods between exercise bouts may be necessary to maintain power output. Contact: n.borges@cqu.edu.au

## PHYSICAL ACTIVITY IS ASSOCIATED WITH ALLERGIC DISEASE, BUT NOT ALLERGIC SYMPTOMS OR SENSITIZATION, IN ADOLESCENTS

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**Introduction:** Allergic sensitization, including asthma and rhinitis, is often associated with decreased physical activity (PA). However, it is not clear whether allergy discourages PA, PA prevents allergy, or both. We examine the relationships between moderate and vigorous PA (MPA, VPA), participation in sport, and respiratory allergy in adolescents, in order to determine which conditions, if any, are associated with decreased PA in this population. **Methods:** 1168 Germans (45% male, age  $15.5 \pm 0.5$  years) completed 7-day accelerometry, activity diary, standardized questionnaires, physical examination and IgE RAST for aero-allergens. Measurements of PA included daily minutes of MPA and VPA as well as participation in sports (such as football.) In each sex, PA (any sport participation, MPA, or VPA) was modeled as function of asthma, rhinitis, aero-sensitization, or current symptoms of asthma (wheezing) or rhinitis (nose/eye itching), corrected for age, height, location, and parental education. **Results:** Despite high prevalence of symptoms (wheeze, 6% of children; eye/nose symptoms, 11%) over  $\frac{1}{4}$  of our subjects had sport during accelerometry. 8% had asthma, 11% had rhinitis, and 45% were aero-allergen sensitized. Asthmatic girls more often wheezed (68 vs. 43%) or were untreated (22% vs. 6%) than asthmatic boys. Nevertheless, allergic diagnoses were associated with low PA only in boys. In corrected models, boys with asthma had 33% less VPA ( $p < 0.01$ ) and 14% less MPA ( $p = 0.03$ ) per day, and those with rhinitis had 14% less MPA ( $p = 0.03$ .) There was no effect for sensitization, and allergic children were as likely as lung-healthy controls to participate in sport. Results were consistent when analysis was restricted to normal-weight children or those with negative bronchial-challenge tests, and neither PA nor sport participation was associated with respiratory symptoms in either sex. **Conclusion:** Boys with asthma or rhinitis were less physically active than lung-healthy controls. The relationship was not mediated by sport participation or explicable by current high body weight or residual symptoms, and was consistent with known immunomodulatory effects of PA. We suggest that PA may help prevent and mitigate immune dysfunction, adding urgency to the need for greater access to sport.

## REFERENCE VALUES OF PHYSICAL FITNESS IN ANDALUSIAN FIBROMYALGIA PATIENTS: THE AL-ÁNDALUS PROJECT.

ÁLVAREZ-GALLARDO, I.C., CARBONELL-BAEZA, A., SEGURA-JIMÉNEZ, V., SORIANO-MALDONADO, A., INTEMANN, T., APARICIO, V.A., ESTÉVEZ-LÓPEZ, F., CAMILETTI-MOIRÓN, D., HERRADOR-COLMENERO, M., BORGES-COSIC, M.

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**Delgado-Fernández, M., Ortega, F.B.** **Introduction** Physical fitness is an important indicator of health in fibromyalgia (Aparicio et al., 2015). Therefore, it is essential to have reference values on the different fitness components, which will allow better interpretation of the results of fitness assessment in this population. The aims of this study were (1) to report age-specific physical fitness levels in people with fibromyalgia of a representative sample from Andalusia (southern Spain); and (2) to compare the fitness levels of people with fibromyalgia with non-fibromyalgia controls. **Methods** This cross-sectional study included 489 (21 men) people with fibromyalgia and 416 (55 men) controls. The sample of people with fibromyalgia was geographically representative from Andalusia. Physical fitness was assessed with the Senior Fitness Test battery (chair sit-and-reach, back scratch, 30-s chair stand, arm curl, 8-foot up-and-go and 6-min walk tests) plus the hand-grip strength test. We applied the Generalized Additive Model for Location, Scale and Shape (GAMLSS) to calculate percentile curves for women and fitted mean curves using a linear regression for men. Sex and group (fibromyalgia vs. control) differences in physical fitness were tested through two-way ANOVA. **Results** The present study provided reference values for all the physical fitness components in women and men with fibromyalgia. People with fibromyalgia showed worse performance than controls in all the fitness tests evaluated ( $p < 0.001$ ). **Discussion** Physical fitness levels observed in fibromyalgia are very low in comparison with age-matched healthy controls. The reference values provided in the present study are useful to correctly interpret physical fitness assessments and might help health care providers to identify individuals at high risk of losing physical independence, as well as to design personalized intervention programs. **Reference** Aparicio VA, Segura-Jiménez V, Álvarez-Gallardo IC, Soriano-Maldonado A, Castro-Piñero J, Delgado-Fernández M, & Carbonell-Baeza A. (2015). *Med Sci Sports Exerc*, 47, 451-9. Contact: alvarezg@ugr.es

## EPICARDIAL ADIPOSE TISSUE, EXERCISE AND CARDIOVASCULAR DISEASE IN DIABETES

CHRISTENSEN, R.1, SCHOLTEN, B.2, ROSENMEIER, J.3, HANSEN, C.2, ELLINGSGAARD, H.1, REINHARD, H.2, PARVING, H.4, PEDERSEN, B.1, JØRGENSEN, M.2, JACOBSEN, P.4, ROSSING, P.2

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**Background:** Epicardial adipose tissue (EAT) is the visceral fat of the heart. Patients with type 2 diabetes (T2D) have more and inflamed EAT compared to non-diabetic individuals, and EAT excretes substances that may provoke coronary atherosclerosis (1,2). The role of EAT in cardiovascular disease (CVD) and the impact of weekly exercise on EAT and CVD in diabetic patients was investigated in this study. **Methods:** This was a prospective study including 200 T2D patients without known CVD. EAT was measured from baseline echocardiography (3). Physical activity was self-reported as hours of exercise per week. Coronary artery calcium (CAC) and markers of low-grade inflammation (IL-1β, IL-6, IL-8, TNFα and hsCRP) were measured at baseline. Follow-up was performed after (median) 6.1 years with no lost to follow-up. Primary endpoint was the composite of incident CVD and all-cause mortality. Data were expressed as mean±SD. Exercise and EAT were investigated as continuous variables, and EAT was split in quartiles (the highest vs. the three lowest). Time-to-event data were analysed by Kaplan-Meier survival plots and Cox regression. Adjustment was performed for risk factors of CVD (sex, age, LDL-cholesterol, smoking, HbA1c, and systolic blood pressure). **Results:** 152 (76%) were men, age average of  $59 \pm 9$  years, and known diabetes duration of  $13 \pm 7$  years. Median weekly exercise (IQR) was 3.27 (0,3.5) hours. Mean EAT was  $3.3 \pm 1.7$  mm and EAT in the highest quartile was  $5.6 \pm 1.2$  mm vs.  $2.4 \pm 0.9$  mm EAT in the three lower quartile groups. During the follow-up period 66 patients had experienced a CVD event or died. Patients with elevated EAT had an increased risk of the composite endpoint when compared with patients with normal EAT (HR 1.8 (95% CI 1.0-3.2),  $p = 0.047$ ). Weekly exercise duration was negatively associated with the composite endpoint, even after adjusting for CVD risk factors (HR 0.84 (95% CI 0.7-0.9)). EAT and exercise tended to be negatively correlated ( $p = 0.07$ ) and EAT was positively correlated to CAC ( $p = 0.032$ ) and TNFα ( $p = 0.047$ ). **Discussion:** In a prospective study with 200 T2D patients without known CVD, we found that elevated EAT and low weekly exercise duration were associated with our composite endpoint of CVD and all-cause mortality. Our novel data suggest further research exploring the role of EAT and physical activity in T2D and cardiovascular complications. **References:** (1) Eiras et al. *Cytokine*. 43, 174-180 (2008) (2) Yerramassu et al. *Atherosclerosis*. 220, 223-230 (2012) (3) Iacobellis et al. *Obes. Res.* 11, 304-10 (2003)

## FAT OXIDATION CAPACITY AND ITS POSSIBLE COUPLING TO WEIGHT LOSS MAINTENANCE

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**Introduction:** Current perception is that the majority of participants after intensive weight loss interventions regain all of their weight within 5 years. Dissent regarding fat oxidation impairment in obese subjects makes it clinically relevant to study the possible adaptations in maximal fat oxidation (MFO) after a persistent long-term weight loss and its impact on weight loss maintenance. The aim of this study was to investigate if MFO differs in relation to size of weight loss, including cellular mechanisms that contribute to MFO in skeletal muscle. The hypothesis was that weight loss maintenance is positively correlated to MFO. **Methods:** 78 former (>4y) participants in a 12 wks. intensive Lifestyle Intervention (LI) were recruited. The LI program consists of hypo caloric diet, structured physical activity and health education. Participants were stratified into 3 groups based on the size of weight loss at follow up; High Maintenance (HM >10%) Moderate Maintenance (MM 0-10%) and No Maintenance (NM <0%). A muscle biopsy from m. vastus lateralis was obtained and a graded cycle ergometer exercise test determines MFO and the intensity at which this occur (Fatmax). Subsequently a VO<sub>2</sub>max test was performed. HAD and CS activity were examined fluorometrically and CD36 and FABPpm expression using western blot technique. One-way Anova was used to test for the between group differences and the level of significance was set at 0.05. **Results:** There were no differences in BMI before or BMI and weight loss at the end of LI. The weight loss compared to before LI was (22±1, 5±1 and -9±1%) in HM, MM and NM, respectively. MFO was higher (P<0.05) in HM and NM compared to MM (0.5±0.1; 0.5±0.1; 0.4±0.2 g/min), respectively. VO<sub>2</sub>max was higher (P<0.05) in HM compared to MM and NM (32±1; 25.8±1; 21.3±1 ml/min/kg). HAD (123±5; 105.6±6; 97±4 μmol/g/min) and CS activity (155±6; 130±8; 113±5 μmol/g/min) were higher (P<0.05) in HM compared to MM and NM, respectively. FABPpm expression was higher (P<0.05) in HM compared to MM and NM (36 and 40%), respectively. Finally CD36 expression was higher (16%, P<0.05) in HM compared to NM. **Discussion:** This study demonstrates that when a clinically significant (>10%) weight loss is maintained over a longer period, MFO is increased in parallel with higher VO<sub>2</sub>max, mitochondrial activity and FA transport capacity. Interestingly the high MFO in NM, despite low CS, HAD, FABPpm and CD36, indicates the presence of a 'healthy and unhealthy' MFO, where MFO in NM most likely is driven by high availability of IMTG and/or plasma FA. This may explain the U-shaped relationship between weight loss and MFO and also VO<sub>2</sub>max and MFO. Contact: karinalu@sund.ku.dk

## Oral presentations

### OP-BN01 Biomechanics

## COMPARISON OF DIFFERENT MARKER SETS FOR MARKER TRAJECTORY BASED CLASSIFICATION OF SIMULATED GAIT IMPAIRMENTS

CHRISTIAN, J.1, HEBENSTREIT, F.2, ESKOFIER, B.M.2, SCHWAMEDER, H.1

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**Introduction** 3D marker trajectories can be used straightforwardly as input for gait classification without prior mechanical modelling (Eskofier et al., 2013). Such an approach is computationally efficient and independent of specific mechanical model assumptions. This study investigated how the choice of the marker set affects the performance of selected algorithms for classifying impaired gait patterns. A full body marker set and three reduced marker sets were tested. To enable full control of the location and extent of the impairment it was simulated by means of artificially induced restriction of motion in the knee joint. The reduced marker sets were particularly chosen to be distributed with different spreads around the restricted joint. **Method** 3D kinematics of 29 healthy males were recorded for normal and simulated impaired walking. Latter was realized by restricting knee extension of one leg to approximately 170° by means of an orthosis. The data analysis was conducted with four marker sets of different sizes (number of markers): full body (37), lower body (16), restricted leg only (8) and hip, knee and ankle of the restricted leg (3). Principal component analysis was used for dimensionality reduction. Linear Support Vector Machine (SVM), naïve Bayes (NB), AdaBoost (AB) and Random Forest (RF) were trained to classify normal and simulated impaired walking. Cross validation was used to check for accuracy. Mean posterior accuracy and 95% credible intervals were estimated to compare marker sets and classifiers (Brodersen et al., 2010). **Results** The accuracies of all classifiers were around chance level with the full body marker set and tended to increase with a lower number of markers. RF, AB and SVM classified significantly above chance level with the smallest marker set. Accuracies of the classifiers did not differ significantly within each marker set, whereas SVM tended to perform best with a mean posterior accuracy of 77% on the smallest marker set. **Discussion** Selecting a reduced marker set can be beneficial independent of the type of classifier. This is remarkable as the smaller marker sets are subsets of the larger sets. The simulations were well controlled and thus allowed logical considerations for selecting a small marker set that definitely contains discriminative information. Reducing the number of less informative dimensions might facilitate classification. Future work should address developing a heuristic data driven procedure for choosing a proper marker subset without prior knowledge about the impairment in order to enhance practical applications. **References** Brodersen KH, Cheng SO, Stephan KE, Buhmann JM (2010). 20th International Conference on Pattern Recognition, 3121-3124 Eskofier BM, Federolf P, Kugler PF, Nigg BM (2013). Comput Methods Biomech Biomed Engin, 16, 435-442 Contact Josef.Christian@sbg.ac.at

## LOWER LIMB MUSCLE FORCES DURING SLOPED WALKING AT DIFFERENT INCLINATIONS

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**Introduction** Lower limb joint forces are increased during sloped walking compared to level walking (Alexander & Schwameder, 2016). Furthermore, muscle forces were previously shown to be major contributors to lower limb joint forces (Correa et al., 2010). Therefore, the aim of this study was to analyse lower limb muscle forces during sloped walking at different inclinations in order to understand the underlying mechanisms of the increased joint forces and to provide evidence based training program recommendations. **Methods** Male participants (n=18, 27±5 y, 1.80±0.05 m, 75±8 kg) walked at a pre-set speed of 1.1 m/s on a ramp at the inclinations of 0°, ±6°, ±12° and ±18°. Kinematic data were captured with a motion analysis system (Vicon, 250 Hz) and kinetic data were recorded with two force plates (AMTI, 1000 Hz) imbedded into the ramp. A musculoskeletal model (AnyBody) previously validated for sloped walking (Alexander &



Schwameder, 2015) was used to compute the forces of 18 lower limb muscles. Changes in mean muscle forces were analysed using the Friedman test. In cases of significance, Wilcoxon tests with Bonferroni correction were used as post-hoc. Results All lower limb muscle forces (except gluteus medius) were significantly altered during sloped compared to level walking. Amongst others, downhill walking increased quadriceps (>140%) and decreased hamstrings (<22%) and gastrocnemii (<22%) muscle forces. Uphill walking increased mean quadriceps (>96%), hamstrings (>36%) and gastrocnemii (>12%) muscle forces. Joint-muscle-force waveforms provided information on possible muscle contributions to joint compression forces. The most important muscles were: gluteus medius for hip forces, quadriceps and gastrocnemii for tibiofemoral forces, quadriceps for patellofemoral forces and triceps surae for ankle forces. Discussion Muscle forces during level walking were consistent with data presented previously (Correa et al., 2010), but did not entirely support results of a predictive simulation of uphill walking (Dorn et al., 2015). In agreement with Correa et al. (2010), gluteus medialis provided the greatest contribution to the compressive hip force. The crouched posture during sloped walking (Dorn et al., 2015) is most likely responsible for the increased quadriceps force (Steele et al., 2012) and therefore the increased tibiofemoral and patellofemoral joint loadings. The study provided important information on muscle forces during sloped walking as a useful basis for the development rehabilitation and training procedures. References Alexander N, Schwameder H (2015). J Appl Biomech, doi:10.1123/jab.2015-0021. Alexander N, Schwameder H (2016). Gait Posture, 45, 137-142. Correa TA, Crossley KM, Kim HJ, Pandey MG (2010). J Biomech, 43(8), 1618-1622. Dorn TW, Wang JM, Hicks JL, Delp SL (2015). PLOS ONE, 10(4), e0121407. Steele KM, Demers MS, Schwartz MH, Delp SL (2012). Gait Posture, 35(4), 556-560. Contact nathalie.alexander@sbg.ac.at

## MUSCLE STIFFNESS IS REDUCED FOLLOWING A SINGLE STATIC STRETCHING EXERCISE BUT NOT FOLLOWING SIX WEEKS OF STATIC STRETCHING TRAINING

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1: KFU Graz (Austria) 2: AU Thessaloniki (Greece) Introduction There is evidence that a single static stretching (SS) exercise decreases muscle stiffness (Kay et al. 2015). However, it is not yet well understood if this structural change of a single SS causes a chronic adaptation following several weeks of repeated SS. Therefore, the purpose of this study was to investigate the effects of a single SS exercise (4x30sec) and six-week SS training (5/week for 4x30sec) on the muscle-tendon unit (MTU) of the gastrocnemius medialis (GM). We hypothesized a gain in range of motion (RoM) following the single SS exercise and the SS training for six weeks. Besides a decrease in muscle stiffness following a single SS training, we expected also an adaptation of the muscle tissue following SS for six weeks (Kato 2009). Methods Forty-six healthy male (23.2±2.7years, 179.4±5.7cm, 75.6±6.8kg) and 27 healthy female (23.5±3.7years, 169.8±4.6cm, 61.3±5.3kg) physically active subjects participated in the study. They were randomly assigned to a SS group (n=25) and control groups for the single SS (n=24) and the six week SS (n=24), respectively. Before and after the single SS exercise and the six-week SS intervention, the RoM, passive resistive torque (PRT), maximum voluntary contraction (MVC), and several parameters of the muscle and tendon structure (muscle stiffness, tendon stiffness...) of the GM were determined with a dynamometer and ultrasound. Effects of the stretching interventions were tested with paired t-tests. Results There was an increase in RoM following the single SS exercise (1.2±2.6°; P=0.04) and the six-week SS training (5.4±5.0°; P<0.01). Following the single stretching exercise the yield in RoM was accompanied by a decrease in muscle stiffness (1.1±2.1N/mm; P=0.02), joint stiffness (0.1±0.1Nm/°; P<0.01), and PRT (3.0±3.9Nm; P<0.01). Besides RoM, no other significant changes were observed following the six-week SS training. Moreover, no significant changes of the MVC, tendon stiffness, fascicle length, and pennation angle were found in single SS or SS for six weeks. No significant difference in any parameter was detected in the control groups. Discussion The findings of our study indicate that altered muscle tissue properties return to the initial state following a single SS (Mizuno et al. 2013). Despite an increase of RoM no structural adaptation of the MTU due to repeated SS for six weeks was observed. It seems probable that RoM changes are due to an increased stretch tolerance (Magnusson et al. 1996). References Kato E. ECSS BOA 2009:194-195. Kay AD, Husbands-Beasley J, Blazevich A. Med Sci Sport Exer. 2015;47(10):2181-2190. Magnusson SP, Simonsen EB, Aagaard P, et al. J Physiol. 1996;497(1):291-298. Mizuno T, Matsumoto M, Umemura Y. Scan J Med Sports. 2013;23(1):23-30.

## TENDON SIZE AND STIFFNESS: INFLUENCE OF SHORT-TERM AND CHRONIC STRENGTH TRAINING

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Introduction Tendon stiffness increases following short-term (3 months) strength training with sustained high-loads, with some equivocal data for tendon hypertrophy. The potential for tendons to adapt to strength training, especially after several years of chronic exposure, remains largely unexplored. This study compared patellar tendon (PT) size and mechanical properties (stiffness, Young's modulus) between untrained controls, short-term strength trained (post-12 weeks training) and chronic-strength trained (>3 years of systematic training) groups. Methods Following familiarisation, maximal voluntary torque (MVT) and tendon stiffness were determined in duplicate measurement sessions. A control group (CON) comprised n=54 untrained males. A short-term strength group (SST, n=15 males) was measured post 12-weeks isometric knee extension strength training (3 x wk, 40 reps of 3-s at 75% MVT). A chronic strength-trained (CST) group comprised n=16 males with 4.0±0.8 (mean ± SD) years systematic heavy-resistance training experience (~3 x wk of quadriceps sessions). Simultaneous force and ultrasound recordings of PT elongation during constant loading-rate ramp contractions were used to derive PT stiffness at a common tendon force level. Tendon stress was calculated and Young's modulus estimated over a common stress range. Muscle volume and mean tendon cross-sectional area were measured from contiguous axial magnetic resonance images (5 and 2 mm). Univariate ANOVA was followed by post-hoc least-significant difference tests (with Holm-Bonferroni correction) between specific groups. Results MVT differed between all three groups (CST 394±68 vs SST 293±47 vs CON 245±42 Nm; All P≤0.001). CST quadriceps volume (2876±311 cm<sup>3</sup>) was much larger than both SST and CON (1967±316 and 1837±257 cm<sup>3</sup>; both P<0.001) though SST and CON muscle volumes were not statistically different (7%; P=0.113). PT stiffness was greater for SST (3279±536 N.mm, P=0.001, +23%) and CST (3076±578 N.mm, P=0.024, +15%) than CON (2664±491 N.mm), though similar between SST and CST (P=0.296). Likewise PT Young's modulus of SST/CST was greater than CON (+19/22%, P=0.009/P=0.004), with no difference in modulus between SST and CST (1.45±0.28 vs 1.49±0.25 GPa, P=0.734). There was no group effect for tendon cross-sectional area (ANOVA P=0.201). Conclusion Our findings indicate that despite substantial differences in maximal strength (+35%) and muscle volume (+46%), ~4 years of chronic strength training does not further increase tendon stiffness and modulus than occurs after 12 weeks of strength training. There was no evidence for tendon hypertrophy after strength training in this study.

**LOAD SPECIFIC PATELLAR AND ACHILLES TENDON ADAPTATION: STRUCTURAL INTEGRITY OR FUNCTION?**

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Introduction Tendon viscoelastic properties enable, inter alia, reducing the metabolic cost of locomotion (Lichtwark et al. 2007), enhancing muscle power production (Alexander & Bennet-Clark 1977) or preventing peak load injuries (Roberts & Azizi 2010). While the dual requirement of being strong but functionally adequate seem to be met by inherent repair and remodelling processes, current knowledge on tendon adaptations is largely fragmented into studies yielding partial information. This study aimed to determine whether distinct sets of tendon properties are seen in athletes engaged in sports with contrasting requirements for tendon function and structural integrity. Methods Thirty-nine male adults ( $27.3 \pm 5.7$  yrs) divided in four groups (elite ski jumpers, endurance runners and water polo players, and controls) were tested. From the original data set by combining ultrasonography, dynamometry, electromyography and 2D motion analysis, the following variables are presented: patellar (PT) and Achilles tendon (AT) stiffness, cross-sectional area normalized to body mass (nCSA), hysteresis and recovered strain energy. Results Tendon nCSA was smaller in water polo players than in other athletes (AT and PT; -24 to -28%) or controls (PT only; -9%). In runners (PT only; +26%) and ski jumpers (PT and AT; +21% and +13%, respectively), nCSA was larger than in controls. However, tendon stiffness only differed in ski jumpers, compared to controls (PT and AT; +11% and +27%, respectively) and water polo players (AT only; +23%). Hysteresis values were lower in the PT of ski jumper (-33%) and runner (-30%) compared to controls. The recovered strain energy was greater in ski jumpers compared to water polo players and controls (PT +55% and +52% and AT +32% and +36%, respectively) and to runners (PT only; +40%). Discussion Tendon strength or fatigue quality requirements seem to be preserved by adjustments of tendon size. However, uncoupled morphological and mechanical properties indicate that functional requirements may also influence tendon adaptations. The ability to conserve mechanical energy does not seem particularly confined to individuals subjected to a high volume of running training. Similar group differences in properties of PT and AT suggest that adaptive mechanisms may override their functional specificity. References 1. Alexander R McN & Bennet-Clark H C. Storage of elastic strain energy in muscle and other tissue. *Nature*, 1977. 2. Lichtwark G A & Wilson A M. Is Achilles tendon compliance optimised for maximum muscle efficiency during locomotion? *J Biomech*, 2007. 3. Roberts T J & Azizi E. The series-elastic shock absorber: tendons attenuate muscle power during eccentric actions. *J Appl Physiol* (1985), 2010. Contact: hans-peter.wiesinger@sbg.ac.at

**EFFECTS OF FASCICLE LENGTHENING VELOCITY ON RADIAL AND LONGITUDINAL VASTUS LATERALIS MUSCLE GROWTH AFTER ECCENTRIC EXERCISE**

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Introduction There is evidence that eccentric loading affects the longitudinal muscle growth and that the magnitude of the lengthening velocity of the fibers and the fiber length at which the eccentric load is applied are important influential factors (Butterfield and Herzog, 2006; Sharifnezhad et al., 2014). Recent findings of our group (Sharifnezhad et al., 2014) indicated fascicle lengthening velocity-specific effects on the radial and longitudinal muscle growth. Hence the purpose of this study was to investigate the effects of the lengthening velocity during eccentric exercises on radial and longitudinal growth of the vastus lateralis muscle (VL). We hypothesized a lengthening velocity-dependent radial and longitudinal muscle growth with lower velocities favoring radial hypertrophy and higher velocities facilitating longitudinal muscle growth. Methods We applied four different eccentric exercise protocols for the knee extensors (33 sessions, 3 times per week, 5 sets per training day) varying the angular velocity (i.e. 45, 120, 210 and 300°/s) in two experimental groups (both n=13, one protocol on each leg). The total eccentric loading volume was similar in all protocols. A control group (n=12, no training) was also included in the experimental design. Before and after the training we examined the maximal anatomical cross-sectional area (ACSA), fascicle length (FL) and pennation angle (PA) of the VL as well as the moment-angle relationship of the knee extensors using magnetic resonance imaging, ultrasonography and dynamometry. As statistics we performed a one way ANOVA for repeated measures ( $\alpha=0.05$ ). Results According to preliminary results from 8 participants of each exercise protocol, the FL increased significantly ( $p<0.05$ ) from  $128.4 \pm 17$  mm to  $137 \pm 15.3$  mm (45°/s protocol; P45),  $132.4 \pm 19.2$  mm to  $137.8 \pm 21$  mm (P120),  $130.5 \pm 15.2$  mm to  $135.4 \pm 14.8$  mm (P210) and  $131.3 \pm 17.8$  mm to  $139.2 \pm 17.3$  mm (P300) respectively. The PA did not change in any exercise protocol. The mean increase in maximal knee extension moment for all protocols was  $15 \pm 12\%$  ( $p<0.05$ ). The maximal ACSA increased significantly ( $p<0.05$ ) for all protocols from  $35.8 \pm 2.2$  cm<sup>2</sup> to  $37 \pm 1.5$  cm<sup>2</sup> (P45),  $33.5 \pm 4.5$  cm<sup>2</sup> to  $35.7 \pm 4.4$  cm<sup>2</sup> (P120),  $34.3 \pm 4.4$  cm<sup>2</sup> to  $36.3 \pm 4.6$  cm<sup>2</sup> (P210) and  $35.1 \pm 3.8$  cm<sup>2</sup> to  $37.3 \pm 3$  cm<sup>2</sup> (P300) respectively. Discussion The results show that eccentric training leads to significant adaptations in muscle strength, fascicle length and ACSA. However, the preliminary results from 8 participants per group did not confirm our hypotheses of a velocity-dependent radial and longitudinal muscle adaptation. References Butterfield TA, Herzog W. (2006). *J Appl Physiol*, 100, 1489–1498. Sharifnezhad A, Marzilger R, Arampatzis A. (2014). *J Exp Biol*, 217, 2726–2733. Contact robert.marzilger@hu-berlin.de

**Oral presentations****OP-PM08 Liver & Mitochondria****EFFECT OF EXERCISE AND NUTRITION INTERVENTIONS ON LIVER FAT IN OBESE CHILDREN WITH NON-ALCOHOLIC FATTY LIVER DISEASE**

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1: SHMNS, UQ, 2: CAI, UQ, 3: CNRC, UQ, 4: QCMRI, UQ, 5: LCCH, 6: IMB, UQ, 7: HCP, The Wesley Hospital, 8: DCMI, NTNU

Introduction Non-alcoholic fatty liver disease (NAFLD) is the leading cause of paediatric chronic liver disease. Multi-disciplined lifestyle interventions are the cornerstone of therapy for the management of NAFLD in children, however there is minimal evidence evaluating the efficacy of these approaches individually or in combination. We therefore aimed to compare the effect of an exercise and nutrition program versus nutrition advice only on liver fat in obese children. Methods Intrahepatic lipid (IHL) was assessed in 31 obese children (BMI>95th percentile for age & sex) before and after a 12-week exercise and nutrition intervention, or a nutrition intervention alone. Exer-

cise training involved supervised aerobic exercise at 60-95% of HRpeak, for 40 min/session on 3 days per week. The nutrition component consisted of six, fortnightly dietitian consultations. IHL was measured by proton magnetic resonance spectroscopy (1H-MRS). Ten participants (age 7.9±2.2; Tanner puberty stage 2 (2-3.25), female 30%) were identified with NAFLD (IHL>5.5%) and were included in this analysis. Cardiorespiratory fitness was assessed using a maximal treadmill test with expired gas analysis and VO2peak was calculated. Results are presented as mean±SD or median (IQR) when appropriate. Results Participants with NAFLD had a mean baseline IHL content of 7.4% (5.8-10.4%) and VO2peak of 30±5.4mL/kg/min. The combined intervention (n=5) resulted in significantly greater absolute reductions in IHL than the nutrition-only intervention (n=5) (-4.0±1.2% and -1.8±1.2% respectively, p=0.03), which was equivalent to a median 38% versus 7% relative reduction. This reduction was independent of improvements in VO2peak (p=0.02). Five participants (50%) reversed NAFLD following the combined (n=4) and nutrition only (n=1) interventions. Discussion A 12-week supervised exercise program combined with nutrition advice was effective in reducing IHL in obese children. The hepatic benefits were independent of improvements in cardiorespiratory fitness. Suggested benefits of exercise on IHL include peripheral adaptations leading to lower hepatic free fatty acid uptake and enhanced skeletal muscle glucose uptake resulting in reduced substrate for lipogenesis (Johnson et al. 2012). References Johnson NA, Keating SE, George J. Exercise and the liver: implications for therapy in fatty liver disorders. *Semin Liver Dis.* 2012;32(1):65-79. Contact: katrin.dias@uqconnect.edu.au

### **IMPAIRED LIPID STORAGE AND MITOCHONDRIAL NETWORK ORGANIZATION IN OBESE HUMAN SKELETAL MUSCLE. IMPROVEMENTS ASSOCIATED TO GASTRIC BYPASS AND LINK TO INSULIN RESISTANCE REMISSION**

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**Introduction:** Obesity-induced insulin resistance (IR) has been proposed to be caused by lipotoxicity arising from ectopic lipid deposition and mitochondrial dysfunction in skeletal muscle. The aim of this project is to compare the amount and structural quality of lipid droplets (LDs) and mitochondrial network in morbidly obese subjects with lean sedentary controls and relate these features to improvements in insulin sensitivity (IS) during Roux-en-Y gastric bypass (RYGB)-induced weight loss. **Methods:** 10 obese subjects undergoing RYGB surgery were divided into normoglycemic (NGT, n=5, BMI=42.1, SEM=1.1) and type 2 diabetic patients (n=5, BMI=43.4, SEM=2.9). The subjects were tested four times, A) at inclusion, B) after an 8-10% weight loss, C) 4 months after RYGB, and D) 18 months after RYGB, where measurements were made and muscle biopsies obtained. LDs, PLIN2 and mitochondria in single muscle fibers were stained immunohistochemically using Bodipy, anti-PLIN2 and anti-COXIV, visualized with confocal microscopy and analyzed with Fiji software. LD fractional area (fa), LD density (LDd), PLIN2 fa and mitochondrial fa as well as the ratios between them were compared with lean NGT (n=5, BMI=22.0, SEM=0.7) and correlated to IS estimated by the Matsuda index. **Results:** Morphologically, we found that LDs became markedly smaller and more evenly distributed throughout the fibers and that the mitochondrial network became more organized from A to D in both obese groups. In the lean controls we observed disruption and disorganization of the mitochondrial network but no obvious impairments in the lipid storage. Our results show a statistically significant difference between the obese and the lean subjects at time point A when looking at LD fa (P=0.03), LDd (P=0.02), LDd/Mitochondrial fa (P=0.02) and LD fa/Mitochondrial fa (P=0.03), and that the obese significantly improve towards time point D with regards to LDd (P<0.001), LD fa (P=0.02), PLIN2 fa (P<0.001), LDd/Mitochondrial fa (P<0.001), LD fa/Mitochondrial fa (P=0.02), PLIN2 fa/LDd (P<0.001), and PLIN2 fa/LD fa (P=0.04). Analyses also show that IS correlates negatively with LDd/Mitochondrial fa (R=-0.4, P=0.008), LD fa/Mitochondrial fa (R=-0.4, P=0.006), and positively with PLIN2 fa/LDd (R=0.3, P=0.03) and PLIN2 fa/LD fa (R=0.5, P=0.001). **Discussion and conclusion:** Our results indicate that physical inactivity lead to impaired mitochondrial dynamics, which combined with obesity leads to impaired LD storage which coincide with reduced skeletal muscle insulin sensitivity. Contact: s-meidahl@hotmail.com / wzv997@alumni.ku.dk

### **THE ACUTE COLD-INDUCED INCREASE IN PGC-1A IS MEDIATED SYSTEMICALLY THROUGH INCREASED $\beta$ -ADRENERGIC STIMULATION.**

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**INTRODUCTION** Post-exercise cold water immersion (CWI) increases the PGC-1 $\alpha$  mRNA response to exercise (Ihsan et al. 2014). The molecular mechanisms mediating this response are yet to be fully elucidated but may involve upregulation of the local signalling kinases AMPK and p38 MAPK (Ihsan et al. 2015) and/or increased systemic  $\beta$ -adrenergic stimulation (Puigserver et al. 1998; Ihsan et al. 2014). Using a single leg immersion protocol our aim therefore was to examine whether the cold-induced post exercise increase in skeletal muscle PGC-1 $\alpha$  mRNA is locally and/or systematically mediated. **METHODS** In a repeated measures cross-over design 10 active subjects completed high-intensity intermittent cycling (8 x 5 minute bouts separated by 60 sec rest, ~80% peak power output) followed by seated rest (CON) or single-leg cold water immersion (CWI; 10 min, 8°C). Muscle biopsies of the immersed (CWI) and CON legs were taken pre, post- and 3h post-exercise. In the non-immersed leg (NOT) biopsies were taken post- and 3h post-exercise. qRT-PCR and Western Blots were performed to assess gene expression (mRNA) and signalling kinase activity respectively. Plasma normetanephrine concentration was used as a measure of the systemic  $\beta$ -adrenergic response. Two factor (condition x time) within-subjects GLM with repeated measures determined treatment differences. LSD pairwise comparisons was used to locate the difference. **RESULTS** Exercise per se induced increases in PGC-1 $\alpha$  mRNA 3h post-exercise (~5-fold; P < 0.001). These changes were further elevated following CWI (~9-fold; P < 0.001) and were similar in both CWI and NOT (~12-fold; P < 0.05). Plasma normetanephrine concentration was higher in CWI vs. CON (P = 0.034) (860 vs. 665 pmol/L post-immersion). **DISCUSSION** We report for the first time that local cooling of the immersed limb evokes transcriptional control of PGC1- $\alpha$  in the non-immersed limb. This suggests that increased systemic  $\beta$ -adrenergic stimulation, and not the effects of localised cooling on skeletal muscle signalling kinases, mediates the post-exercise increases the PGC-1 $\alpha$  mRNA. Results from the present study have important implications for research designs which adopt contralateral non-immersed limbs as a control condition, whilst presenting new directions for mechanistic research into cold-induced PGC-1 $\alpha$  responses. **REFERENCES** Ihsan M, Markworth JF, Watson G, Choo CH, Govus A, Pham T, Hickey AJ, Cameron-Smith D & Abbiss CR (2015). *AJP- RCP*; DOI: 10.1152/ajpregu.00031.2015. Ihsan M, Watson G, Choo HC, Lewandowski P, Papazzo A, Cameron-Smith D & Abbiss CR (2014). *MSSE*, 46(10), 1900-1907. Puigserver P, Wu Z, Park CW, Graves R, Wright M & Spiegelman BM (1998). *Cell*, 92(6):829-39. **CONTACT** R.J.Allan@2013.ljmu.ac.uk 2747characters

## **SKELETAL MUSCLE MITOCHONDRIAL QUALITY CONTROL AND MITOPHAGY IN OBESE AND ENDURANCE TRAINED MEN**

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**Introduction** Mitochondrial content is determined by coordinated biogenesis and degradation processes. An increase in mitochondrial volume occurs from organelle biogenesis and fusion to the existing reticulum. Decreased volume occurs with the removal of dysfunctional portions of the reticulum through fission. Mitophagy, a selective form of autophagy targeting mitochondria with a depolarized membrane potential, works in conjunction with fission to degrade portions of the reticulum that cannot be repaired. In obesity and diabetes, conditions associated with reduced muscle mitochondria content, the state of fusion and fission and the role of mitophagy remain unclear. The aim of this study was to compare the levels of a number of fusion, fission, and mitophagy-related proteins in muscle from men varying for fitness, obesity and insulin sensitivity. **Methods** Vastus lateralis m. biopsies were obtained from 42 men aged 34-53 yrs in 4 groups: non-obese sedentary (S: BMI<25kg/m<sup>2</sup>), sedentary obese (OB: BMI>30kg/m<sup>2</sup>), sedentary glucose intolerant obese (OBI), and endurance-trained non-obese (ET). An OGTT was used to assess glucose tolerance, a euglycemic-hyperinsulinemic clamp to measure insulin sensitivity (M/I), and a cycle ergometer incremental test to exhaustion to assess VO<sub>2</sub>max. Protein levels were assessed by Western blotting, and enzyme activities measured spectrophotometrically. **Results** ET had VO<sub>2</sub>max values ~80% greater than the OB and OBI, S only slightly more fit than the obese. ET had the greatest insulin sensitivity (M/I, ~50% greater than obese). Muscle cytochrome-c oxidase (COX) and citrate synthase (CS) activities were respectively ~73% and ~94% greater in the ET. An ~50% higher level of the fusion protein Opa1 was observed in the ET, the lowest levels in the obese groups. No differences were seen for the fission proteins Fis1 and Drp1. OBI muscle also had ~50% less of the anti-mitophagy PARL and ~100% more of the pro-mitophagy Parkin. OPA1 levels correlated negatively with obesity (r range ~-0.32 to -0.34), and positively with VO<sub>2</sub>max (r=0.36) and COX (r=0.36). Similarly, PARL levels correlated negatively with obesity (r range ~-0.39 to -0.46), and positively with VO<sub>2</sub>max (r=0.52) and mitochondrial enzymes (CS, COX, r range 0.53 to 0.59). In contrast, Parkin levels did not correlate with obesity or fitness, but were negatively associated with mitochondrial activities (CS, HADH, r range -0.31 to -0.43). **Discussion** Decreased muscle mitochondrial content in obesity with or without impaired glucose tolerance appears to result from decreased fusion and increased mitophagy. Endurance training could increase mitochondrial content in these subjects through its specific effects reversing these processes. Contact Denis.joanisse@kin.ulaval.ca

## **Oral presentations**

### **OP-PM47 Physiological Response to HIT**

#### **HIGH-INTENSITY EXERCISE TRAINING ABROGATES AGE DIFFERENCES IN SPOMATOTROPIC HORMONE CONCENTRATIONS**

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**Aim:** The aim of this investigation was to compare systemic concentrations of growth hormone (GH), Insulin-like growth factor 1 (IGF-1), and Insulin-like growth factor-binding protein (IGFBP-3) in response to a combined sprint and strength training program in young and middle-aged men. **Methods:** Thirty-eight healthy, moderately trained men participated in this study. Young and middle-aged men were randomly assigned into two experimental conditions (training or control). A young training group (21.4±1.2yrs, YT, n=10), a young control group (21.3±1.3yrs, YC, n=9), a middle-aged training group (40.4±2.1 yrs, MAT, n=10) and a middle-aged control group (40.3±1.7 yrs, MAC, n=9) were assessed before (P1), and after (P2) a high-intensity sprint and strength training program (HISST) for 13 weeks (4 times/week). At P1 and P2, maximal oxygen uptake (VO<sub>2</sub>max) and maximal anaerobic power was assessed using the Wingate Anaerobic Test (WAnT). Blood samples were collected at rest, after warm-up (50% VO<sub>2</sub>max), immediately post-, and 10 min post-WAnT. **Results:** Resting serum GH, IGF-1, and IGFBP-3 increased significantly (p<0.05) after HISST in MAT. This increase approached values to those of YT after HISST. In response to warm-up and the WAnT, GH and IGF-1 levels increased significantly (p<0.05) in YT and MAT after HISST. VO<sub>2</sub>max and maximal anaerobic power increased (p<0.05) after HISST in both YT and MAT compared to YC and MAC. **Conclusion:** These data suggest combined sprint and strength training improves muscle power, VO<sub>2</sub>max, and increases activity of the GH/IGF-1 axis. Moreover, GH/IGF-1 axis sensitivity to a WAnT in middle-aged men was additionally increased. However, the causal of these hormonal adaptations remains to be clarified.

#### **HIGH INTENSITY INTERVAL TRAINING IMPROVES GLUCOSE METABOLISM IN DIABETIC MICE DESPITE THE ABSENCE OF MITOCHONDRIAL ADAPTATIONS**

CHAVANELLE, V., BOISSEAU, N., MAILLARD, F., COMBARET, L., DARDEVET, D., MONTAURIER, C., DENIS, P., METZ, L., PELTIER, S., SIRVENT, P.

AME2P - EA 3533

**Introduction** Type 2 diabetes (T2D) is a long term metabolic disorder characterized by high blood glucose level, insulin resistance, and relative lack of insulin. Recent studies have proved in patients with T2D the positive effects of High Intensity Interval Training (HIIT) programs on hyperglycemia and muscle mitochondrial capacity (Little et al., 2011). The aim of this work was to compare the effects of HIIT with a traditional Moderate Intensity Continuous Training (MICT) on glucose metabolism and mitochondrial function in diabetic mice. **Methods** 30 db/db mice aged 6 weeks were subdivided into MICT group, HIIT group, or control group (CON). Animals in the training groups ran on a treadmill 5 days/week during 10 weeks. In vivo starch and insulin tolerance tests were performed at the end of the protocol along with 24h respiratory measurements realized in metabolic chambers. In vitro measurements included high resolution respirometry, assessment of mitochondrial density markers (Citrate synthase and  $\beta$ -Hydroxyacyl-CoA activities and oxidative phosphorylation complexes protein content) and insulin signaling by enzymatic assays and western blot in muscle and liver. **Results** HIIT lowered fasting glycemia (-40%) and % HbA1c (-20%), and improved response to starch and insulin tolerance tests compared to CON group. No changes were noted in MICT group regarding the glucose homeostasis. 24h respiratory exchange ratio was increased in HIIT (+6%) and



MICT group (+4%) after the training program but without any changes in 24h total energy expenditure. Assessment of muscle and liver mitochondrial density markers and ex vivo gastrocnemius mitochondrial respiration showed no differences between the three groups. Western blot analysis revealed a significant 2-fold increase of muscle Glut4 content only in HIIT group. Similarly, only HIIT increased liver Foxo1 phosphorylation ratio and decreased JNK phosphorylation ratio. Discussion This study showed that HIIT may improve glucose metabolism more efficiently than traditional MICT in diabetic mice by mechanisms independent of mitochondrial adaptations, as already reported in the literature (Li et al. 2011). This effect could be partly explained by an increased muscle GLUT4 content, and a decreased activity of JNK/FoxO1 pathway in the liver, both involved in the pathophysiology of insulin resistance (Cheng & White, 2011). References Cheng Z., White F. (2011). Antioxid Redox Signal 14(4):649-61 Li L. et al. (2011). Diabetes. 60(1):157-67 Little JP. et al. (2011). J Appl Physiol (1985) 116:1554-60 Contact vivien.chavanelle@hotmail.fr

#### **LOW-VOLUME HIGH-INTENSITY INTERVAL EXERCISE IMPROVES GLYCAEMIC CONTROL SIMILARLY TO CONTINUOUS MODERATE-INTENSITY EXERCISE DESPITE INCREASED POSTPRANDIAL OXIDATIVE STRESS.**

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Background: Meal consumption increases circulating blood glucose and oxidative stress which, if in excess, can lead to chronic disease. Acute exercise can reduce postprandial oxidative stress (PPOS) and glycaemia and improve metabolic health, however the effects of exercise intensity are unclear. We investigated the effects of low-volume high-intensity interval exercise (LV-HIIE) and continuous moderate-intensity exercise (CMIE) on PPOS and glycaemic control in overweight and inactive adults. Methods: Twenty-seven adults were randomised into LV-HIIE (9 females, 5 males; age: 30±1 years; BMI: 29±1 kg/m<sup>2</sup>; M±SEM) or CMIE (8 females, 5 males; age: 30±2.0; BMI: 30±2.0) groups. Participants consumed a standard breakfast (cereal and milk) on a non-exercise day and an exercise day. On the non-exercise day, participants rested in the laboratory. On the exercise-day, participants performed a single session of LV-HIIE (8x1 min cycling bouts @ 100% Wmax, 1 min recovery periods) or CMIE (38±1 mins of continuous cycling @ 50% Wmax) 1 hr after consuming breakfast. Plasma oxidative stress (TBARS and hydrogen peroxide; H<sub>2</sub>O<sub>2</sub>) and antioxidant activity (catalase and superoxide dismutase; SOD) were measured at baseline, 1hr postprandial (pre-exercise) and 3 hrs postprandial (1.5 hrs post-exercise). A continuous glucose monitor (CGM) was used to measure 24 hr glycaemic control over the rest and exercise day. Results: On the non-exercise day, plasma oxidative stress and antioxidant activity were increased 1 hr (H<sub>2</sub>O<sub>2</sub>: 23%; TBARS: 35%; catalase: 41%; SOD: 15%) and 3 hrs postprandial (H<sub>2</sub>O<sub>2</sub>: 22%; TBARS: 20%; catalase: 26%; SOD: 16%); and increased 1 hr post-prandial (prior to exercise) on the exercise day (H<sub>2</sub>O<sub>2</sub>: 40%; TBARS: 29%; catalase: 50%; SOD: 21%). CMIE performed 1 hr after breakfast attenuated the 3 hr PPOS response (H<sub>2</sub>O<sub>2</sub>: -14%; TBARS: -23%; SOD: -12%), whereas this response was exacerbated with LV-HIIE (H<sub>2</sub>O<sub>2</sub>: 27%; TBARS: 25%; catalase: 25%). Compared to the non-exercise day, both LV-HIIE and CMIE similarly decreased CGM 24 hr average glucose levels (-6% and -4%), area under the curve (-6% and -4%), peak glucose concentrations (-9% and -12%) and the 2 hr postprandial glucose response to dinner (-11% and -8%). Conclusion: In contrast to CMIE, LV-HIIE performed 1 hr after breakfast did not attenuate PPOS. Despite this, LV-HIIE provided similar benefits in glycaemic control over a 24 hr period, and consisted of 30% less total work and a substantially lower time requirement. LV-HIIE may therefore be a convenient exercise model for improving glycaemic control in overweight and inactive populations.

#### **HOW INTERVAL TRAINING AND PROBIOTIC SUPPLEMENTATION AFFECTS THE COGNITIVE FUNCTION IN A TRANSGENIC MICE MODEL OF ALZHEIMER'S DISEASE?**

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Over 46 million people live with dementia worldwide, Alzheimer's disease (AD) contributes to 60-70% of cases. The illness is associated with the loss of acquired knowledge and the ability to learn. Inflammation and neuron loss indicated by amyloid-beta peptide accumulation underlies this disease. So far there is no effective treatment, but it is proven that physical exercise protects against neurodegenerative diseases, while numerous studies support the positive effects of healthy gut flora on these processes. Experimental design: A total of 32 APP/PS1 transgenic male mice were in the experiment. 8-8 animals in control, exercise, probiotic supplementation (Framelim) and combined treatment groups, respectively. 20 weeks of interval treadmill running and/or probiotic supplementation were used. Aims: We suggest that the use of interval treadmill running and the probiotic supplementation attenuates the ongoing loss of cognitive function, delays the AD progress and reduces the cerebral inflammation caused by the illness. Results: Cognitive test revealed the continuous development in the performance of the animals on combined treatment. During Morris Water Maze test, on the second day the animals showed significantly better performance, the 3rd and 4th day revealed a tendency for improved learning skills compared to the control group. Also in the spontaneous alternation test, a remarkable increase in performance was observed, demonstrating better exploratory activity, and better preservation of cognitive function. 6E10 immunohistochemistry against beta-amyloid plaques revealed, that the number of plaques in hippocampus in the exercise group were significantly lower than in the control and combined group. The plaque area in the hippocampus was significantly lower in all treated groups when it compared to the control group. This suggests an absence of direct link between cognitive function and the number of plaques. Astrocytes were stained with anti-S 100 antibody. We observed an increased number of astrocytes around the plaques, however significant differences in the density of astrocytes in different groups were not found. This phenomenon presumes an increased astrogliosis due to neuron damage in the plaque area. Our results confirm that physical exercise and the use of probiotics can ameliorate cognitive function in AD, however further investigation is needed to prove its effects on cerebral inflammation and neuronal loss.

## Oral presentations

### OP-PM55 Low Back Pain

#### OBJECTIVELY MEASURED MODERATE TO VIGOROUS PHYSICAL ACTIVITY BUT NOT SEDENTARY BEHAVIOUR IS ASSOCIATED WITH LOW BACK PAIN

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**Introduction** Low back pain (LBP) is a common and costly condition with high absence from work. Insufficient physical activity (PA), excess SB and poor physical fitness are potential risk factors for LBP. Former research on PA and SB relies on questionnaire data with known biases. The purpose of this study was to investigate the independent associations of actual PA, SB and fitness on self-reported (1) occurrence of LBP (yes/no) and (2) LBP with at least one visit to physician during the past 12 months. **Methods** Participants (n=1156) were men and women aged 30 to 69 from PA and fitness sub-sample of the national Health 2011 Survey who had sufficient (min 4days with at least 10h/day) accelerometer data (Hookie AM20, Traxmeet Ltd, Espoo, Finland), performed the six minute walk test (6MWT) and answered questions on LBP. PA parameters were based on the mean amplitude deviation (MAD), derived from raw data with validated cut-points. Epoch length was 6 seconds, a single MAD value the 1min exponential moving average. The accelerometer position on the waist (i.e. the angle of postural estimation, APE) was determined by the direction of Earth's gravity vector and upright walking posture. PA/SB parameters, calculated as the mean of daily values were (a) highest metabolic equivalent (MET) level of specific bout durations (1, 5, 10, 15, and 30min), (b) accumulated time of specific bouts of MVPA/light PA/ standing/sitting/lying, (c) number of >30min bouts of standing/sitting/lying and (d) number of standing ups. Multivariable logistic regression analysis were conducted between LBP and PA, SB and fitness, adjusting for age, sex, civil status, education, smoking and body mass index. **Results** The highest MET levels of all bout durations except 1min, and accumulated daily time of MVPA bouts of at least 5 and 10min had strong associations ( $p \leq 0.001$ ) with occurrence of LBP. The highest daily MET 15min had odds ratio (OR) of 0.80 (95% confidence interval (CI) from 0.71 to 0.91), the MET level being 4.1 for those without LBP (n=869) and 3.7 for those with LBP (n=287). Fitness, light PA and SB were not associated with occurrence of LBP. Accumulated daily time of MVPA bouts at least 5 and 10min and number of 10 min bouts showed strongest associations ( $p=0.002$ ) with visits to physicians due to LBP (n=76), the latter having OR of 0.46 (95% CI from 0.29 to 0.75). **Discussion** Higher amount of MVPA was associated with lower occurrence of LBP and less visits to physician in Finnish adults even after further adjusting for SB and fitness. Prospective studies are needed to assess causality. Contact [jaana.h.suni@uta.fi]

#### MULTISENSORY TRAINING RELATED LOW BACK PAIN

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**Introduction** If asymmetric forces act on the body for long time and muscles cannot balance these forces maladaptation will occur, which might result in chronic musculoskeletal problems like spine deformities later on (Steihaug, 2005). All of the forces that maintain the normal posture must be in balance (Jovovoch, V., 2008). **Purpose** The aim of this study was to investigate the relationship between the quality of body posture (based on static and dynamic balance) and back pain syndromes and to study the effectiveness of a multisensory therapeutic exercise intervention on pain and postural control markers, respectively. **Methods** 53 patients (30 male and 23 female, respectively), age:  $35.2 \pm 4.1$  yrs.; body mass  $74.2 \pm 6.7$  kg; height  $180.0 \pm 5$  cm) were tracked, suffering from back pain. Baseline assessment was performed before starting the exercise program and included ODI questionnaire and balance assessment. Body-stability and functional movement symmetry assessment was performed using MFT-S3-Check device TST GmbH, Austria. Re-evaluation was performed immediately following the 3 months of exercise intervention. Multisensory intervention training program was applied (12 weeks; 3 times per week; 40 min per session), in a way that all different analyzers included in sensorimotor tasks. Descriptive and analytical procedures were performed using SPSS. **Results** Oswestry Disability Index (ODI) significantly ( $p < 0.000$ ) decreased following 12 week of therapeutic exercise intervention, demonstrating that severity of pain and disability was significantly lower following exercise treatment. Initially 40 clients were enrolled into ODI stage 2 (79.8%) and 13 into ODI stage 3 (20.2%), respectively. Following the exercise intervention 41 patients (82.1%) improved to stage 1 according to ODI, 9 (10.9%) improved to ODI stage 2, and only 3 patients (7%) did not improve and remained in stage 3 according to ODI. Body-stability and functional movement symmetry characteristics both improved significantly ( $p < 0.01$ ) following 12 weeks of exercise treatment. **Conclusion** Exercises treatment may be helpful for patients with chronic low back pain to increase return to normal daily activities and work. Reference Steihaug S. Can chronic muscular pain be understood? Scand J Public Health Suppl. 2005 Oct;66:36-40. Jovovoch, V. Mehanički uzroci i posledice poremećaja statike lokomotornog aparata. Glasnik Antropološkog društva Srbije, 2008, br. 43, str. 349-355 E-mail: lshalaj1@hotmail.com

#### THE INTERVERTEBRAL DISC POSITIVELY ADAPTS TO RUNNING EXERCISE

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**Introduction** Muscle, bone and tendon tissues are known to respond positively to specific exercise types. Yet for the intervertebral disc (IVD), this is not clear. Certain sport types such as swimming, gymnastics, volleyball, rowing, baseball, are known to have negative effects on the IVD, resulting in more IVD degeneration (reviewed in Belavy et al, 2016). But it is not known what exercise in humans can impact positively on the IVD, if any. A healthy IVD is evinced by a well-hydrated nucleus pulposus (i.e. high T2-relaxation time on magnetic resonance imaging) with clear distinction between the nucleus and annulus. We hypothesized that IVDs in people who performed regular jogging and running would have higher T2-relaxation time than individuals who performed no sport. **Methods** 25 long-distance runners (>50km per week, minimum of 5 years, no other sports), 30 joggers (20-35km per week, minimum of 5 years, no other sports), and 24 sedentary referents who performed no exercise in the last 5 years were included. All subjects were aged between 25 and 35yrs. Age, height and proportion of females to males were similar across groups. All scanning was done after midday and a minimum of 20 minutes sitting prior to scanning was strictly enforced. T2-relaxation time was quantified in the lumbar IVDs (for the entire IVD, annulus subregion and nucleus subregion), via magnetic resonance imaging. **Results** Long distance runners showed the highest lumbar IVD T2-

time values (mean[SD]: 115[15]ms) being 11% higher than sedentary referents ( $p=0.0009$ ). Joggers had an IVD T2-time of 113[13]ms which was 9% higher than the referent group ( $p=0.0014$ ). This effect was strongest in the hydrated, nuclear, region of the disc. The T2-time in the nucleus pulposus of long-distance runners was 15% ( $p=0.0011$ ), and joggers 11% ( $p=0.003$ ), higher than the referent group. In the annular region the difference was +7% ( $p=0.005$ ) and +5% ( $p=0.025$ ) respectively. The positive impact of long-distance running was also significant at the L3/4, L4/5 and L5/S1 vertebral levels. Discussion This is the first study to show that certain exercise types can have a positive effect on the IVD. Specifically, running sports were associated with better IVD hydration (higher T2-time) with this effect being strongest in the IVD nucleus pulposus. Importantly, the effect was present at the lower lumbar IVDs which are those most commonly affected by disc degeneration in the community. This contradicts the wide-spread assumption (Adams & Roughley, 2005) that repetitive loading is necessarily negative for the IVD. References Adams MA & Roughley PJ. (2005). Spine 31: 2151-2161. Belavy DL, Albracht K, Bruggemann G-P, Vergroesen P-P, van Dieën JH. (2016). Sports Med, in press. Contact belavy@gmail.com

## INCIDENCE OF BACK INJURIES IN YOUTH FLOORBALL AND BASKETBALL: A PROSPECTIVE THREE-YEAR FOLLOW-UP STUDY

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1 Tampere Research Center of Sports Medicine, UKK Institute for Health Promotion Research, Tampere, Finland 2 Department of Health Sciences, University of Jyväskylä, Jyväskylä, Finland 3 Injury and Osteoporosis Research Center, UKK Institute, Tampere, Finland INTRODUCTION In Finland, nearly half of adolescents aged 10–16 years take part in organized sports club activities, floorball and basketball being among the 10 most popular sports. Sports is one of the leading causes for injuries and various musculoskeletal disorders in adolescents. Team sports and sports comprising pivoting movements possess increased risk of injury. The aim of this prospective study was to investigate the incidence and nature of back injuries among young floorball and basketball players in Finland. METHODS Four-hundred- and-twenty-nine adolescent basketball ( $n=109$  female and  $n=102$  male) and floorball ( $n=106$  female and  $n=112$  male) players entered the study (mean age 16.4), of whom 266 were observed prospectively for one, 87 for two and 76 for three study years. Total of 642 athlete-years were collected (2011 to 2014). During the follow-up, all time-loss back injuries were registered weekly and verified by a study physician. RESULTS Altogether 72 back injuries were reported by the players ( $n=422$ ). Two thirds were overuse injuries ( $n=46$ , 63.0%) and most of them were at the lower back ( $n=42$ , 89%). Total of 36 low back and pelvis injuries occurred in floorball players and 32 in basketball players. The overall incidence of low back injuries was 91.9/1000 athlete-years. Respectively, the incidence of upper back injuries was 9.4 and that of pelvic injuries 15.6. 42.6% ( $n=20$ ) of the overuse injuries and 15.0% ( $n=6$ ) of the acute injuries were classified as severe (over 29 days time-loss from sports). DISCUSSION The overall unadjusted incidence of back injuries is high in adolescent floorball and basketball players. Our results showed that overuse injuries were more common than acute traumatic injuries. In the future plausible predisposing factors should be investigated to prevent back problems among adolescent floorball and basketball players. CONTACT marleena.rossi@gmail.com

## PREVENTIVE PROFILING – A SYSTEMATIC APPROACH TO PREDICT THE ONSET OF LOW BACK PAIN

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INTRODUCTION Costs for the treatment and rehabilitation of chronic low back pain (LBP) represent a great part of the yearly expenses in the healthcare system [1]. Research activities in this area increased in the past years, but the synergy of factors leading to LBP can not be fully explained. It is a complex construct: Single trials with a necessarily high number of subjects can only investigate some selected parameters. The inhomogeneity in the study designs leads to a limited validity of systematic reviews and meta analysis trying to combine the results of those single trials. METHODS As a first step a systematic literature review is in process, which investigates the synergy of physical parameters indicating LBP. Focusing on an available dataset, this literature search will obtain information about norm values and the influence of the following selected parameters on the development of LBP: muscle strength, flexibility, physical capacity, body weight, body composition (e.g. BMI), blood pressure, coordination, somatotype, body height, gender and age. In the second step a Mega Trail will examine a consistently growing dataset with more than 500.000 subjects to proof, if the literature based assumptions can be verified and quantified. PRELIMINARY RESULTS The systematic literature search for LBP in the databases pubmed, SportDiscus, Web of Science and Cochrane Library resulted in 8228 articles. The dataset contains currently 559.905 subjects, 280.058 women and 279.847 men. The average age of the female subjects is  $39.0\pm 11.7$  yrs, the male subjects are  $45.5\pm 13.0$  yrs. Within the sample, 10.827 subjects state the presence of LBP. First results support the literature, that women are more likely to develop LBP [3]. 62% of the subjects suffering from LBP are female. Another risk factor is age and BMI. The main risk group of LBP is 40–59 yrs old and has a normal BMI [3]. The female subjects in our dataset with LBP are  $39.5\pm 12.6$  yrs with a BMI of  $25.8\pm 5.2$  and the male subject are  $44.7\pm 13.2$  yrs with a BMI of  $27.1\pm 4.2$ . This indicates a very good dataset for studying the dependency on risk factors for LBP. OUTLOOK Based on the given parameters and the perceptions of the literature review the structure of a multidimensional radar chart will be created. The analysis of the influences of each single parameter and the interaction between the dependent variables will be quantified by the Mega Trail and are still ongoing. The resulting preventive profile might be used as early-warning system to identify the risk for LBP.

## MUSCLE STRENGTH AND NEUROMUSCULAR CONTROL OF SPINE STABILITY IN LOW BACK PAIN: ELITE ATHLETES VERSUS GENERAL POPULATION

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Introduction Chronic low back pain (LBP) is a worldwide-recognized problem with dramatic consequences for the quality of life of the affected patients. There is evidence that LBP patients show deficits in the neuromuscular control of the spine stability compared to healthy controls (Graham, 2014; Hodges, 2009). However, there is a lack of studies taking into account the specificity of LBP in competitive sports. Our purpose was to investigate the athletic-based specificity of neuromuscular differences between healthy and LBP individuals and to identify appropriate markers for the characterization and evaluation of LBP. Method Two groups of athletes with ( $n=15$ ) and without LBP ( $n=15$ ) and two groups of non-athletes with ( $n=15$ ) and without LBP ( $n=14$ ) participated in the study. Muscle strength of the trunk was assessed during maximal isometric and isokinetic contractions using dynamometry. To quantify the neuromuscular control of trunk stability we examined trunk stiffness and damping as well as muscle response patterns using Quick Release experiments. Furthermore,

we investigated the local dynamic stability of the spine using the maximum finite-time Lyapunov exponent ( $\lambda_{\max}$ ) under static and dynamic conditions. For the statistical analysis a two-way ANOVA was performed. Results The maximum isometric trunk extension moments were significantly lower in the LBP participants compared to healthy controls in both athletes and non-athletes. The analysis of interaction between condition (LBP) and groups showed that trunk stiffness was lower only in the non-athlete LBP participants. Trunk damping was significantly higher for the LBP participants in both groups. No significant differences were found in the muscle reaction times and in  $\lambda_{\max}$  between groups and conditions. Discussion Isometric muscle strength decrease of the trunk extensors is a LBP specific characteristic in athletes as well as in non-athletes. This provides evidence that this parameter is a suitable marker for the evaluation of LBP. Trunk stiffness is not sensitive enough to distinguish LBP participants from healthy controls in elite athletes, indicating an athletic-based specificity in the neuromuscular control of spine stability. References Graham R.B. et al, J. Biomech, 47(6):1459–64, 2014. Hodges P. et al, J. Biomech, 42(1):61–66, 2009.

## Oral presentations

### OP-PM36 Handball Performance

#### TEAM HANDBALL MATCH ANALYSIS BY COMPUTER TRACKING FROM THE MEN'S EUROPEAN CHAMPIONSHIPS 2016

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**Introduction** Using time-motion analysis in team handball (TH) has some limitations, since this analysing method is influenced by subjective assessments and does not actually measure the precise locomotion speed. Now a new analysing system has been developed by Prozone Sports, which measures the actual locomotion speed of the players, and in addition can account for all changing actions, i.e. accelerations and decelerations, that occur during match-play even when the speed is low. **Methods** The activity pattern of top international male elite TH players were evaluated by computer tracking at the men's European Championships 2016 in Poland during matches in the main round. The matches were recorded using a three camera setup (Baumer TXG13c) in order to gain full coverage of the TH court. The three videos were independently tracked to produce trajectories and events for each individual player based on the video images. As a result the players are not required to wear a device, and the system is able to capture both playing teams. The player's on-court coordinates are then analysed by quality control operators to verify the player trajectories and events. Finally, software quantifies the locomotion and technical variables for each player and team. **Results** The mean total playing time (TPT) per match for all players (n=136) including all stoppages, but excluding the half-time break, was 77.12±3.11 min (group means±SD), corresponding to 28.5 % extension compared to the normal effective match time of 60 min. In average, wing players (WP) played longer (50.46±23.39 min~65.4% of TPT, p<0.05) than goalkeepers (G: 42.60±28.55 min~55.2%), pivots (PV: 35.11±20.65 min~45.5%) and backcourt players (BP: 34.27±20.25 min~44.4%), respectively. The mean total distance covered (TDC) for field players (FP, n=118) was 2915±1662 m with a mean playing time of 38.40±22.23 min (~49.8% of TPT, range: 0.9-80.4 min). WP covered a longer mean total distance (3987±1778 m, p<0.05) than the other playing positions (BP: 2574±1491 m; PV: 2562±1363 m, G: 1550±1077 m). For FP with long on-court playing time (61.80±10.52 min~80.1% of TPT), TDC per match was 4625±863 m. High-intensity running (HIR) constituted only 1.8±1.0 % of TPT corresponding to 8.8±4.6 % of TDC. However, in relation to the total effective playing time of 60 min, HIR constituted for FP 2.5±1.3% and was higher for WP (4.2±2.8 %, p<0.05) compared to the other playing positions (PV: 2.1±3.8 %; BP: 1.6±2.9 %, G: 0.02±0.2 %). Furthermore, FP performed a mean of 76±124 accelerations and 66±105 decelerations when the speed was low, where WP performed the highest number compared to all other playing positions (102±117, 86±112, p<0.05). **Conclusions** Match analysis by computer tracking showed that male top international elite TH imposes moderate-to-high demands on the aerobic energy system and very high demands on the anaerobic energy systems during certain periods of the match. The activity pattern differed markedly between playing positions, with WP showing a more intense locomotion activity profile than BP, PV and G.

#### SCIENCE BASED TRAINING IN ELITE MALE TEAM HANDBALL

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**Introduction** Team handball is an Olympic sport game that is very popular in Europe. In most of these countries, the leading teams are managed very professionally. However, professional training in elite team handball is mostly based on practical experience because science based knowledge is lacking. Consequently, the aim of this study was to generate and perform professional training based on scientific tests in an elite male handball team. **Methods** 16 (2 goal keepers and 14 field players) elite male team handball players performed a game based performance test (Wagner et al., 2014) consisting of an incremental treadmill-running test, a 30m sprinting test, lower and upper body strength test, and a counter movement jump (CMJ) test at the beginning and at the end of the first (general), at the end of the second (specific) preparation phase as well as at the end of the primary round in the Handball League Austria (HLA). We measured peak oxygen uptake ( $\text{VO}_{2\text{peak}}$ ), utilizing portable metabolic system (Cosmed K4B2), peak blood lactate concentration ( $\text{BLCP}_{\text{peak}}$ ) (EKF, Biosen C), heart rate (Polar, Kempele, Finland), sprinting time, offensive and defensive time actions (Inmotion LPM-system, Abatec, Austria), ball velocity and jump height during a jump throw (PeakMotus, Vicon Peak, UK), isometric leg force and shoulder and trunk rotation torque (ISOMED, D&R Ferstl, Germany) and jump height in the CMJ (AMTI, Watertown, USA). Based on results of the performance tests, the focus in training, adjacent to the normal team handball training, was the polarized endurance (threshold and high-intensity interval) training (Stöggl et al., 2014) in the first and team handball specific coordination and endurance training in the second preparation phase and strength training during the primary round in the HLA. One-way analysis with repeated measures was used to determine the increase in performance. **Results** We found a significant increase in  $\text{VO}_{2\text{peak}}$  (P<.01) in the first and second preparation phase, in sprinting time (P<.001), offensive time (P<.001), defensive time (P<.001) and jump height in the jump throw (P<.001) in the second preparation phase as well as in the isometric leg force (P<.01) during the primary round in the HLA. It was remarkable that the increase in  $\text{VO}_{2\text{peak}}$  was 0.8 l/min (4.1 l/min at the beginning of the first and 4.9 l/min at the end of the second preparation phase) and a decrease in the defensive time 0.6s (6.4s at the beginning of the first and 5.8s at the end of the second preparation phase). **Discussion** The present study revealed that the use of scientifically based training method enables a significant increase in specific endurance and agility in elite



team handball players within the preparation phase of a regular season. We propose that this combined effect of scientific tests and practical training is also appropriate to increase performance in other elite team sports. References Wagner H, et al. (2014). J Strength Cond Res, (in press) Stöggl T, Sperlich B. (2014). Frontiers Physio, 5, 33.

### SEASONAL VARIATIONS OF PERFORMANCE PARAMETERS IN FEMALE ELITE HANDBALL

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**Introduction** For elite handball players, a high level of physical fitness is of particular importance not only to improve performance but also to prevent injuries. Up to now, less empirical evidence is given how physical performance changes over season (Granados et al., 2008). Furthermore, changes of injury risk parameters haven't been investigated yet. Especially for female athletes, injuries in lower extremities (e.g. ACL rupture) must be considered as a severe problem. For this reason, this study investigates changes in performance parameters and potential injury risk factors of the lower extremities of elite female handball players during the competition season. **Methods** 16 elite female handball players of the first national league (mean age 25.8 +/- 3.6 years) were tested at the end of the preparation (T1) and the first competition period (T2). The assessment included 20m sprint test, drop jump test (DJ), landing technique test (LESS), Functional Movement Screen (FMS) as well as lactate threshold test. Sprint times at 0-5m (t5) and 0-20m (t20), velocity (v) and heart rate (hf) at 4mmol blood lactate threshold, contact time (ts) and reactive strength index (RSI) as well as LESS Score and FMS Score were determined. T-test ( $p \leq 0.05$  criterion) and Cohens d were calculated. Results Sprint times for 5m (T1:  $1.2 \pm 0.1$ s; T2:  $1.2 \pm 0.1$ s) and 20m (T1:  $3.4 \pm 0.1$ s, T2:  $3.4 \pm 0.1$ s), FMS Score (T1: 17.3, T2: 17.5), hf (T1: 171, T2: 174bpm) and v (T1: 13.1m/s, T2: 13.2m/s) did not show any substantial differences for both measures. LESS Score decreased 14.5% (5.5 to 4.7) whereas RSI increased 4.8% (150 to 157). Both didn't show any statistical significance. Only ts decreased significantly ( $p = 0.012$ ;  $d = 0.388$ ) between T1 (194.4ms) and T2 (175.9ms). **Discussion** Changes of ts and RSI indicate an increased reactive strength of the lower extremities, whereas – in accordance to Granados et al. (2008) – sprint and endurance parameters remained stable. These findings confirm that a specific level of physical performance acquired in the preparation period can be maintained and partly improved during the first competition period in elite female handball players. In addition, the risk of being injured did not rise as potential injury risk factors decreased tendentially. For deeper insight in the development of performance parameters and injury risk factors longitudinal studies are needed that also consider how training contents and loads correspond with performance and risk of injury. **References** Granados, C., Izquierdo, M., Ibanez, J., Ruesta, M., & Gorostiaga, E. M. (2008). Effects of an entire season on physical fitness in elite female handball players. *Med Sci Sports Exerc*, 40(2), 351-361. doi: 10.1249/mss.0b013e31815b4905

### EFFECTS OF PRE-COMPETITIVE PREPARATION PERIOD ON THE EVOLUTION OF ISOKINETIC PROFILE IN INTERNATIONAL PROFESSIONAL HANDBALL PLAYERS

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**Introduction** Handball is a team sport played between two teams of seven players on an area of 40 m long and 20 m wide, for 2 periods of 30 min. In team sports, such as handball, in order to prepare for the very long period of competition, the pre-competitive preparation period (Pc2P) usually involves the development of technical and tactical qualities and those of all the physical qualities (Seo et al., 2015; Gorostiaga et al., 1999). Given the importance of the lower limb strength in handball, it seems interesting to analyze the influence of the Pc2P on the evolution of isokinetic muscle values (Crosier et al., 2008). Our hypothesis was that Pc2P may increase the maximum strength and power parameters of the flexor (Hamstring - H) and extensor (Quadriceps - Q) muscles of the knee joint. **Methods** 19 male handball players, all French or foreign international handball players, belonging to the Ligue 1 club Montpellier Agglomération Handball (MAHB - France), participated in this study. Pc2P, with a duration of 8 weeks, included three distinct phases. Firstly, a recovery phase of 2 weeks, with 3 sessions of strength training per week, devoted to the lower limbs. Secondly, a phase of 4 weeks, with 2 sessions of lower limb weight training per week. Finally, a final phase of two weeks, with 2 sessions per week. An isokinetic test protocol on dynamometer Biodex System 3® was carried out before and after the Pc2P. The evaluation was performed on the dominant and non-dominant leg in concentric ( $60^\circ \cdot s^{-1}$  and  $240^\circ \cdot s^{-1}$ ) and eccentric ( $30^\circ \cdot s^{-1}$ ) modality, in order to determine the peak torque (PT), average power (AP) and ratio, dominant and non-dominant leg (DNDR), agonist/antagonist (AAR) and combined (CR). Results At  $60^\circ \cdot s^{-1}$ , in concentric modality, the comparison of PT values, before and after Pc2P, shows no significant difference for Q. For H, we observed a significant increase ( $p < 0.001$ ) of PT on both sides. At  $240^\circ \cdot s^{-1}$ , in concentric modality, our results showed a significant increase (0.001

### EFFECT OF 3 VERSUS 3 SMALL SIDED HANDBALL GAME TRAINING ON AEROBIC CAPACITY AND ANAEROBIC ENDURANCE OF MALE HANDBALL PLAYERS

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**Introduction** Today handball is more dynamic and faster than ever before. During handball game players perform several high intensity repeated sprint bouts of short duration with partial rest (Póvoas et al. 2012; Sibila, Vuleta & Pori 2004) which is associated with good endurance capability and anaerobic endurance of players. Developing fitness through skill based conditioning is more suitable than traditional training. Small sided games are a type of skill based conditioning which combines both sports specific skills and fitness. Therefore, the aim of our study is to assess the effect of 3 versus 3 small sided handball game training on aerobic capacity and anaerobic endurance of male handball players. **Methods** Twenty four (24) male handball players were selected and randomly classified into two groups namely 3 versus 3 small sided handball training group (3 vs 3 = 12) and control group (CON = 12). Twenty four handball players were tested on aerobic capacity and anaerobic endurance before the start, at middle and after twelve weeks of training. The 3 versus 3 small sided handball training was performed three days per week for twelve weeks. To assess the training effect  $2 \times 3$  repeated measure ANOVA on last factor repeated was performed. Results The result of our study showed that six and twelve weeks of 3 versus 3 small sided handball game training significantly improved aerobic capacity ( $F = 51.36$ ,  $p = 0.000$ ) and anaerobic endurance ( $F = 32.48$ ,  $p = 0.000$ ) of handball players. **Discussion** The result of our study showed that 3 versus 3 small-sided handball game has large effect and which confirm that 8.66% improvement in aerobic capacity and anaerobic endurance by 6.74% improved after twelve weeks of training. Coutts and his colleagues (2010) clearly state that game based training improves both fitness (Chittibabu 2013) and skill. The improvement in  $VO_2$  max is associated with changes in cardiovascular function and anaerobic endurance is enhanced through faster lactate removal and PCr restoration, thus enhancing power and force recovery (Bassett et al. 1991). It is concluded that 3 versus 3 effective in improving

aerobic capacity and anaerobic endurance of male handball players. References Póvoas SC, Seabra AF, Ascensao AA, Magaihaes J, Soares JM, Rebelo AN. (2012). J Strength Cond Res, 26, 3365-3375. Sibila M, Vuleta D, Pori P. (2004). Kinesiology, 36: 58-68. Bassett DR, Merrill PW, Nagle F, Agre JC, Sampedro R. (1991). J Appl Physiol, 70: 1816-1820. Coutts AJ, Hill-Haas S, Moreira A, Aoki MS. (2010). Brazilian Journal of Sport and Exercise Research, 1(2): 108-111. Chittibabu B. (2013). International Journal of Physical Education, Fitness and Sports, 2(4): 4-7. b.chitti@hotmail.com

## Oral presentations

### OP-PM18 Training & Testing: Mixed session

#### CONTEMPORARY REFERENCE VALUES FOR PEAK OXYGEN UPTAKE IN HEALTHY EUROPEAN CHILDREN AND ADOLESCENTS

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Background Cardiopulmonary exercise tests (CPET) are widely used for the assessment of cardiovascular and respiratory capacity during exercise. Ever since its introduction, CPET measures have been compared with a normal reference frame. Most available reference values are based upon older studies. However, times change and so do lifestyles. In that view, reference values should be regularly updated and validated. Furthermore, exercise capacity shows a large variability and thus reference values are ideally obtained from large samples of the population, which has often not been the case. Therefore the aim of this study was to obtain contemporary reference values for peak VO<sub>2</sub> and establish prediction equations for healthy boys and girls. Methods Between January 2000 and April 2015, 1580 healthy children (1010 boys; mean age 12.4 years; range 5-18) completed a maximal graded exercise test until exhaustion either on a bicycle or on a treadmill. Minute ventilation, oxygen uptake (VO<sub>2</sub>), and carbon dioxide (CO<sub>2</sub>) production were measured on a breath-by-breath basis and continuous electrocardiography was performed. Peak VO<sub>2</sub> was expressed in mL/min and mL/min/kg. Prediction equations based on sex, age, weight and height were calculated by means of regression analysis and cross-validated through concordance correlation coefficient determination and Bland-Altman analyses. LMS chart maker was used to provide age-related percentile curves. Results Multivariate regression analysis revealed age, sex and weight as statistically significant determinants of peak VO<sub>2</sub>. Hence, following prediction equation was established and cross-validated: peak VO<sub>2</sub>=44.5-218\*sex+27.1\*age+37.4\*weight (p≤0.001; sex=0 for boys and sex=1 for girls). Finally, the distribution of peak VO<sub>2</sub> per kg body weight with age was described by percentile curves and reference values were established for boys and girls of less and more than 12 years old, separately. Conclusions Our study is the largest and most recent population-based study to provide sex-specific reference data and prediction equations for peak VO<sub>2</sub> for a West-European population of healthy children between the ages of 6-18 years.

#### A POST-SEASON SHORT DURATION MESOCYCLE FOR TAPERING IN WATER-POLO

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A post-season short duration mesocycle for tapering in water-polo Petros G. Bottonis, Argyris G. Toubekis, Theodoros I. Platanou Department of Aquatic Sports, School of Physical Education and Sports Science, University of Athens, Greece. Introduction In water-polo, although elite coaches' experience has been reported (Mujika, 2009), no scientific evidence exist regarding methods of effective tapering prior to a series of critical matches usually playing post-season. The aim of the present study was to examine the effectiveness of a four-week mesocycle, including an overloaded (week 1 and 2) and a reduced training load periods (week 3 and 4), on wellness, swimming performance and perceived internal training load (ITL) in water-polo players preparing for play-offs. Methods Eight national-level water-polo players (age: 25±7 years, body height: 181±5 cm, body mass: 84±7 kg) participated in the study. ITL was estimated using the session-RPE method and perceived ratings of wellness (e.g. fatigue, muscle soreness, sleep quality, stress level and mood) (Hooper & Mackinnon, 1995) were assessed daily. Sport-specific performance was evaluated through 400-m and 20-m tests performed before (baseline) and after overloading training as well as at the end of reduced training load phases. Analysis of variance for repeated measurements on dependent samples was employed to detect differences between training phases. A Tukey post-hoc test was used for multiple comparisons. Correlation coefficient (r) was used to test the associations between changes (Δ) in performance variables and the respective changes in ITL, wellness, sleep quality, fatigue perception muscle soreness, stress level and mood state across the training weeks. Statistical significance was set at p<0.05. Results In week 3 and 4, ITL was reduced compared to week 1 by 19.0±3.8% and 36.0±4.7%, respectively (p=0.00 and p=0.00). Wellness was significantly improved in week 4 compared to weeks 1 and 2 (p=0.00). At the end of the mesocycle, swimming performance at 400-m and 20-m tests was improved compared to baseline (0.8±0.6% and 2.1±2.2%, respectively, p<0.05) and overloading training period (1.3±0.8% and 2.5±2.8%, respectively, p<0.05). High correlations were observed between the percentage reduction of ITL (week 4-1) and the respective changes in 20 m swim time (r=0.88, p<0.01), in fatigue perception, muscle soreness, stress levels and the overall wellness scores (r=0.74-0.79, p<0.05). Discussion The reduction of ITL improved the overall perceived wellness and sport-specific swimming performance of players. The abovementioned approach might be an effective training strategy in the lead-up to play-offs tournament providing useful and practical tool for screening changes in wellness and recovery status of the players. References Hooper SL, Mackinnon LT. (1995) Sports Med, 20, 321-327. Mujika I. (2009). Tapering and peaking for optimal performance. Champaign, IL: Human kinetics. Contact pboton@phed.uoa.gr

#### EFFECT OF STATIC AND DYNAMIC STRETCHING DURING A FULL WARM-UP ON ATHLETIC PERFORMANCE IN ATHLETES

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Introduction Significant evidence indicates that static muscle stretching can acutely reduce muscle force/power production whilst dynamic stretching may increase it. However, study designs have not been appropriate in the majority of studies to determine whether muscle stretching affects performance when it is performed within a full, sports-specific warm-up (Behm et al. 2016). We aimed to determine the

effects of static and dynamic stretching during a 'sport-specific warm-up' on running, jumping, agility and flexibility performances in athletes. Methods Twenty men competing in running-based sports completed a familiarization and four weekly testing sessions. Using a randomized, cross-over design the subjects performed 5-s static passive stretches of lower limb muscles, 3x10-s static stretches, dynamic stretches (5 reps/leg, identical body positions to static stretches) or a non-stretch control condition within a warm-up (5-min general warm-up before stretch, and test-specific, progressive warm-up including maximal efforts after stretch). Researchers were blinded to the warm-up condition, and subjects nominated which condition they believed would yield best performance before the study (subject-level bias) as well as their perception of 'preparedness' (1-10 scale) after each warm-up condition. Results Eighteen of 20 subjects believed that dynamic stretching would yield best performances, however no between-condition differences ( $p=0.23-0.99$ ) were detected in: (1) 5 m, 20 m or 10-20 m sprint times, (2) squat, countermovement or 3-step running jump heights, or (3) agility T-test time. Magnitude-based inference statistics showed a high likelihood of 'trivial' changes. Small and equal post-warm-up increases in sit-and-reach flexibility (1.9-2.4 cm,  $p<0.01$ ) were achieved in the stretch conditions compared to no stretch. Subjects typically felt more prepared ( $>5.2/10$ ) for testing when some stretching was performed (no stretch= $3.9/10$ ), with no differences between conditions. Discussion No stretch-specific effect on performance was observed when a warm-up protocol that included low-intensity exercise before muscle stretching was followed by a progressive, test-specific warm-up to maximum exercise intensity in athletes. Thus, although subjects felt better prepared for exercise, short- (5 s) or moderate-duration (30 s) static stretching or dynamic stretching had no group-level effect on performance when used in a full warm-up. Subject belief (i.e. subject-level bias) also did not influence test performances. Based on current and previous data, and contradictory to (some) current recommendations, muscle stretching appears not to influence physical performance when used as part of a full 'sport-specific warm-up' in athletes. Reference Behm D., Blazevich A.J., Kay A.D., McHugh M. (2016). *Appl Physiol Nutr Metab*, 41, 1-11. Contact a.blazevich@ecu.edu.au

### MUSCLE METABOREFLEX: POSSIBLE EFFECT ON ARTERIAL BAROREFLEX FUNCTION AT REST

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Introduction Arterial baroreflex is a determinant of cardiovascular regulation both at rest and during exercise (Rowell and O'Leary, 1990). Furthermore, it has been shown that muscle metaboreflex activation during dynamic exercise may influence the arterial baroreflex sensitivity (BRS) (Ichinose et al., 2014). However, it is not known whether muscle metaboreflex activation via muscle blood flow restriction modifies per se or in combination of muscular contraction the BRS. The aim of this study was to investigate whether restriction of muscle blood flow affects the function of arterial baroreflex. Methods A group of 26 healthy subjects, aged  $33\pm2$  yrs, participated in this study. Cardiovascular response, muscle and cerebral oxygenation were continuously recorded during a resting period of 10 minutes under two separate experimental conditions: (a) with thigh cuffs (C) inflated to 120 mmHg on both legs and b) without cuffs (NC). Furthermore, BRS (in ms/mmHg) was assessed by the sequence method using Beatscope software. Results Cuff inflation effectively reduced muscle oxygenation as indicated by the increase of  $\Delta[\text{HHb}]$  (NC:  $-0.12\pm0.21$   $\mu\text{M}$  vs. C:  $11.28\pm1.15$   $\mu\text{M}$ ,  $p<0.001$ ) and the decrease of  $\Delta$ (difference between  $\text{O}_2\text{Hb}$  and  $\text{HHb}$ ) (NC:  $0.15\pm0.44$   $\mu\text{M}$  vs. C:  $-8.89\pm1.07$ ,  $p<0.001$ ). Muscle blood flow restriction did not affect the cardiovascular response, i.e. heart rate and arterial blood pressure, whereas BRS was significantly reduced (NC:  $11.20\pm0.57$  ms/mmHg vs. C:  $9.79\pm0.57$ ,  $p=0.009$ ). Furthermore, cerebral oxygenation was affected by muscle blood flow restriction. Specifically,  $\Delta[\text{HHb}]$  was increased (NC:  $-0.24\pm0.06$   $\mu\text{M}$  vs. C:  $0.35\pm0.19$   $\mu\text{M}$ ,  $p=0.004$ ) and  $\Delta$ (difference between  $\text{O}_2\text{Hb}$  and  $\text{HHb}$ ) was decreased (NC:  $-0.24\pm0.06$   $\mu\text{M}$  vs. C:  $0.35\pm0.19$   $\mu\text{M}$ ,  $p=0.004$ ), whereas  $\Delta[\text{O}_2\text{Hb}]$  (NC:  $0.51\pm0.15$   $\mu\text{M}$  and C:  $0.09\pm0.29$   $\mu\text{M}$ ,  $p=0.19$ ) and  $\Delta\text{THb}$  (NC:  $0.25\pm0.13$   $\mu\text{M}$  vs. C:  $0.50\pm0.37$   $\mu\text{M}$ ,  $p=0.54$ ) were not significantly affected. Discussion Muscle blood flow restriction via thigh cuffs inflation at 120 mmHg may not be enough to activate muscle metaboreflex pressor response at rest. However, the reduction of BRS indicates that a greater increase of external thigh pressure was probably required for a metaboreflex response to be exhibited. Interestingly, the reduction of muscle oxygenation at rest increases oxygen extraction at cerebral level, a phenomenon which may also contribute to the observed lower baroreflex sensitivity. References Rowell LB, O'Leary DS. (1990) Reflex control of the circulation during exercise: chemoreflexes and mechanoreflexes. *J Appl Physiol*, 69, 407-418. Ichinose M, Maeda S, Kondo N, Nishiyasu T. (2014). Blood pressure regulation II: what happens when one system must serve two masters – oxygen delivery and pressure regulation? *Eur J Appl Physiol*, 114, 451-465. Contact ngeladas@phed.uoa.gr

## Oral presentations

### OP-PM24 Indicators of Fatigue

#### SUBJECTIVE INDICATORS OF FATIGUE IN FOOTBALL - EFFECTS OF FATIGUE STATUS AND SUBJECT IDENTITY

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Introduction Current athlete monitoring approaches in many sport settings use a mix of subjective and objective indicators of fatigue. Whilst, there is recent evidence to suggest subjective measures reflect training load with greater sensitivity and consistency than objective measures (1,2), the appropriateness of a fatigue indicator will ultimately be determined by its long-term diagnostic accuracy, along with its potential sources of variability and bias. Thus, this study aims to analyse the inter- and intra-individual variability of football players' subjective ratings of wellness during the seasonal competition phase. Methods 35 male football players (1st League Australia,  $25.3 \pm 4.8$  y) participated in the study. Individual perceptual ratings of wellness (fatigue (F), sleep quality (SQ), muscle soreness (MS), stress (S) and mood (M)) were repeatedly collected during the competition phase of a football season using a previously published questionnaire (3). Individual's ratings were retrospectively classified into 'fatigued' and 'recovered' states according to recent physical load. Players were defined as fatigued after performing  $>30$  match-day minutes and as recovered when they had  $>1$  post-match rest/recovery day. A minimum of 6 observations per fatigue and subsequent recovery status was necessary to be included for analysis ( $n=14$ ). Variability was then analysed using a mixed effects model (fixed factor: fatigue status, random factor: subject ID and fatigue status-by-subject ID interaction). Results The fixed effect of fatigue status was highly significant for all fatigue parameters ( $p < 0.001$ ). The proportion of total variability attributable to fatigue status-by-subject ID was: W (40.7%), F (34.2%), SQ (19.4%), MS (21.8%), S (18.5%), and M (17.6%). Between-subject variability (random effect subject ID) was calculated to be redundant for F, SQ and W and very small for M (4.6%) and S (9.1%). Discussion The current study indicates that fatigue status-by-subject ID interaction ('individual response') explains a substantial proportion of variability

ity in subjective ratings of fatigue in elite football players. By contrast, between-subject variability in fatigued and recovered ratings was small. Thus, when longitudinally examining the fatigue status of a footballer it is relevant to consider inter-individual differences in the magnitude of fatigue induced changes in ratings of subjective wellness. References 1. Thorpe, R. T., Strudwick, A. J., Buchheit, M., Atkinson, G., Drust, B., Gregson, W. (2015) *Int J Sports Physiol Perform*, 10(8), 958-64. 2. Saw, A.E., Main, L.C., Gastin, P.B. (2015) *Br J Sports Med*, 0, 1-13. 3. McLean, B.D., Coutts, A.J., Kelly, V., McGuigan, M.R., Cormack, S.J. (2010) *Int J Sports Physiol Perform*, 5, 367-383. Contact [denny.noor@uni-saarland.de](mailto:denny.noor@uni-saarland.de)

## INDICATORS OF FATIGUE IN FOOTBALL – EFFECTS OF FATIGUE STATUS AND SUBJECT IDENTITY

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**Introduction** Large variability has been reported for indicators of exercise induced physical fatigue (1,2). This obviously impedes on their diagnostic accuracy. However, despite the practical importance of monitoring fatigue, not much data about the sources of this variability is currently available. Therefore, this study aims to analyse the inter- and intra-individual variabilities in indicators of physical fatigue during in-season training phases in football players. **Methods** 41 male football players (4th League Germany,  $26.5 \pm 4.2$  y) participated in the study. Within a period of 3 months in the regular football season venous blood samples (analysed for CK and UREA) and counter movement jump (CMJ) performances were collected repeatedly in 'fatigued' and 'recovered' states. Players were defined as fatigued after performing >2 training sessions within 48h and as recovered when they had at least 1 day off. Training load was documented throughout data collection. A minimum of 3 observations per fatigue status was necessary to be included for analysis ( $n = 35$  included). Standard error of measurement expressed as a percentage of the groups mean score (coefficients of variation (CV)) for CK, UREA and CMJ was calculated. Variability was analysed using a mixed effects model (fixed factor: fatigue status, random factor: subject ID and fatigue status-by-subject ID interaction). Results CV for fatigued values was: CK: 52.3%, UREA: 14.6%, CMJ: 4.3%; and for recovered values: CK: 45.2%, UREA: 14.0%, CMJ: 4.5%. The fixed effect of fatigue status was highly significant for CK and UREA ( $p < 0.001$ ) but not significant for CMJ ( $p = 0.49$ ). The proportion of total variability attributable to subject ID was 37.9% for CK, 54.7% for UREA and 64.8% for CMJ. Fatigue status-by-subject ID interaction accounted for only 1.1% of total variability for CK and 0.5% for UREA. **Discussion** The current analysis indicates a high inter- as well as intra-individual variation in fatigue induced changes of CK, UREA and CMJ. By contrast status-by-subject ID interaction ('individual response') is negligible. Regarding the large between subject variability individualised interpretation using baseline measurements might lead to greater accuracy in the monitoring of the fatigue status in footballers. References 1. Meeusen R, Duclos M, Foster C, Fry A, Gleeson M, Niemann D, Raglin J, Rietjens G, Steinacker J, Urhausen A. (2013). *Med Sci Sports Exerc*, 45(1), 186-205. 2. Hecksteden A, Skorski S, Schwindling S, Hammes D, Kellmann M, Pfeiffer M, Ferrauti A, Meyer T. (2016) *PLoS One* in press.

## RELIABILITY OF A FATIGUE RESPONSE IN ELITE YOUTH FOOTBALL PLAYERS

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**Introduction** In football, reliable and time-efficient methods of player monitoring are desirable as the effects of prior football-specific exercise may dictate the programming of subsequent training loads. Therefore, this study aimed to assess the reliability of different methods of assessing the fatigue response to a standardised exercise bout. **Methods** In 12 elite youth football players and for two consecutive weeks, subjective ratings of wellness (fatigue, sleep quality, muscle soreness, stress and mood), indices of jump height (countermovement jump; CMJ, squat jump; SQJ, and drop jump; DJ-H), drop jump contact time (DJ-CT), drop jump reactive strength index (DJ-RSI), as well as locomotor profile recorded during a sub-maximal run, requiring players to complete a 20 m shuttle run at a speed of 12 km.h<sup>-1</sup>, whilst wearing a 100-Hz tri-axial accelerometer (Kionix: KXP94, Minimax S4, Catapult Sports). Accelerometer data collected was analysed for PlayerLoad (PL) in the anteroposterior (Fwd), mediolateral (Side) and vertical (Up) planes with the percent contribution of each plane retrospectively analysed. Testing took place over four consecutive days, leading up to and following a standardised football training session including: a repeated sprint protocol, possession drills and small sided games. A magnitude based inference approach (>75% likelihood of the effect size; ES, being greater than or equal to  $\pm 0.2$  pre-post exercise) determined the effect of training. Using data collected 24 h post exercise for two consecutive weeks the reliability of the fatigue response was expressed as a coefficient of variation (CV; %) and intraclass correlation (ICC). Results Substantial changes 24 h post exercise existed for sleep quality, muscle soreness, total wellness, DJ-H, DJ-RSI and all locomotor profile variables except PL (ES -1.27 - 0.46). However, when comparing the response 24 h post exercise over both weeks of testing, a reliable fatigue response was only found for DJ-H (CV 7.0%, ICC 0.84), DJ-RSI (CV 8.6%, ICC 0.93), PL Fwd (CV 10.9%, ICC 0.85), PL Side (CV 6.1%, ICC 0.84), PL %Fwd (CV 5.1%, ICC 0.90) and PL %Up (CV 4.6%, ICC 0.76). **Discussion** Drop jump height, reactive strength index and a number of locomotor profile variables, in particular PlayerLoad Side and % Fwd were reliably able to detect a training induced fatigue response in elite youth football players. These specific variables could therefore be employed prior to training to assess residual fatigue in an applied environment.

## DOES ACUTE FATIGUE AFFECT PLAYER LOAD DURING AN AGILITY TASK?

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**Introduction** Accelerometers have been used to quantify deceleration (Nedergaard et al., 2014) and may be useful for monitoring neuromuscular fatigue (Buchheit et al., 2015). Whether they can be used to quantify fatigue-induced changes in loading during reactive agility tasks is unknown. Therefore, the aim of this study was to examine the differences in loading during an agility test (AT) before and after an acute bout of fatigue (AFT). **Methods** Seven male trained soccer players (mean $\pm$ SD age:  $26.1 \pm 5$ y, weight:  $72 \pm 8$ kg, height:  $174 \pm 7$ cm) were fitted with 100Hz integrated tri-axial accelerometers (Catapult S5, Catapult innovations, Canberra) at the scapulae (SCAP) and right (R) and left (L) ankle. Following a standardized warm-up participants performed a 20m maximal sprint and upon hearing an audio signal would decelerate, change direction (180°) and return to the start line. The audio signal was randomly provided at 1.0, 1.5 and 2.0s with players performing 2 repetitions for each time condition both pre- and post-AFT (12 in total). The AFT consisted of maximal 25m (2x12.5m) shuttle sprints interspersed with 20s rest. The test was ceased when a 5% decrement in sprint performance was reached. Load was measured using the player load variable (PL) and its tri-axial components. Repeated measures ANOVA was used to compare temporal differences across the AFT and the magnitude of the effects (ES) was calculated. A paired-sample t-test was conducted to examine differences in stride variables (e.g. number of steps and distance covered) between pre- and post-fatigue. Results A 5% sprint decrement ( $p < 0.01$ , ES: -



2.5) corresponded to average decrease in PL of 19.9, 23.3, and 17.3% ( $p < 0.01$ , ES: 1.4-2.34) for SCAP, R and L. The AFT did not have a statistically significant effect on PL ( $p > 0.05$ ) during any of the agility tests (ES: trivial to small in all unit locations, 0.1-0.4). The vertical component of PL was 5 times higher at the ankles compared to SCAP. No changes were observed for stride variables ( $p > 0.05$ ). Discussion A 5% reduction in sprint performance was associated with a 4-fold larger reduction in PL, possibly due to reduced vertical stiffness (Girard et al., 2011). Our findings may support the use of accelerometers to monitor fatigue as well as quantifying player load during agility tasks. The use of accelerometers may also provide practical insight into the changes experienced during agility tasks. References Buchheit M, Gray A, Morin JB (2015). *Journal of Sports Science and Medicine*, 14, 698-701. Girard O, Micallef JP, Millet GP (2010). *European Journal of Applied Physiology*, 111, 125-134. Nedergaard NJ, Kersting U, Lake M (2014). *Journal of Sports Science*, 32, 1897-1905. Contact: joao.marques@aspetar.com

## DIFFERENCES IN STRENGTH, POWER AND FATIGUABILITY BETWEEN ALPINE SKIERS OF FIS WORLD CUP AND EUROPEAN CUP

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**Introduction** Physical and technical abilities are important factors for alpine skiing performance. Races are high-intensity exercises of short duration (60-120s) requiring repeated high-force isometric and eccentric contractions (Ferguson, 2010). Aerobic capacity, strength, power and muscle fatigue are all considered crucial for success but limited information is available on top level and elite athletes (Neumayr et al., 2003). The aim of this study was to compare World Cup (WC) and European Cup (EC) skiers. **Methods** At the end of the preparation period, 26 male (12 WC and 14 EC) and 20 female (9 WC and 11 EC) skiers performed a peripheral knee extensors (KE) neuromuscular assessment, a counter-movement jump test (CMJ) and an incremental cycling test to exhaustion. Athletes also completed a specific test consisting of 3 sets of eccentric/concentric fixed workloads normalized per body weight with durations of 20, 60 and 90 s on a custom-built isokinetic horizontal leg press (LP). Decrements (baseline to after 90s LP) in CMJ and KE evoked twitches were used as a measure of fatigability. Comparisons between WC and EC were assessed for each gender. Data was analyzed using a magnitude-based inference approach. Percent differences ( $\pm 90\%$  confidence interval) and Cohen's d are presented. **Results** An almost certain difference in age was found for males ( $33 \pm 8\%$ , 1.66) and females ( $36 \pm 18\%$ , 1.97). Differences in anthropometric,  $\dot{V}O_2$  peak and peak power output during incremental test were unclear in both genders (trivial/small d). CMJ height reported a very likely difference only in males after 90s LP ( $11 \pm 8\%$ , 0.90). CMJ absolute peak power differences were very likely ( $12 \pm 9\%$ , 0.89) after 90s LP for males and likely ( $-7 \pm 9\%$ ,  $-0.55$ ) at baseline, but unclear ( $-3 \pm 10\%$ ,  $-0.22$ ) after 90s LP for females. CMJ absolute peak force differences were unclear at baseline (males  $5 \pm 9\%$ , 0.30; females  $5 \pm 8\%$ , 0.42) and became very likely for males ( $12 \pm 8\%$ , 1.01) and likely for females ( $11 \pm 10\%$ , 0.81) after 90s LP. Evoked KE peak torque differences after 90s LP were very likely for both males ( $73 \pm 60\%$ , 1.00) and females ( $57 \pm 96\%$ , 0.51). **Discussion** Strength and power levels of WC and EC skiers were not substantially different at baseline in most of the investigated parameters. However, sizable differences between the two groups, detected after 90s LP, suggest lower levels of fatigability in both male and female WC skiers. The longer period of specific practice for WC skiers can be a factor explaining the present findings. **References** Ferguson RA. (2010). *Exp Physiol* 95(3), 404-10. Neumayr G, Hoernagel H, Pfister R, Koller A, Eibl G, Raas . (2003). *Int J Sports Med*, 24, 571-75. Contact andrea.bosio@mapeisport.it

## OPTIMISATION OF ASSESSMENT OF HEART RATE KINETICS FOR TRACKING FATIGUE-INDUCED PERFORMANCE DECREMENTS

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**Background:** High volumes of physical training are required to generate physiological adaptations that improve performance, but can also lead to fatigue and temporary decrements in performance. Being able to quantify fatigue induced performance decrements to gain insight into an athlete's readiness to perform exercise could be useful for adjusting training and competition schedules. The maximal rate of increase in heart rate (rHRI) is assessed during 5 min of exercise, when transitioning from rest-exercise or from one workload to another, and has been shown to track fatigue induced performance decrements. Whether rHRI also tracks performance changes if assessed over shorter time periods has not been assessed. **Method:** Data from 15 athletes were collected prior to and after a period of heavy, fatigue inducing running training (HT). HR data was collected as R-R intervals pre-exercise and during 4 separate 5-min treadmill running tests: at 8 km/h (a workload primarily reflecting cardiac parasympathetic withdrawal; rHRIPNS), 10.5 km/h (rHRI10.5), and 13 km/h (rHRI13), and during a transition from 5 min of running at 8 km/h to 5 min of running at 13 km/h (a shift in intensity primarily reflecting cardiac sympathetic activation; rHRISNS). rHRI was the first derivative maximum of a sigmoidal curve fit to differing durations (1, 2, 3, 4 and 5 min) of the HR data for each treadmill test. Running performance was assessed using a 5 km treadmill time trial (5TTT) prior to and after HT to provide an index of the effects of the fatigue-inducing HT on exercise performance. **Results:** Time to complete 5TTT slowed from pre- to post-HT (Pre  $1132.1 \pm 121.9$  sec, Post  $1154.8 \pm 122.0$  sec,  $P = 0.002$ ). No method of assessment resulted in a change in rHRI from pre- to post-HT ( $P = 0.064$  to  $0.931$ ). Significant negative correlations were found for the 2 min assessment time in rHRIPNS ( $P = 0.04$ ,  $r = 0.38$ ) and the 1 minute assessment time during rHRISNS ( $P = 0.01$ ,  $r = 0.44$ ). Borderline significant correlations were found for the 3 and 1 min intervals during rHRIPNS (3 min:  $P = 0.05$ ,  $r = 0.36$ ; 1 min:  $P = 0.05$ ,  $r = 0.36$ ), and during the 3 and 2 min intervals during rHRISNS (3 min:  $P = 0.06$ ,  $r = 0.36$ ; 2 min:  $P = 0.06$ ,  $r = 0.37$ ). **Discussion:** Changes in 5TTT performance were better tracked by changes in rHRI assessed over periods  $\leq 2$  min. This suggests that exercise induced fatigue primarily influences HR kinetics during the first minutes of exercise following a change in exercise intensity, with changes in performance being tracked most strongly when rHRI was modelled using the first 1 min of data during a transition from running at 8 km/h to 13 km/h. Assessment of readiness to perform exercise using a two-stage rHRI protocol with a short duration may provide useful information for informing training and competition schedules.

## Oral presentations

### OP-PM10 Muscle Growth

#### THE EFFECT OF A FAILURE- VERSUS A SUBMAXIMAL BLOOD FLOW RESTRICTION PROTOCOL ON CHANGES IN NUMBER OF MYONUCLEI, SATELLITE CELLS AND MUSCLE SIZE

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**INTRODUCTION:** Low-load blood flow restriction resistance exercise (BFRRE) has been shown to induce a robust increase in muscle size, number of myonuclei and satellite cells (SC) when conducted to voluntary failure (1). However, the importance of BFRRE to failure on cellular adaptation has not been investigated. The purpose of the present study was to compare the effect of a failure- vs. a submaximal BFRRE protocol on the changes in number of satellite cells, myonuclei and muscle size over a period of two blocks with 7 BFRRE bouts (within 5 days), interspersed by 10 days rest. **METHODS:** Seventeen (18-45 yrs) untrained male participants had their legs randomly assigned to either failure- (FA; four sets to voluntary failure) or submaximal protocol (SU; 30-, 15-, 15-, 15 repetitions) using unilateral knee extensions at 20% of 1 repetition maximum (1RM) with 30 seconds rest between sets. BFRRE was conducted with partial blood flow restriction (100mmHg) induced by a pressure cuff with a 135mm pressure zone. Muscle biopsies were taken from both legs in m.vastus lateralis (VL) at baseline, during and 10 days post intervention. Biopsies were cut in 8 µm thick cross sections and stained against SC (NCAM + Laminin), myonuclei (DAPI) and fiber type (SC71 + dystrophin). Fluorescence microscope was used to quantify SC and myonuclei. Muscle thickness of VL was measured using ultrasound imaging. Strength was measured as 1RM in knee extension. **RESULTS:** The number of myonuclei increased significantly in both type 1 (mean±SD) FA: 12±16%; p=0.02 vs. SU: 17±16%; p=0.002, respectively) and type 2 fibers (FA: 20±17%; p<0.001 vs. SU: 23±13%; p<0.001, respectively) compared to baseline. Both groups increased the number of satellite cells significantly in type 1 (FA: 134±149%; p=0.03 vs. SU: 92±20%; p=0.003), but the number of satellite cells in type 2 fibers did not change in any of the groups. Muscle fiber area decreased in type 1 fibers in the failure leg (-10±16%; p=0.02), whereas it remained unchanged in the submaximal leg. Muscle thickness increased significantly in the failure leg (6.6±5.7%; p<0.001), while the submaximal leg had a tendency to increase (p=0.08) compared to baseline. 1RM in knee extension increased significantly in the failure leg (9±8%; p<0.001) and in the submaximal leg (11±7%; p<0.001) after 24 days post intervention. No group differences were observed in changes in number of myonuclei, satellite cells, muscle thickness or 1RM in post intervention. **DISCUSSION:** Both BFRRE protocols increased the number of myonuclei in type 1 & 2 myofibers, as well as satellite cells in type 1 myofibers. We did not observe any group differences in changes of myonuclei addition, satellite cell proliferation, muscle size or 1RM. Surprisingly, type 1 muscle fibre area was reduced in the failure leg, and the possible mechanisms warrants further investigations. **REFERENCES** (1) Nielsen JL, et al. (2012) J Physiol 590: 4351-4361. **CONTACT:** Rob.branko@gmail.com

#### MUSCLE ADAPTATION THROUGHOUT RESISTANCE TRAINING: INTEGRATED MYOFIBRILLAR PROTEIN SYNTHESIS MODULATION AND THE ROLE OF MUSCLE DAMAGE IN HYPERTROPHIC RESPONSES

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**Introduction** Muscle hypertrophy is one of the main outcomes from regular resistance training (RT) practice, but how it is modulated throughout training and the mechanisms regulating it are still obscure. It is known that intermittent increases in myofibrillar muscle protein synthesis (MPS) after RT bouts accumulate increasing muscle cross-sectional area (CSA). Indeed, studies have shown a qualitative agreement between MPS and hypertrophy, but, intriguingly we and others (1,2) recently reported that infusion-derived MPS, measured through hours after the first RT bout, did not align with the eventual hypertrophy after RT. Whether this have a physiological mechanistic reason as MPS was measured only after the first bout when, for example, muscle damage is highly pronounced burdening MPS to regenerate the tissue, or if it just a method issue (infusions trials, through hours only) of measuring MPS is not known. To explore this further, we used an integrated approach to measure MPS using deuterium-oxide and assessed muscle damage parameters, at the beginning (T1), 3wk into training (T2), and at 10wk of RT (T3). **Methods** Ten young men (age: 27±1 y; BMI: 23.6±1.0 kg·m<sup>-2</sup>) were evaluated for muscle and fiber CSA by ultrasound at T1, T2 and T3 of RT. Integrated MPS analysis through D2O ingestion and muscle damage through Z-band streaming assessments were conducted before and 48h after the RT bout at T1, T2, and T3. **Results** Hypertrophy only occurred significantly at T3. 48h integrated MPS increased after the RT bout at the 3 evaluation weeks, but the increase was greater at T1 than T2 and T3 (similar values at T2 and T3). Z-band streaming increased at T1, was mildly attenuated at T2 and strongly reduced at T3. Increases in MPS at both T2 and T3, but not at T1, were correlated (r~0.9, p<0.05) with hypertrophy. No significant correlations were found between muscle damage and hypertrophic responses. **Discussion** Integrated MPS assessed at different phases of RT allowed a more precise and encompassing measurement to capture its contribution to chronic hypertrophy. At T1 muscle damage is the highest and MyoPS do not correlate with hypertrophy, and at T2 and T3 damage is progressively attenuated reaching a minimal magnitude, but MPS is highly correlated with hypertrophy. These facts added to the absence of any correlations between damage and MPS or hypertrophy precludes any role for muscle damage in hypertrophic responses. **References** 1) Mitchell et al. (2014). PLoS One, 9(2), e89431. 2) Mayhew et al. (2009). J Appl Physiol, 107(5), 1655-62. **Contact** felipedamas@usp.br

#### SPARC PROTEIN EXPRESSION IN RESPONSE TO RESISTANCE EXERCISE TRAINING IN IMMOBILIZED RAT SKELETAL MUSCLE.

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**Abstract Introduction:** Secreted protein acidic and rich in cysteine (SPARC) is related to skeletal muscle atrophy.(1) Here, we investigated the effects of resistance ladder training on SPARC and examined SPARC expression during pre-training and following muscle atrophy in fast-type dominant muscle. We also hypothesized that resistance exercise training would improve muscle quality and alleviate increased SPARC protein expression in the rat atrophy model. **Methods:** Male Sprague-Dawley rats underwent resistance ladder training for 12

weeks and hindlimb immobilization for 7 days. Grip strength and muscle cross section areas were measured. SPARC protein expression in the plantaris, soleus, and serum after exercise training and immobilization were then analyzed. Results: Resistance training affects body weight ( $P < 0.001$ ) and skeletal muscle mass (Soleus;  $P < 0.01$ , plantaris;  $P < 0.05$ , gastrocnemius medialis;  $P < 0.05$ ) as well as the grip strength ( $P < 0.001$ ) in normal and atrophy conditions. In the plantaris, muscle atrophy after hindlimb immobilization was alleviated by resistance training (31.82%). SPARC level of plantaris muscle was also alleviated in atrophy-induced rats after exercise ( $P < 0.05$ ). Conclusion: We identified an association between resistance training and SPARC protein expression in atrophy-induced skeletal muscle. Furthermore, we demonstrated a possible compensatory effect for SPARC protein expression in skeletal muscle. Thus, SPARC would be a useful therapeutic target to overcome muscular atrophy and sarcopenia. Reference [1] Nakamura K, Nakano S, Miyoshi T, Yamanouchi K, Nishihara M. Loss of SPARC in mouse skeletal muscle causes myofiber atrophy. *Muscle Nerve* 2013;48:791-799

### THE LEVEL OF 44/42 KDa MAPK PROTEIN IS CLOSELY RELATED TO THE FIBER TYPE COMPOSITION IN HINDLIMB SKELETAL MUSCLES OF SEDENTARY ADULT RATS AND IN THE SOLEUS MUSCLE DURING DEVELOPMENT

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Introduction: The relationship between the levels of mitogen-activated protein kinase (MAPK) and the phenotype of skeletal muscles is controversial (Dupont et al., 2011; Shi et al., 2008). To address this issue, we determined the relationship between the fiber type composition and the expression levels of 44/42 kDa MAPK protein in hindlimb muscles of sedentary rats. Methods: Fiber type composition based on immuno-histochemical staining and the expression levels of phosphorylated 44/42 kDa MAPK protein by Western blotting were analyzed in two experiments (Exp.). Exp. 1: the soleus (Sol), plantaris (Plt), and deep and superficial portions of the gastrocnemius (Gasd and Gass) muscles were excised from 10-week-old male Wistar rats and analyzed. Exp. 2: the Sol was excised at various times between 3-65 weeks of age and analyzed. Results: Exp. 1: in descending order, the percent fast fiber type composition was Gass (100%) > Plt (83%) > Gasd (71%) > Sol (14%) and the level of phosphorylated MAPK (relative to the Sol level) was Gass (301%) > Plt (277%) > Gasd (151%) > Sol (100%). Exp. 2: the Sol of 3-week-old rats contained ~40% fast fibers and this gradually decreased to 1.5% at 65-week time point. The expression level of phosphorylated 44/42 kDa MAPK protein (relative to the 3-week level) in the Sol gradually decreased from 3- to 65-weeks, i.e., 100, 51, 41, 33, and 1% at the 3-, 10-, 20-, 46-, and 65-week time points, respectively. Discussion: The data show that there is a close relationship between the levels of phosphorylated 44/42 kDa MAPK and the percent fast fiber phenotype across hindlimb muscles at the adult stage and in the soleus muscle during development. Thus these results suggest that the levels of phosphorylated 44/42 kDa MAPK may play a regulatory role in determining the fast fiber phenotype composition of rat skeletal muscles. References: Dupont E, Cieniewski-Bernard C, Bastide B, Stevens L. (2011). *Am J Physiol Regul Integr Comp Physiol*, 300, R408-R417. Shi H, Scheffer JM, Pleitner JM, Zeng C, Park S, Hannon KM, Grant AL, Gerrard DE. (2008). *FASEB J*, 22, 2990-3000. Contact: oishi@gpo.kumamoto-u.ac.jp

### EXPRESSION OF METABOLIC AND MYOGENIC FACTORS DURING TWO COMPETITIVE SEASONS IN ELITE JUNIOR CYCLISTS

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Introduction It is not known whether the seasonal training patterns of endurance athletes produce corresponding adaptations of mitochondrial and myogenic processes and whether these relate to the metabolic load during exercise. Methods Ten male elite junior cyclists (mean  $\pm$  SE, 17.3  $\pm$  0.15 years) were monitored over two seasons of preparation and competition. Aerobic performance and content of mitochondrial proteins (NDUFA9, SDHA, UQCRC1, COX4A1, ATP5A1, UCP3), myogenic regulators (myogenin, myoD, Tenascin-C) and myosin heavy chain (MyHC) were determined in m. vastus lateralis after the preparation and competition phase. Results Energy spent in training was comparable in the preparation and competition phase of the first season (9354 and 9825 MET/week) but decreased to 6800 MET/week at the end of the second preparation phase. Average mitochondrial protein content changed in anti-cyclical pattern to VO<sub>2</sub> peak, capillarisation, satellite cell and myonuclear number and correlated with the METs spent in the preceding training phase ( $r=0.71$ ). Mitochondrial protein content was decreased after the first (-22%) and second (-45%) competitive phase, and increased (+21%) after the preparation phase. Tenascin-C (+34%) and myogenin (+166%) increased after the second preparation phase. Satellite cell number correlated with mitochondrial protein content ( $r=-0.65$ ), as well as with slow and fast type MyHC content ( $r=0.73$ ). Discussion The findings indicate a particular role of seasonal metabolic load for adjustments in muscle protein expression with training of elite junior cyclists and suggest that the capacity for mitochondrial biogenesis may become exhaust at the end of the competition phase when muscle enters a regeneration program. Contact mflueck@research.balgrist.ch

## Oral presentations

### OP-BN11 Performance Tests

#### A NEW INSTANTANEOUS PERFORMANCE PARAMETER FOR ALPINE SKIING AND INDIVIDUAL SPORTS

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Introduction To help gain insight into the intricacies of athlete performance in alpine ski racing, several measures of instantaneous performance have been proposed (Federolf, 2012; Supej, 2010). Since alpine ski races are held on inclined slopes, these instantaneous performance measures are usually expressed as functions of the instantaneous vertical altitude drop of the skier. (Supej, 2010) employed change in mechanical energy per altitude drop as a performance measure while (Federolf, 2012) employed difference in path length and speed per altitude drop as a performance measure. These measures are valid as long as the slope includes a vertical drop, but fail when the terrain is flat or uphill. Therefore, this study presents a new instantaneous performance measure that is independent of the slope inclination and therefore more applicable in the analysis of entire courses. Methods Athlete center of mass trajectories were cap-

tured by either video-based photogrammetry (Reid, 2010) or GNSS (Gilgien, 2015). Speed and path length were computed for each position along the trajectories (Reid, 2010). For each analyzed course, an average trajectory was calculated from the start to finish line based on all skier trajectories. A virtual plane was spanned normal to the average trajectory every 30 cm and was intersected with each of the single trajectories (Supej et al., 2011). At each intersection point, values for time, speed, path length and forces were interpolated and stored as a function of the distance from the start to the virtual plane in question. Results Instantaneous performance was expressed as time differences to the leader in the finish as a function of distance from start. To explain the differences in performance time, speed and path length were expressed as differences to the speed and path length values of the leader as a function of the distance from start. Forces were used in combination with time synchronized video of the skiing to explain the reasons for speed differences that occurred. Discussion Since GPS technology is applied in alpine skiing entire runs are tracked instead of some turns as it was common with video based photogrammetry. Hence, a larger range of terrain inclinations is included in the data sets, also flat and uphill terrain (Gilgien, 2015). The new performance parameter facilitates instantaneous performance analysis in any type of terrain and skiing discipline. The measures applies also to other individual sports like motorsport or cycling. References Federolf, P. (2011). J Sp Sci, 30, 1063-1068. Supej M, (2008). J App Biom, 24, 121-125. Reid R, (2010). Norw Scho Spo Sci, 1-371. Gilgien et al. (2015). J Spo Sci, 33, 960-969. Supej M, Holmberg HC. (2011). Res Qua Exerc Sp, 82, 400-411. Supej M, Kugovnik O, Nemec B. (2003). Kines Slov, 9, 11-17. Gilgien M, et al. (2015). PlosOne, 10, e0118119. Contact Matthias.gilgien@nih.no

## CONSTRUCT VALIDITY OF THE ELEMENTARY MOTOR SPEED ABILITY

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Introduction Rapid movements are connected with many terms, like quickness, speed, agility and power. Sheppard & Young (2006) reported on many studies of rapid complex movements. Later they derived for the training of agility and speed the influence of perception and anticipation. Voss, Witt and Werthner (2007) found the existence of elementary motor speed ability. These authors arranged reaction time, frequency speed, acyclic speed during reactive movements and non-reactive movements from defined preliminary tension or relative rest as categories of the elementary motor speed ability. Wenzel (2013) defined on the example of plantar flexion the speed with non-reactive movements as arbitrarily initiated. The purpose of this study was to inspect this theoretical construct of four elementary motor speed ability factors with an empirical data set using a confirmatory factor analysis (CFA). Methods First, with 78 students the reliability of 10 tests and 15 items were checked. Second, the construct validity with 214 students (95 women, age M = 21.54, SD = 2.47 and 114 men, age M = 22.39, SD = 2.64) were investigated, using the Maximum-Likelihood-Method (IBM SPSS Statistics, SPSS AMOS 21). The goodness-of-fit with the fit indices by Hu and Bentler (1999) were calculated. Results The valid model is based on simple and complex reaction speed, frequency speed and arbitrarily initiated speed. The global fit indices of the model are chi square = 86,08, df = 85, p = 0,447; CFI = 0,99; RMSEA = 0,009; SRMR = 0,071. The local fit indices were used for improvement of the model fit. Correlations were complemented on the residual variance based on the modification indices. All demands by Hu and Bentler (1999) are fulfilled for a good model fit. Discussion The reaction speed is integrated in a second order factor with the two factors simple and complex reaction speed. There is a middle correlation ( $r = 0.31$ ) between the reaction speed and frequency speed (tapping tests). The arbitrarily initiated speed is an independent factor. For the reactive speed only the test drop jump could be used, therefore, a factor could not be proved. Further investigations into the validity of the elementary motor speed ability are in preparation. References Hu L, Bentler PM (1999). Fit indices in covariance structure analysis: Conventional criteria versus new alternatives. Structural Equation Modeling 6(1), 1-55. Sheppard JM, Young WB. (2006). Agility Literature Review: classification, training and testing. Journal of Sport Sciences 24(9), 919-932. Voss G, Witt M, Werthner R. (2007). Herausforderung Schnelligkeitstraining. Meyer & Meyer, Aachen. Wenzel U. (2013). Zu ausgewählten Einflussfaktoren der willkürlich initiierten Schnelligkeit. Lehmanns Media, Berlin. Contact krug@rz.uni-leipzig.de

## VALIDATION OF DATA COLLECTED WITH MOBILE METABOLIC MEASUREMENT SYSTEMS OVER TIME DURING ACTIVE COMMUTING

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Introduction With the aim of attaining valid descriptions of metabolic demands during active commuting in greater Stockholm new approaches have been used. We have previously reported evaluations of a mobile metabolic measurement system both in the laboratory (Rosdahl et al. 2010) and during simulated field conditions, including check of stability over time (Salier-Eriksson et al. 2012). However, to be confident with the validity of the metabolic data collected over time during mobile field conditions we have used new approaches. Methods During the period of data collection in the field with the mobile metabolic system (Oxycon Mobile, JLAB 5.21, CareFusion, Germany) this was controlled once by the manufacturer and 11 times in our own laboratory using a commercially available metabolic calibrator (Vacumed, syringe No.1750 and mass flow controller No. 17052, Ventura, CA, USA). On each occasion VO<sub>2</sub> and VCO<sub>2</sub> were checked between 1 - 4 L/min with the corresponding VE at 40-160 L/minute and tidal volume at 2 L. The calibration information (offset, gain and delay time) from the O<sub>2</sub> and CO<sub>2</sub> analyzers and volume sensor, being collected pre and post the field commuting tests, was analyzed. Additionally, the results of each experiment was critically examined in several means including an inspection of parallelism in heart rate and VO<sub>2</sub>. Results and Discussion As examined with the metabolic calibrator, all parameters (VO<sub>2</sub>, VCO<sub>2</sub>, RER and VE) measured by the mobile metabolic system were in general well within the boundaries of acceptance. Adequate stability of the O<sub>2</sub> and CO<sub>2</sub> analyzers and volume sensors for the time duration of each experiment was confirmed by small differences in the pre- and post-calibration factors. Based on two researchers' ocular inspections of heart rate and oxygen uptake recordings during active commuting, all but one were rated as generally parallel, and thus passed this type of check of the field measurements. Overall, the present investigation favors that data collected over time with a mobile metabolic system can be validated by a combination of metabolic calibrator measurements, analyses of calibration information and a critical examination of the variables from each single measurement. References Rosdahl, H., Gullstrand, L., Salier Eriksson, J., Johansson, P. & Schantz, P. 2010. Evaluation of the Oxycon Mobile metabolic system against the Douglas bag method. Eur J Appl Physiol 109 (2):159-71. Salier Eriksson, J., Rosdahl, H. & Schantz, P. 2012. Validity of the Oxycon Mobile metabolic system under field measuring conditions. Eur J Appl Physiol, 112 (1): 345-355. Huszczuk, A., Whipp, B.J and Wasserman, K. 1990. A respiratory gas exchange simulator for routine calibration in metabolic studies. Eur. Respir. J. 3:465-468.



## VALIDITY OF A MODIFIED LACTATE MINIMUM TEST, A MODIFIED REVERSE LACTATE THRESHOLD TEST, AND ESTABLISHED THRESHOLD CONCEPTS TO DETERMINE MLSS

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**Introduction** The maximal lactate steady state (MLSS) is generally regarded as the foremost indicator of aerobic endurance. Most existing single-session tests use either fixed-[La] or inflection-point as determination criteria for MLSS. However, these criteria are arbitrary or empirically derived. The lactate minimum test (LMT) (Knoepfli et al. 2011) and the reverse lactate threshold test (RLT) (Dotan 2012) are the only single-session tests which are based on the physiologically founded lactate appearance-disappearance equilibrium concept that forms the basis for the MLSS test, as well. Anyhow, the originally suggested protocols show some limitations like the underestimation of the MLSS by the LMT or the missing determination of VO<sub>2</sub>max during the RLT. The aim of the present study was to validate and compare modified-LMT/-RLT (mLMT/mRLT) and established threshold concepts (OBLA & mDmax) for the determination of MLSS. **Methods** 19 subjects performed a mLMT, mRLT, a step test (100W start, +20W every 3 min) and 3 or more constant-load tests of 30 minutes to determine power output at MLSS on a cycle ergometer. mLMT and mRLT both consisted of a first ramp test with the aim to determine VO<sub>2</sub>max and to increase [La]. After a break, the initial load of the subsequent incremental or reverse segment was calculated individually and was increased or decreased by 10 W every 90 sec respectively. After the step test OBLA and mDmax were determined. **Results** The mean difference to MLSS was  $+2 \pm 7$  W for mLMT,  $+5 \pm 10$  W for mRLT,  $+9 \pm 21$  W for OBLA and  $+1 \pm 14$  W for mDmax, showing the lowest difference and the smallest limits of agreement for the mLMT. The correlation between power output at MLSS and mLMT was highest ( $r=0.99$ ), followed by mRLT ( $r=0.98$ ), mDmax ( $r=0.95$ ) and OBLA ( $r=0.90$ ). The regression lines for all tests mainly run in parallel to the line of identity. VO<sub>2</sub>max measured during the ramp tests was significantly higher compared to the step test ( $56.1 \pm 7.5$  vs.  $53.5 \pm 7.0$  [mL·min<sup>-1</sup>·kg<sup>-1</sup>]). **Discussion** Due to the higher accuracy, especially of the mLMT, but also of the mRLT to determine MLSS compared to OBLA and mDmax, we suggest both tests as valid and meaningful concepts to estimate power output at MLSS in one single test in moderately up to well trained athletes. Furthermore, mLMT/mRLT revealed higher VO<sub>2</sub>max values, providing a more complete assessment of training status. Additionally our modified tests do not require detailed knowledge of subjects' training status compared to previous LMT- or RLT-protocols. **References** Dotan R. (2012) *Int J Sports Physiol Perfor*, 7, 141-151 Knoepfli-Lenzin C, Boutellier U (2011) *J Strength Cond Res*, 25(5), 1355-1359 Contact Wahl@dshe-koeln.de

## Oral presentations

### OP-PM16 Mixed session: Training & Exercise

## THE EFFECT OF UNSTABLE RESISTANCE TRAINING ON MUSCLE POWER OF UPPER AND LOWER BODY

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1: Department of Sports Kinanthropology, Faculty of Physical Education and Sports, Comenius University (Bratislava, Slovakia), 2: Sports Technology Institute, Faculty of Electrical Engineering and Information Technology, Slovak University of Technology (Bratislava, Slovakia), 3: Institute of Languages and Sports, Faculty of Mechanical Engineering, Slovak University of Technology (Bratislava, Slovakia) **Introduction** Power output during resistance exercises is more profoundly compromised under unstable than stable conditions when higher weights are lifted [1]. This effect is more evident for chest presses on the Swiss ball as compared to the squats on the BOSU ball [2]. The question remains whether these differences diminish after exercise regimens including unstable surfaces. This study evaluates changes in power during 8 weeks of the stable and unstable resistance training. **Methods** The subjects, divided into two groups, underwent resistance training either under stable ( $n=14$ , age  $23.5 \pm 2.4$  y, height  $182.7 \pm 5.5$  cm, weight  $79.2 \pm 8.4$  kg) or unstable conditions ( $n=13$ , age  $22.9 \pm 2.2$  y, height  $179.6 \pm 6.9$  cm, weight  $76.5 \pm 11.0$  kg) for a period of 8 weeks (3 sessions/week). Prior to and following 4 and 8 weeks of the training, they performed chest presses and squats on a stable support base and on an unstable Swiss ball and BOSU ball with previously established weight of 70% 1RM under stable conditions. The FITRO Dyne Premium system was used to monitor force and velocity and to calculate power. **Results** Mean power in the concentric phase of chest presses was significantly higher on the bench than on the Swiss ball before ( $427.8 \pm 41.0$  W and  $379.5 \pm 37.7$  W,  $p=0.029$ ) and also after 4 weeks of the training ( $431.5 \pm 37.5$  W and  $392.0 \pm 36.6$  W,  $p=0.037$ ). However, the values did not differ significantly after completing the training program ( $434.7 \pm 39.7$  W and  $417.6 \pm 40.4$  W,  $p=0.243$ ). Similarly, pre-training mean power was significantly higher during squats on the stable surface than on the BOSU ball ( $493.8 \pm 48.4$  W and  $416.7 \pm 42.0$  W,  $p=0.019$ ), whereas there were no significant differences in power after 4 ( $508.4 \pm 44.1$  W and  $467.7 \pm 37.9$  W,  $p=0.166$ ) and 8 weeks of the training ( $514.1 \pm 42.5$  W and  $477.3 \pm 39.8$  W,  $p=0.180$ ). **Discussion** Finding showed that significant differences in power under unstable and stable conditions prior to the training disappear after 4 weeks during squats and after 8 weeks during chest presses. This effect may be ascribed to a greater enhancement of power following the unstable as compared to stable resistance training in subjects practicing conventional resistance exercises. **References** 1. Zemková E, Jeleň M, Kováčiková Z, Ollé G, Vilman T, Hamar D. (2014). *J Appl Biomech*, 30(2), 213-220. 2. Zemková E, Jeleň M, Kováčiková Z, Ollé G, Vilman T, Hamar D. (2012). *J Strength Cond Res*, 26(12), 3230-3236. Contact zemkova@fsport.uniba.sk

## SHORT-TERM ADAPTATIONS TO TRADITIONAL AND DAILY UNDULATING KNEE EXTENSOR TRAINING IN STRENGTH-TRAINING EXPERIENCED WOMEN

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**INTRODUCTION** Strength training periodization has been successfully applied to various athletic populations over the last decades. Currently, traditional (TP) and daily-undulating (DUP) periodization models are most frequently discussed in literature but the more effective approach is yet to be determined. Conflicting study outcomes were hereby mainly due to methodological limitations such as insufficient control of mechano-biological exercise characteristics in the majority of studies (Toigo & Boutellier, 2006; Harries et al., 2015). For more accurate program comparison, this work analyzed TP and DUP during short-term knee extensor training with biofeedback-controlled

training stimuli. METHODS 19 strength-trained experienced women performed 6 weeks of unilateral dynamic knee extensor training with 3 sessions per week, exercising 1 leg using TP and the contralateral leg using DUP. Intensities varied between 40%, 60%, and 80% of individual one repetition maximum (1RM) and were progressively adjusted in a weekly rhythm. To detect possible outcome differences, maximum voluntary isometric and isokinetic-concentric knee extensor strength (MVC), EMG-estimated neural drive of the M. quadriceps femoris (QF), and muscle architecture of the M. vastus lateralis (VL) and M. rectus femoris (RF) were analyzed by 2-factor ANOVA (time \* training leg). RESULTS Significant temporal changes occurred for isometric (TP: 15%, DUP: 13%) and isokinetic-concentric (TP: 8%, DUP: 10%) knee extensor MVC and 1RM (TP: 18%, DUP: 23%). VL and RF-muscle thickness significantly ( $P < 0.05$ ) increased ranging from 12-20% for TP and from 13-19% for DUP respectively. Maximal voluntary QF-EMG-activity remained statistically unchanged in both legs. Importantly, no significant periodization effects occurred for any study outcome and similar effect sizes were calculated in both training legs. DISCUSSION According to current meta-analysis (Harries et al., 2006), our results indicate that TP and DUP were equally adapted to improve maximum QF knee extensor strength, EMG-estimated neural drive and VL + RF muscle architecture following 6-weeks of biofeedback-controlled dynamic strength training. Thus, mechanical alterations in the exercises force-velocity characteristics for instance might act as key neuromuscular adaptation triggers during intensive short-term training periods rather than stimuli periodization. REFERENCES Harries SK, Lubans DR, Callister R. (2015). J Strength Cond Res, 29(4), 1113-25. Toigo M, Boutellier U. (2006). Eur J Appl Physiol, 97(6), 643-63. CONTACT Email: pelzer@uni-mainz.de

## IDENTIFICATION OF MAIN PHYSIOLOGICAL DEMANDS DURING A SIMULATED FIREFIGHTING EXERCISE

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Introduction Firefighters wear full personal protection gear and a self-containing breathing apparatus (SCBA) when responding to an emergency situation. The SCBA delivers oxygen for 20-30 minutes. Air consumption and its relation to firefighting performance parameters have hardly been researched yet. Therefore, the purpose of this study was to investigate the physiological demands of a standardized German firefighting exercise and the relationship between firefighting performance and oxygen related endurance parameters. Methods 43 professional firefighters performed two firefighting tasks and a maximum treadmill testing. The treadmill test was done under laboratory conditions in order to establish maximum heart rate (HR), peak oxygen uptake ( $\text{VO}_{2\text{peak}}$ ), ventilatory threshold (VT1), and respiratory compensation point (RCP). Three physiological intensity zones were identified according to the HR values corresponding to VT1 and RCP. A simulated firefighting exercise was performed twice by each subject with full personal protection gear and (1) SCBA to measure air depletion and (2) with a spirometry mask to measure the metabolic demands of the exercise. Then, optimal firefighting performance was defined as a model minimizing physical strain in terms of HR, duration of the exercise, and air depletion from SCBA. Based on this model, multiple regression analysis finally served to identify a small number of physiological variables that quantify overall individual physical fitness. Results The firefighting scenario with the spirometry mask required  $13.8 \pm 2.1$  min to complete, with an average oxygen uptake of  $24.15 \pm 2.9$  ml/min/kg and a heart rate of  $80 \pm 7\%$  of  $\text{HR}_{\text{max}}$ . The exercise with the SCBA required  $13.3 \pm 2.2$  min to complete and heart rate averaged at  $79 \pm 7\%$  of  $\text{HR}_{\text{max}}$ . Firefighters spent  $22 \pm 26\%$  of testing time in Zone 1,  $70 \pm 25\%$  in Zone 2, and  $8 \pm 16\%$  in Zone 3. Air consumption averaged at  $169 \pm 28$  bar. Based on our model multiple regression identified three main factors that show a great influence on firefighting performance (70% of total explained variance):  $\text{VO}_{2\text{peak}}$ , ventilation and the time spent in Zone 1. Discussion We found that the highest energy contribution during the exercise came from the aerobic-anaerobic system (time spent between VT1 and RCP). Based on the main factors influencing firefighting performance as identified by multiple regression we now recommend a periodic endurance screening for incumbents to establish sufficient  $\text{VO}_{2\text{peak}}$ , ventilation and ventilatory thresholds. The model we developed could also be used in planning individualized training programs to improve each firefighter's job performance. Contact stephanie.inwinkl@tum.de

## ASSOCIATION BETWEEN PHYSICAL FITNESS CHARACTERISTICS AND SUCCESS IN BASIC MILITARY TRAINING IN LUXEMBOURGISH ARMY RECRUITS

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The army of the Grand-Duchy of Luxembourg continuously recruits new candidates to enrol in basic military training (BMT). An increasing number of them do not manage to successfully finish their BMT and are released for medical or personal reasons. The purposes of this retrospective study were to define the extent of dropouts in military recruits during their BMT, as well as to determine possible risk factors for these dropouts. A total of 640 recruits were enrolled in the Luxembourgish army for a 4-month BMT between 2013 and 2015. Anthropometry (age, height, weight, body mass index), education level and physical fitness (ball throw, sit ups, standing broad jump, lying-start 24m sprint, push-ups, 2400m endurance run) were evaluated before BMT. Injuries leading to a dropout of BMT were assessed by the military medical doctor. Unadjusted logistic regressions were used to compute odds ratios (OR) and their 95% confidence intervals (95%CI) and to identify risk factors for dropping out of BMT, whatever the reason. Significance was accepted at the  $p < 0.05$  level. Participants (605 male and 35 female) were aged between 18 and 25 years ( $20.3 \pm 1.8$  y), were  $176.6 \pm 7.5$  cm tall and weighed  $72.3 \pm 11.0$  kg. Their body mass index was  $23.1 \pm 2.8$  kg/m<sup>2</sup>. In total, 72% of the recruits did not have a high-school degree. Physical fitness testing revealed the following performances:  $608 \pm 76$  cm for 3 kg ball throwing,  $64 \pm 10$  sit ups in 2 min,  $223 \pm 21$  cm for the standing broad jump,  $4.8 \pm 2.0$  s for the sprint,  $53 \pm 11$  push-ups in 2 min and  $11.2 \pm 1.2$  min for the 2400 m endurance run. In total, 262 recruits (41%) dropped out of BMT, of which 92 (14%) due to medical reasons, 100 (16%) for personal motives, 58 (9%) because of failure in the final exams and 12 (2%) due to dismissal for disciplinary reasons. Being younger was associated with a higher risk for dropping out of BMT (OR=0.90; 95%CI=0.82 to 0.99;  $p=0.03$ ). Height (cm) and weight (kg) were identified as protective factors with taller and heavier candidates having a lower dropout risk (Height: OR=0.98; 95%CI=0.95 to 1.00;  $p=0.03$ ; weight: OR=0.98; 95%CI=0.97 to 1.00;  $p=0.04$ ). Furthermore, a lower educational level (no high-school degree) was associated with a higher risk of dropout (OR=0.55; 95%CI=0.35 to 0.87;  $p=0.01$ ). Finally, performance in the ball throwing (cm; OR=0.99; 95%CI=0.99 to 1.00;  $p=0.02$ ), long jump (cm; OR=0.99; 95%CI=0.98 to 1.00;  $p<0.01$ ), sprint (sec; OR=2.39; 95%CI=1.42 to 4.03;  $p<0.01$ ) and endurance test (sec; OR=1.01; 95%CI= 1.00 to 1.01;  $p<0.01$ ) were also associated with BMT failure, the poorest performers being at higher risk. This study quantified the overall incidence of costly dropouts in young army recruits in Luxembourg. The analysis indicated that some characteristics related to physical fitness are associated with failure in BMT and represent a modifiable protective factor. Hence, prevention strategies, better medical surveillance and higher fitness readiness could decrease the rate of failure during BMT.

## FIT AND FAT PARENTS: CAN MATERNAL EXERCISE OVERCOME THE DETRIMENTAL EFFECTS ON GLUCOSE TOLERANCE IN OFFSPRING OF A HIGH FAT EATING DAD?

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**Introduction** The 'Developmental Origins of Health and Disease' paradigm investigates how environmental cues early in life impact on long-term disease susceptibility, such as type 2 diabetes. Rat offspring sired by fathers fed a high-fat diet demonstrate impaired insulin secretion. On the other hand, maternal exercise improves glucose tolerance in adult rat offspring, but the underlying mechanisms remain unknown. Therefore, we investigated if adult offspring of fathers fed a high fat diet have impaired glucose tolerance, and if maternal exercise can overcome these detrimental metabolic effects. **Methods** Female Sprague-Dawley rat offspring were divided into 4 groups (n=8-10) according to their parents' treatment: normal chow fed fathers and sedentary mothers (N-S); high-fat fed fathers and sedentary mothers (HF-S); normal chow fed fathers and trained mothers (N-T); and, high-fat fed fathers and trained mothers (HF-T). Fathers consumed high-fat diet (42% energy as fat, 8 weeks) before mating. Meanwhile, mothers were exercised for 4 weeks before and 3 weeks during gestation, on a treadmill gradually reducing the duration and intensity (5 day/week, 60-20 min/day, 20-10m/min and 10-0° slope). At 24 weeks of age, an intraperitoneal glucose tolerance test (IpGTT) was performed, and blood glucose and plasma insulin were analysed. At 25 weeks of age, epitrochlearis and soleus muscles were dissected to evaluate insulin-stimulated 2-deoxyglucose (2DG) uptake and protein expression of glucose transporter 4 (GLUT4) with stain-free technology. Statistical differences were determined by repeated measures ANOVA. **Results** Although glucose tolerance was similar during the IpGTT among the four groups, HF-S pups had lower ( $P<0.05$ ) insulin levels at 15 min which was normalised in HF-T pups. Basal and insulin-stimulated 2DG uptake in the soleus muscle was similar among the groups. However, in the epitrochlearis muscle, HF-S pups had lower basal and insulin-stimulated 2DG uptake, and this again was normalised by maternal exercise. GLUT4 expression in the HF-S pups was lower but not significant (-18%,  $P>0.05$ ), however, HF-T pups had augmented GLUT4 compared with HF-S (+38%,  $P=0.05$ ). **Discussion** Paternal high-fat diet impairs insulin secretion and both basal and insulin-stimulated glucose uptake in the epitrochlearis muscle of adult offspring. In most of the outcomes measured, maternal exercise protects adult offspring against the negative effects of paternal high-fat diet, indicating a healthier phenotype.

## SUPERVISED PHYSICAL ACTIVITY DURING PREGNANCY LOWERS FETAL HEART RECOVERY TIME AFTER MATERNAL EXERCISE.

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**INTRODUCTION** Aerobic exercise influences cardiac autonomic nervous system (ANS) function in adults, seen as lower resting heart rate and heart rate recovery post-exercise (1). Intrauterine life could be affected by maternal habits during pregnancy (2). Recent research has reported improved ANS function in fetuses of active pregnant women (3,4). The aim of this study is to evaluate fetal heart adaptations due to enhancement of the fetal ANS as a result of maternal exercise. **METHODS** A randomized controlled trial (ID: RCT, NCT01723293) enrolled 81 pregnant women in two study groups. All participants signed an informed consent. The study was approved by the Clinical Research Ethics Committee University Hospital of Fuenlabrada (Madrid). The exercise group (EG n=43) received a supervised physical activity program(PAP) three times a week from 9-11 to 37-39 weeks gestation (5). The control group (CG n=38) did not receive any supervised PAP. All women were tested between 34-36 weeks gestation using two walking tests of three minutes each: 40% maternal heart rate reserve(MHRR) and 60% MHRR (4). Fetal heart rate (FHR) at rest and fetal recovery time (FRT) post-exercise in minutes/seconds (m/s) were recorded. **RESULTS** FHR at rest was similar in both groups  $140,88\pm9$  EG vs  $141,95\pm7,35$  CG ( $p>.05$ ). FRT after 40% test was:  $2m15s\pm3m2s$  EG vs  $7m6s\pm5m27s$  CG ( $p<.001$ ). FRT after 60% test was:  $3m\pm4m$  EG vs  $9m\ 25s\pm7m33s$  CG ( $p<.001$ ). **DISCUSSION** Results show a faster recovery in fetuses of participants in EG, which could be an effect of the PAP performed during pregnancy (3). These fetuses received a training effect similar to that seen in trained adults. Further research in this field should be carried out to discover more evidence about the influence of exercise on fetal ANS development and its possible maintenance in the newborn's life. 1. Heffernan K, Fahs C, Shinsako K, Jae S, Fernhall B. Heart rate recovery and heart rate complexity following resistance exercise training and detraining in young men. *Am J Physiol Heart Circ Physiol.* 2007;293:H3180-6. 2. Barker DJ. Fetal origins of coronary heart disease. *BMJ.* 1995;311(6998):171-4. 3. May L, Glaros A, Yeh H-W, Clapp J, Gustafson K. Aerobic exercise during pregnancy influences fetal cardiac autonomic control of heart rate and heart rate variability. *Early Hum Dev.* 2010 Apr;86(4):213-7. 4. Roldan O, Perales M, Mateos S, Barakat R. Supervised physical activity during pregnancy improves fetal cardiac response. *Rev int med cienc act fis dep.* 2015;15(60):757-72. 5. ACOG. ACOG committee opinion. Exercise during pregnancy and the postpartum period. Number 267, January 2002. American College of Obstetricians and Gynecologists. *Int J Gynaecol Obs.* 2002;77(1):79-81.

## Oral presentations

### OP-BN03 Motor Learning & Control

## IMPROVED RETENTION PERFORMANCE AFTER VARIABLE PRACTICE COMES IN LINE WITH AN INCREASED ALPHA BAND POWER OVER THE PREFRONTAL CORTEX

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**Introduction** It is widely accepted that variable practice enhances the motor performance after a period of consolidation (Shea & Morgan, 1979). This effect could be explained by cognitive demanding processes in the prefrontal cortex which potentiate subsequent memory consolidation (Kantak et al., 2010). However, it is still unknown which neural processes lead to the enhanced motor performance. The aim of this study was to investigate the electrophysiology of learning related frequency bands over prefrontal areas in a motor adaptation task under variable practice conditions. **Methods** Subjects (n=24) were equally distributed in two groups (blocked, random) and performed goal-directed arm reaching movements handling a robotic device. Both groups performed a similar schedule over two consecutive days containing a familiarization and training block on day 1 (each 148 trials) and a retention block on day 2 (32 trials). During the

training block, subjects' movements were perturbed by a viscous curl force field with three gradations (10, 15, 20 Ns/m) in either blocked or random order. In the retention block, the force field was consistent at 15 Ns/m. We recorded hand-trajectories to quantify subjects' motor performances while adapting to the force field. Electroencephalography (EEG) was collected using 32 active-electrodes. After artifact correction, the percentage power of theta (4-7 Hz), alpha (8-13 Hz), and gamma (60-85 Hz) bands as well as theta-gamma phase-amplitude coupling (Canolty et al., 2006) were computed during movement execution. Statistical analyses were done using permutation testing. Results The kinematic data exhibited a significant interaction ( $p=.037$ ;  $p\text{Eta}^2=.18$ ) between time (training, retention) and group revealing an increased performance improvement for the random compared to the blocked group. Furthermore, EEG alpha band power during movement execution showed a significant time and group interaction ( $p=.047$ ;  $p\text{Eta}^2=.17$ ) indicating an increased alpha power during memory retrieval for the random group. Discussion This is the first study investigating the consolidation of variable practice in a force field adaptation task using EEG. The results show a positive effect of variable practice on motor performance which comes in line with an increased alpha band power over prefrontal areas. This supports previous hypotheses (Kantak et al., 2010) that the benefit of variable practice is facilitated by cognitive processes in the prefrontal cortex. References Kantak SS, Sullivan KJ, Fisher BE, Knowlton BJ, Winstein CJ (2010). *Nat Neurosci*, 13, 923-925. Shea JB, Morgan RL (1979). *J Exp Psychol Hum Learn*, 5, 179-187. Canolty RT, Edwards E, Dalal SS, Soltani M, Nagarajan SS, Kirsch HE, Berger MS, Barbaro NM, Knight RT (2006). *Science*, 313, 1626-1628. Contact benjamin.thuerer@kit.edu

## CHANGES IN INTRACORTICAL INHIBITION IN RESPONSE TO BALANCE TRAINING

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Introduction The adequate development of intracortical inhibitory processes seems crucial for an intact motor control. With respect to balance, it was previously shown that healthy adults, both young and old, decrease short interval intracortical inhibition (SICI) when they perform challenging postural tasks (Papegaaij et al., 2015). However, the level of SICI is generally lower in elderly, who – at the same time – display worse balance skills than young subjects (Papegaaij et al., 2014). Therefore, we asked the question whether improvements in postural control due to balance training are accompanied by increased intracortical inhibition when tested during the performance of challenging postural tasks. Methods For this purpose, a training group (TG, practiced 6 trainings of 1 hour on a movable platform,  $n = 13$ ) and a control group (CG,  $n = 13$ ) were measured with transcranial magnetic stimulation (TMS). Two pulses with an interstimulus interval of 2.5ms were elicited in order to assess SICI during three postural tasks: standing, standing on a movable platform that was partly secured with elastic straps (straps), or that was freely moving (free). During each postural task, 20 single and 20 paired pulses were elicited by TMS in the soleus (SOL) and tibialis (TA) muscles. Results The TG significantly improved the time in balance by 80% after the training, whereas the CG increased the time in balance by 21%. The SOL did not reveal significant main effects or interactions for SICI, whereas the TA, showed significant increase of SICI by 22% for the TG about a reduction of 12% for the CG: main effect of POSTURAL TASKS ( $F_2, 48 = 24.6$ ;  $p < 0.001$ ), and TIME x GROUP interaction ( $F_1, 24 = 5.9$ ;  $p = 0.02$ ). The increase in balance performance was correlated to an increase in intracortical inhibition ( $r = 0.478$ ,  $p = 0.021$ ) in the TA muscle. Discussion The purpose of this study was to evaluate whether balance training induced changes in postural control are accompanied by increased SICI. In summary, two weeks of balance training significantly improved postural skills in young adults. At the same time, an enhancement of SICI was observed in the TA and was correlated with the improvement in balance performance. This is an important finding, as it shows for the first time that neural adaptations induced by balance training were correlated with enhanced intracortical inhibition. This suggests that intracortical inhibitory processes may play an important role in the control and adaptation of upright posture. References: Beck S, Taube W, Gruber M, Amtage F, Gollhofer A, Schubert M. (2007). *Brain Res*, 1179, 51-60. Papegaaij S, Taube W, Hogenhout M, Baudry S, Hortobágyi T. 2014. *Front Aging Neurosci*, 6, 126. Papegaaij S, Taube W, van Keeken HG, Otten E, Baudry S, Hortobágyi T. 2015. *Experimental Gerontology*. Audrey.mouthon@unifr.ch

## CARDIORESPIRATORY EFFECTS OF COMBINING TRANSCUTANEOUS SPINAL STIMULATION AND ROBOT ASSISTED WALKING: A CASE STUDY.

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Introduction Previous research has demonstrated that spinal control of locomotor patterns can be up-regulated by assisted walking or spinal stimulation. However it remains to be elucidated if a combined approach may enhance function in spinal cord injured individuals. The current case study examined the effect of combining transcutaneous spinal stimulation with robot assisted walking on cardiorespiratory measures of exercise performance in a spinal cord injured individual. Methods The participant (39 year old male; height 1.81m, mass 84kg) with spinal cord lesions at T9 and L1 vertebral levels, had been assessed clinically as motor and sensory complete (ASIA A). Test sessions of 60 min robot assisted walking were performed on three consecutive days using an exoskeleton (EKSO bionics). Each session included 4 by 15 min of walking with 5 min of seated recovery between exercise bouts. Electrical current was delivered transcutaneously to the spinal cord at the level of T10 (30Hz) and C01 (5Hz) during 2 of the 15 min exercise bouts in each session. This resulted in the completion of 12 by 15 min exercise bouts (6 with and 6 without stimulation). Cardiorespiratory data were collected via a portable metabolic analyser (Cosmed K4b2); hip and knee motor torque data were collected from the exoskeleton throughout all sessions. Data averaged over 3 min increments within each 15 min exercise bout were statistically compared using a 2-factor repeated measures ANOVA (time by stimulation). Results Robot assisted walking resulted in a mean  $\text{VO}_2$  of  $12.3 \pm 1.5 \text{ mL.kg}^{-1}.\text{min}^{-1}$ . The addition of spinal stimulation to robot assisted walking resulted in a significant increase in  $\text{VO}_2$  ( $14.7 \pm 1.5 \text{ mL.kg}^{-1}.\text{min}^{-1}$ ,  $F=35.6$ ,  $P<0.01$ ). Heart rate was also significantly greater with combined spinal stimulation and robot assisted walking ( $128 \pm 10$  vs.  $107 \pm 8 \text{ beats.min}^{-1}$ ,  $F=32.2$ ,  $P<0.01$ ). Both  $\text{VO}_2$  and heart rate significantly increased during the course of the 15 min exercise bout ( $F=5.8$ ,  $P<0.01$ ;  $F=11.6$ ,  $P<0.001$ , for  $\text{VO}_2$  and heart rate, respectively). Knee torque data were consistently lower throughout the 15 min exercise bouts with stimulation, however this result was not statistically significant. Both left and right knee torque data significantly increased throughout the 15 min exercise bouts ( $F=3.2$ ;  $P<0.01$  for left;  $F=3.1$   $P<0.05$  for right). Discussion The addition of transcutaneous spinal stimulation significantly increased metabolic and cardiovascular cost associated with robot assisted walking in a paraplegic individual. No significant differences in hip or knee joint torque data were observed. Further research is therefore required in order to establish what is causing the increased energy cost and whether this effect is consistent across a group of spinal cord injured individuals.



**INFLUENCE OF MOTOR UNITS NUMBER ON TORQUE STEADINESS IN YOUNG AND OLDER ADULTS**

BAUDRY, S., JOHANSSON, J., DUCHATEAU, J.

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**Introduction.** A motor unit (MU) is considered as the elementary unit of motor control that consists of a motor neurone, its axon and the muscle fibres it innervates. The number of functioning MU has been reported to decrease with ageing, contributing to the age-related decrease in maximal force capacity (2). However, the influence of MU number on motor control, especially during fine motor tasks such as producing a constant torque as steady as possible, has not been directly investigated, even though a simulation study suggests that it should not be an influential factor in a hand muscle (1). The present work investigated the relation between MU number and torque steadiness during submaximal isometric contractions in young and older adults. **Methods.** MU number estimation (MUNE) in tibialis anterior was computed with the spike-triggered averaging technique of surface electromyogramme (sEMG) from concurrent intramuscular MU recordings in ten young ( $27.4 \pm 5.4$  yrs) and eleven older adults ( $70.8 \pm 5.6$  yrs). For each subject, at least ten MU was recorded for a total of 113 MU in young and 123 MU in older adults. The MUNE was calculated as the ratio of the amplitude of the maximal muscle compound action potential and the averaged amplitude of MU action potentials recorded by sEMG (Brown et al. 1988). The coefficient of variation (CV) for torque, used as an index of torque steadiness, was measured during isometric contraction of ankle dorsiflexor muscles performed at 5, 10, 15 and 20% of maximal dorsiflexion torque. **Results.** The maximal dorsiflexion torque was significantly greater in young ( $57.9 \pm 15.9$  N.m) than older adults ( $38.2 \pm 14.3$  N.m;  $p = 0.010$ ) whereas the CV for torque was significantly lesser in young than older adults ( $p = 0.002$ ). MUNE was greater in young ( $172.2 \pm 20.2$ ) than older adults ( $90.7 \pm 18.9$ ;  $p < 0.001$ ) and was negatively associated with CV for torque at 5% contraction intensity but only in older adults ( $r^2 = 0.43$ ;  $p = 0.040$ ). **Discussion.** The results confirm that MU number in tibialis anterior decreases with ageing (2) whereas torque steadiness was significantly reduced in older adults. The data further show that the number of MU may influence the ability to produce constant torque as steady as possible during low-torque dorsiflexion contractions in older adults. In addition to other age-related changes within the neuromuscular system, this study suggests that the decrease in MU number likely contributes to alter performances in fine motor tasks performed with leg muscles in old adults. **References.** 1. Enoka et al. (2003) *J Electromyogr Kinesiol.* 13: 1-12 2. McNeil et al. (2005) *Muscle Nerve* 31: 461-7 Ms Johanna Johannssonis supported by a grant of the National Research Fund (FNRS) of Luxembourg

**WOBBLE BOARD TRAINING IMPROVES MODULAR CONTROL OF LATERAL LANDING**

OLIVEIRA, A., SILVA, P.B., MRACHACZ-KERSTING, N., KERSTING, U.G.

*Aalborg University*

**Introduction** High occurrence of sports injuries when landing from a jump may be a result of poor motor coordination, which may influence landing technique and energy dissipation. It has been suggested that balance training reduces injury risks by improving motor coordination. However, little is known about changes in motor coordination during landing following balance training. The aim of the present study was to investigate the effects of balance training on the modular control during lateral landing. **Methods** Twenty young adults were assigned to a control (CG = 9) and a training group (TG = 11). Both groups performed maximum effort lateral jumps, single-leg landing with their dominant limb on a force platform. The TG enrolled in a 4-week balance training program, whereas the CG kept their normal activities. We recorded surface electromyography (EMG) from 12 muscle of the dominant limb during lateral landing. We segmented EMG data from -100 ms prior to initial foot contact to 100 ms after the hip reaching its lowest position during load absorption. We applied non-negative matrix factorization (NMF) on the concatenated EMG from all subjects pre and post intervention. From NMF we extracted motor modules and activation signals describing the muscular activation of all subjects from each group. From the motor modules, we computed the similarity between pre- and post-tests. Relative weighting (Rw) for each muscle within one module was expressed as a percentage of the primary muscle defined as the one with the highest amplitude. The sum of Rw per module was used to provide a measure for module organisation. For activation signals, we computed the inter-subject variability (ISV) of the curves by computing coefficients of variance. **Results** Six motor modules were sufficient to reconstruct the original EMG datasets. Four modules were related to specific biomechanical sub-tasks: initial contact, load absorption, body deceleration and ankle stability. Pre-to-post test similarity between motor modules for CG was  $0.76 \pm 0.23$  and for TG it was  $0.70 \pm 0.31$ . The Rw for CG was  $42 \pm 19\%$  and  $42 \pm 20\%$  pre and post the intervention, respectively. For TG, Rw was reduced by  $\sim 25\%$  (from  $43 \pm 21$  for pre- to  $30 \pm 15\%$  post-training). The ISV for the CG was increased  $\sim 9\%$  from  $82 \pm 10\%$  to  $89 \pm 10\%$  from pre- to post-test, whereas the TG showed a reduction of  $\sim 12\%$  from  $80 \pm 10\%$  to  $70 \pm 8\%$ , respectively. **Discussion** The reduced similarity and Rw for motor modules for TG suggests a reorganization of muscle weightings after balance training. The weighting within one module appeared more concentrated on one or few muscles rather than distributed across each module. Moreover, the activation timing was more consistent across TG subjects after balance training. These results may reflect improvements in neural strategies for landing. In conclusion, balance training may improve motor coordination by reorganizing modular organization and temporal properties of muscle activation during landing. e-mail: oliveira@m-tech.aau.dk

**Oral presentations****OP-PM79 Regeneration: Mixed Session****WHOLE-BODY COLD WATER IMMERSION AS A RECOVERY TOOL IN ELITE OLYMPIC WEIGHTLIFTERS**

SCHIMPCHEM, J., WAGNER, M., MEYER, T.

*Saarland University*

**Introduction:** Training and/or competing multiple times per day often induces excessive amounts of stress in athletes. This might result in temporary impairments in performance due to a variety of factors. Hence, the aim of the study was to investigate whether whole-body cold water immersion following intensive training sessions can be a useful recovery tool for elite Olympic weightlifters. **Methods:** Seven male members ( $25 \pm 4$  y) of the German national Olympic weightlifting team participated in the study. A randomized cross-over design was employed, consisting of two four day phases separated by a ten day wash-out period. In both phases, athletes underwent a total of five high-intensity training sessions, which were immediately followed by either a cold water immersion protocol (CWI) or a control protocol (CON). CWI consisted of a single bout of 10 consecutive minutes, during which the athletes were seated and immersed up to their

neck in water at between 12°-15° C, while CON consisted of 10 min of passive recovery in the same body position. A snatch pull movement at 85% and 90% of each athlete's individual snatch 1 RM served as a sport-specific performance test and was executed before and after both phases. Maximal barbell velocity during the pull was recorded. Throughout data collection, venous blood samples were collected from the athletes and subjective ratings of general physical and mental fatigue and recovery were assessed using a questionnaire. Results: Physical performance at either snatch pull intensity (85% 1RM:  $P=0.94$ ; 90% 1RM:  $P=0.25$ ) did not differ significantly between CWI and CON (condition  $\times$  time). While questionnaires revealed a significant decline in ratings of overall recovery ( $P<0.001$ ) and a significantly higher rating of overall stress ( $P=0.03$ ) over time, there were no significant differences between conditions ( $P=0.14$ ;  $P=0.98$ ). Similarly, neither of the analyzed blood parameters changed significantly between conditions over time (CK:  $P=0.53$ ; Urea:  $P=0.43$ ; Cortisol:  $P=0.59$ ; Testosterone:  $P=0.53$ ; T:C ratio:  $P=0.69$ ). On an individual level, responses to CWI varied considerably between subjects. Conclusions: In general, CWI did not prove to be an effective tool to enhance recovery in elite Olympic weightlifters over a three day intensive training period. However, even though the group was rather homogeneous with regard to performance, there were considerable inter-subject differences in their response to CWI. While some athletes improved performance and subjective well-being, others saw a decline in both parameters. Based on this data, it seems difficult to generalize the usefulness of CWI even within a homogenous athletic population. It appears that athletes are best advised on a case-by-case basis.

### **ADDING FISH OIL AND NATURAL ANTIOXIDANTS TO WHEY PROTEIN IMPROVES ECCENTRIC-EXERCISE RECOVERY IN SOCCER PLAYERS**

PHILPOTT, J.D., DONNELLY, C., WALSH, I.H., DICK, J., MCKINLAY, E., GALLOWAY, S.D., TIPTON, K.D., WITARD, O.C.

*University of Stirling*

**Introduction** The physical demands of soccer match-play is known to involve changing speed and direction, repeated sprints and explosive jumps, that predominantly requires eccentric type muscle contractions. Such movements often result in the phenomenon termed muscle damage. Protein feeding has been shown to preserve the functional capacity of skeletal muscle after eccentric exercise. Since fish oil derived n-3 polyunsaturated fatty acids (n-3PUFA) exhibit anti-inflammatory properties, combining ingestion of fish oil with protein may facilitate recovery. Therefore, the primary aim of the present study was to assess the influence of 6 wk supplementation with a juice-based antioxidant-rich drink containing a combination of n-3PUFA, whey protein and vitamin D on muscle function and soreness, inflammation and soccer performance during exercise recovery. **Methods** Competitive soccer players ( $n=27$ ) were assigned to one of three conditions. Drink-A contained n-3PUFA (550 mg DHA, 550 mg EPA), whey protein (15 g) and vitamin D (3  $\mu$ g). Drink-B contained whey protein (15 g) and vitamin D (3.9  $\mu$ g) and Drink-C was an isocaloric carbohydrate control. Eccentric exercise consisted of 12 sets of unilateral knee extension/flexion contractions on both legs separately. Statistical analyses included conventional p-value and magnitude-based inferential approaches. Results Eccentric exercise impaired maximal force and increased ratings of muscle soreness ( $p<0.05$ ). Post supplementation, blood %n-3PUFA/total PUFA was greater in Drink-A ( $36 \pm 6$ ) vs. Drink-B ( $24 \pm 3$ ,  $p<0.05$ ) or Drink-C ( $23 \pm 2$ ,  $p<0.05$ ). Maximum force loss during recovery tended ( $p = 0.10$ ) to be less in Drink-A ( $-19 \pm 22\%$ ) vs. Drink-C ( $-30 \pm 10\%$ ). Muscle soreness (dominant leg), expressed as AUC during 72 h exercise recovery, tended to be less in Drink-A ( $791 \pm 549$  mm  $\times$  72 h) vs. Drink-B ( $1403 \pm 779$  mm  $\times$  72 h,  $p=0.08$ ) and Drink-C ( $1298 \pm 621$  mm  $\times$  72 h  $p=0.10$ ). The blood concentration of c-reactive protein tended ( $p=0.09$ ) to be lower in Drink-A (AUC:  $42 \pm 11$  mg/L  $\times$  72 h) vs. Drink-C (AUC:  $83 \pm 42$  mg/L  $\times$  72 h,  $p < 0.05$ ). Drink-A elicited a very likely (79-96%) beneficial effect on agility t-test performance vs. Drink-B and Drink-C. **Discussion** A juice-based antioxidant-rich drink, containing n-3PUFA, whey protein and vitamin D, appears to mediate a reduced feeling of muscle soreness after eccentric exercise and translates into improved muscle function and soccer-specific performance during acute recovery. Hence, the benefit of whey protein ingestion to exercise recovery may be enhanced by the addition of n-3PUFA and natural antioxidants in competitive soccer players. The present study was funded by Smartfish Ltd. Contact j.d.philpott@stir.ac.uk

### **MODERATE VOLUME, HEAVY-LOAD STRENGTH TRAINING, IN COMBINATION WITH PROTEIN SUPPLEMENTATION. EFFECTS ON MUSCLE MASS, STRENGTH AND FUNCTION IN FRAIL ELDERLY SUBJECTS.**

AAS, S.N., NORDENG, A.L., KAASHAGEN, M., BENESTAD, H.B., RAASTAD, T.

*Norwegian School of Sport Sciences*

**Introduction** Low muscle mass and muscle strength (sarcopenia) is associated with reduced daily life function, in particular after the age of 80. Strength training and sufficient protein intake may be effective counter-measures [1]. Our objective was to investigate the effects of a high intensity, moderate volume strength-training regime, combined with protein supplementation, on muscle mass, strength and function in frail elderly individuals. **Methods** Twenty-two elderly subjects ( $\sigma = 7$ ,  $\varphi = 15$ , age:  $84.8 \pm 5.6$  yr) were randomized to two groups, one performing strength training three times a week for 10 weeks, and with a supplement of 2  $\times$  17 grams of milk protein daily (ST+PRO), and a control group (CON). Training sessions were performed in subgroups of three subjects and lasted 30 minutes. Exercises included step up, leg press, knee extension (KE) and adapted one leg squat (1-3 6-12 RM sets). Prior to randomization, leg lean mass was measured by dual-energy X-ray absorptiometry (DXA), and muscle strength by KE 1RM and IMVC (isometric maximal voluntary contraction). Sit-to-stand  $\times$  5, stair climbing, and habitual gait velocity were tested to assess functional status. 24-hour diet recalls were conducted to assess nutritional status and monitor the impact of supplements. Results Leg lean mass increased in ST+PRO ( $0.7 \pm 0.3$  kg,  $p < 0.01$ ), but was unchanged in the CON group ( $0.1 \pm 0.3$  kg). The ST+PRO group improved 1RM KE strength and IMVC force by  $23 \pm 15\%$  and  $20 \pm 11\%$ , respectively, again with no changes in CON. In addition, IMVC force at 100 ms improved only in ST+PRO, by  $22 \pm 22\%$ . ST+PRO improved sit-to-stand  $\times$  5 ( $10 \pm 13\%$ ), stair climbing ( $11 \pm 12\%$ ) and habitual gait velocity ( $7 \pm 10\%$ ), whereas no significant changes were detected in the control group. The changes in ST+PRO were significantly different from CON for all tests ( $p < 0.05$ ), except for sit-to-stand  $\times$  5 ( $p = 0.12$ ). Protein intake increased from 0.91 to 1.22 g/bm/day in ST+PRO ( $p < 0.05$ ), and did not change in CON. **Discussion** These results show that high-intensity strength training performed 30 minutes three times per week for 10 weeks was sufficient to elicit improvements in strength and function, as well as muscle hypertrophy, in elderly frail individuals. High-intensity, moderate volume strength training is therefore suggested as an effective and practical low-cost strategy to prevent and treat sarcopenia in old people. 1.Chale, A., et al., J Gerontol A Biol Sci Med Sci, 2013. 68(6): p. 682-90.

## Oral presentations

### OP-SH01 Sports History

#### FROM COLD TO CORDIAL. THE CHANGE OF RELATIONS BETWEEN THE UNESCO AND THE IOC IN THE LATE 1970S

REITER, M.

*University of Vienna*

**Introduction** The General Conference of the United Nations Educational, Scientific and Cultural Organization (UNESCO) in 1976 marked a far reaching turning point for the international political sport system. UNESCO's members officially decided to enshrine Sport in their agenda - a subject that had been previously dominated by the International Olympic Committee (IOC). In order to create the International Charter of Physical Education and Sport, an intergovernmental committee was established with the aim of presenting the new, ground breaking Charter at the next General Conference in 1978 (UNESCO, 1977). It goes without saying that this development was seen as an invasion in the field of IOC's activity and therefore evoked major criticism from the 'competing' organization. (Landry et. al. 1996). Interestingly, international politics and media joined the discussions. This study shows why UNESCO's Sport Charter was not only an inter-organizational hot-button issue, but also caused international concerns amidst the lingering Cold War between East and West. **Methods and Sources** The methodological approach to this study is shaped by the primary sources used. Fundamental research has been carried out mainly in the Historical Archives of the Olympic Studies Centre in Lausanne. The analyzed material involves both official IOC and UNESCO documents as well as contemporary news coverage by international papers. Furthermore, the correspondence between the President of the IOC and the UNESCO General Secretary has been included in the analysis. **Results** In 1976 UNESCO's decisions were seen by many as a threat to the IOC's leading role in the international sport system as well as another potential conflict issue between East and West. Yet the fear of some (western) IOC members that UNESCO could become a stakeholder for the countries of the East with regard to sport politics turned out to be unfounded. In the context of the growing conflict between East and West in the late 1970s and early 1980s, the IOC and UNESCO were anxious to cooperate instead of competing in the field of international sport politics. **Discussion** The sudden change of relations from cold to cordial leaves space for discussion and speculation. Could a confrontation between UNESCO and IOC have led to a definitive sport political separation of East and West and would the UNESCO have been able to implement a more democratic approach to international sport politics? **References** Landry F, Yerlès M. (1996). The International Olympic Committee - One hundred years. The Idea - The Presidents - The Achievements III, 126-141. UNESCO (1977). Records of the General Conference. Nineteenth Session Nairobi, 26 October to 30 November 1976, 28. Imprimerie des Presses Universitaires de France, Vendôme. Contact [mi.reiter@univie.ac.at](mailto:mi.reiter@univie.ac.at)

#### RIDING INSTRUCTORS, GENDER, MILITARISM, AND STABLE CULTURE IN SWEDEN: CONTINUITY AND CHANGE IN THE TWENTIETH CENTURY

THORELL, G., HEDENBORG, S.

*The Swedish national Equestrian centre, Gothenburg university, Malmö university*

**Introduction** Swedish equestrian sport underwent significant changes during the twentieth century from being connected to men and the army to being associated with women and leisure activities. Previous research has shown that a stable culture with masculine military norms still exists in spite of these changes. The purpose of this study is to explore why these norms continue to influence Swedish equestrian sport. Riding instructors and their education at the Swedish National Equestrian Centre (SNEC) are focused in order to understand and explain the norms of stable culture. **Method** Institutional economic theory and gender theory are used to explain continuity and change in stable culture. The source material consists of written documents, books and interviews with four riding instructors. **Results** Between the 1960s and the 1980s, SNEC was transformed from the army's equestrian academy to the educational centre for the equestrian federation with civilian students at the riding instructor courses. An increasing number of women begun participated in the courses. Course syllabi show that the instructor courses were very similar before and after the equestrian organization took over SNEC. The riding instructors explain that riding skills and practical skills were important, during their educational time at SNEC, as well as efficiency, orderliness, and responsibility. The leadership was characterized to be authoritarian and provided a sense of security. **Discussion** Military norms have been reproduced in the education of the riding instructors. When the equestrian federation took over SNEC they could have replaced the teachers and demanded a different educational culture, but did not. The result explain why the institutional arrangements of stable culture were difficult to change; such changes would simply have cost too much. The federation would also have needed time to readjust, find new teachers, and exchange one educational system for another. The female informants did not feel that they were treated differently on account of their gender, instead, they underline that they appreciated the military values, and the emphasis on discipline. The military norms creating overlapping gender constructions that diverged from what was regarded as feminine and masculine in society at large. **References** Dashper, K. (2012). Dressage is Full of Queens! Masculinity, Sexuality and Equestrian Sport, *Sociology* 46. Forsberg, L. (2007). Att utveckla handlingskraft. Om flickors identitetsskapande processer i stallet, PhD diss. 43, Luleå tekniska universitet. Hedenborg, S. (2009). Unknown Soldiers and Very Pretty Ladies: Challenges to the Social Order of Sports in Post-War Sweden, *Sport in History* 29, 4. Contact: [gabriella.thorell@stromsholm.com](mailto:gabriella.thorell@stromsholm.com)

#### OXFORD AND CAMBRIDGE BOAT RACE: PERFORMANCES AND PHYSICAL CHARACTERISTICS OF CREWS BETWEEN 1890 AND 2014

EDWARDS, A.M., GUY, J.H., HETTINGA, F.J.

*St Mark and St John University; University of Essex*

**Introduction:** The Oxford and Cambridge Boat Race is one of the oldest, continuing sporting events in the world. Historically as well as scientifically, the race is of unique value, as performance data have been collected in the same event, on the same course over 2 centuries: the ideal set-up for a field-based longitudinal evaluation (Desgorces et al. 2008). The purpose of this study was to examine the historical development of Boat Race performances and physical characteristics of Oxford and Cambridge crews for races between 1890 and 2014. **Methods:** Linear regression analysis was used to investigate the development of performance and average body size of the crews from both universities. Changes to performances and crew characteristics were further assessed in 10-year clusters for decade by decade comparisons. **Results:** Significant negative correlations were observed between performance and time (1890-2014) for both

Oxford ( $r = -0.67$ ;  $P < 0.01$ ) and Cambridge ( $r = -0.64$ ;  $P < 0.01$ ). As an overall effect, crew performance times have improved markedly (~2min 20s faster than the 1890s) with the first significant gains from baseline (1890s) achieved in the 1950s (Cambridge) and the 1960s (Oxford) decades which coincided with significant increases in the average body mass of the competing crews ( $P < 0.01$ ). In 1890, the average body mass of the crews from both universities was 77.2kg, while crews are now significantly heavier than that (~88-95 kg). Conclusion: Analysis of the historical developments in the Boat Race provides a unique opportunity to better understand factors relevant for optimal performance (Hofmijster et al. 2007). Performance in the Boat Race has evolved substantially since 1890 and this has been accompanied by changes to the physicality of the competitors, the equipment they use and the training strategies they employ. References: 1.Desgorces FD, Berthelot G, El Helou N, et al. PLoS One. 2008;3(11):e3653. 2.Hofmijster MJ, Landman EH, Smith RM, et al. J Sport Sci. 2007;25:403-11.

## 09:45 - 11:15

### Invited symposia

#### IS-PM04 Active Pregnancy

##### **GUIDELINES FOR PREGNANCY AND POSTPARTUM PELVIC FLOOR MUSCLE TRAINING AND PREVALENCE OF URINARY INCONTINENCE**

BØ, K.

*Norwegian School of Sport Sciences*

**INTRODUCTION:** Pelvic floor dysfunction (PFD) has been defined as presence of symptoms of urinary (UI) or anal (AI) incontinence, pelvic organ prolapse (POP), sensory or emptying abnormalities of the lower urinary tract, defecation dysfunction, sexual dysfunction and chronic pain syndromes (1). Several studies have found a high prevalence (28-80%) of UI in nulliparous women and in female elite athletes with the highest prevalence in sports involving high impact activities such as trampoline jumping and gymnastics (2). Postpartum prevalence of any type of UI in primiparous women during the first year postpartum, regardless of delivery mode, range between 15% and 30% (1). The aim of this presentation is to give an overview of the effect of pelvic floor muscle training in prevention and treatment of UI during pregnancy and in the postpartum period **RESULTS:** A Cochrane review concluded that 'pregnant women without prior urinary incontinence (prevention) who were randomized to intensive antenatal pelvic floor muscle training (PFMT) were less likely than women randomized to no PFMT or usual antenatal care, to report UI up to six months after delivery (about 30% less; risk ratio (RR) 0.71, 95% CI 0.54 to 0.95, combined result of 5 trials)' (2). Postpartum the Cochrane review concluded that 'postnatal women with persistent urinary incontinence (treatment) three months after delivery and who received PFMT were about 40% less likely than women who did not receive treatment or received usual postnatal care to report urinary incontinence 12 months after delivery (RR 0.60, 95% CI 0.35 to 1.03, combined result of 3 trials)'. It seemed that the more intensive the program the greater the treatment effect. However, the Cochrane review also concluded that 'the extent to which mixed prevention and treatment approaches to PFMT in the postnatal period are effective is less clear. **DISCUSSION:** There is a need for RCTs on the effect of PFMT in elite athletes during pregnancy and in the postpartum period. Given the evidence for PFMT on UI in the general female population during pregnancy and in the postpartum period, elite athletes should be offered supervised PFMT after childbirth. **REFERENCES:** 1. Milsom I et al. Epidemiology of urinary incontinence (UI) and other lower urinary tract symptoms (LUTS), pelvic organ prolapse (POP) and anal incontinence. In: Abrams P, Cardozo L, Khoury A, Wein A. Incontinence. 5th Edition., Health Publication Ltd. Committee 1, 15-107, 2013 2. Bø K. Pelvic floor dysfunction, prevention and treatment in elite athletes. In: Bø K et al (Eds): Evidence-based physical therapy for the pelvic floor. Bridging science and clinical practice, 2nd Ed, Elsevier 2015. 3. Boyle R et al. Pelvic floor muscle training for prevention and treatment of urinary and faecal incontinence in antenatal and postnatal women. Cochrane Database of Systematic Reviews 2012, Issue 10.

##### **GUIDELINES AND BENEFITS OF SUPERVISED PROGRAMS OF MODERATE-INTENSITY EXERCISE PERFORMED THROUGHOUT PREGNANCY**

PERALES SANTAELLA, M., BARAKAT CARBALLO, R.

*Camilo Jose Cela University*

Guidelines and benefits of supervised programs of moderate-intensity exercise performed throughout pregnancy Maria Perales<sup>1</sup>; Ruben Barakat<sup>2</sup> 1 Camilo Jose Cela University-Faculty of Health 2 AFIPE Research Group-Technical University of Madrid The evidence on the benefits of an healthy lifestyle including exercise, in pregnant women's and new-born health and pregnancy outcomes is increasing. However, somehow, there are still social barriers to deliver proper programs and increase adherence of pregnant women and professionals. This presentation will focus the influence of supervised programs of combine moderate-intensity exercise (aerobic and resistance), performed throughout pregnancy on maternal and foetal pregnancy outcomes, such as: the improvement of the maternal perception of health status; how it helps to control excessive weight gain; the risk of preterm delivery for healthy pregnant women; the reduction in the rate of caesarean and instrumental deliveries, its effects on the prevention of antenatal depression, and the maternal cardiac adaptations to this program. Furthermore, it will focus on the current guidelines for exercise performed over the first, second, and third trimesters of pregnancy including aerobic moderate-intensity exercise, light-intensity resistance training and pelvic floor training. These guidelines are essential for designing not only safety but also effective exercise programs to avoid maternal and fetal complications during pregnancy associated with sedentarism



**BIOMECHANICAL LOADING OF GAIT DURING PREGNANCY**

SANTOS-ROCHA, R.1,3, BRANCO, M.1,3, AGUIAR, L.2,3, VIEIRA, F.2,3, VELOSO, A.P.2,3

1: ESDRM-IPSantarém (Rio Maior, Portugal), 2: FMH-ULisboa (Lisboa, Portugal), 3: CIPER (Lisboa, Portugal)

Introduction Pregnancy is a special phase of women's lives, which process leads to several changes in hormonal, anatomical, body composition, and musculoskeletal systems of women. The changes occurring in the body between the second and the third trimesters of pregnancy, lead to an increase in the mechanical load of the lower limb during gait and other motor tasks [1]. The purposes were to analyse the biomechanics (kinematics and kinetics) of gait throughout pregnancy and postpartum [2,3]. Methods Eleven pregnant women participated in the study. Anthropometric and biomechanical data were collected at the Laboratory of Biomechanics and Functional Morphology during the later stages of each trimester of pregnancy and once in the postpartum period. A marker set-up [4] was used for limb segments and CODA protocols for models of the pelvis segment. Kinematic and kinetic data were collected by means of 12 infrared high-speed cameras (Qualisys, Sweden), two Kistler and one AMTI force platforms, at a rate of 1000 Hz. We have described the temporal and spatial parameters of the gait cycle, the angular kinematics [2] of the lower limb, and the moments of force [3] at the ankle, knee and hip joints, in the three trimesters of pregnancy and in the postpartum period. Results Women maintain the same temporal and spatial parameters of gait throughout pregnancy and during the postpartum period. The angular kinematics of lower limb shows few adaptations in pelvis and hip joints. The hip is the joint that shows the greatest changes in joint kinetics during pregnancy, with an increase of the internal loading associated with the hip moments in the transverse plane. In the other planes of motion, joint moments and power shows a significant decrease to the end of pregnancy or an increase from some stages of pregnancy to the postpartum period. Discussion The biomechanical adaptations are related to body stability and fall prevention, however, they might be also related to low back pain. Hip and ankle joints seem to have the major changes and, therefore, the ones with an overload on the lower limb. Based on the data available, some recommendations for exercise prescription can be developed in order to improve the well-being of women throughout pregnancy. References [1] Branco M, Santos-Rocha R, Vieira F. World Scientific Journal 2014 [2] Branco M, Santos-Rocha R, Vieira F, Aguiar L, Veloso AP. Scientifica 2015 [3] Branco M, Santos-Rocha R, Vieira F, Aguiar L, Veloso AP. Acta Bioeng Biomech 2016 [4] Cappozzo A, Cappello A, DellaCroce U, Pensalfini F. IEEE Transactions on Biomedical Eng 1997 Support FUNDAÇÃO PARA A CIÊNCIA E TECNOLOGIA / Portuguese Foundation for Science and Technology (PTDC/DES/102058/2008). Contact ritasantosrocha@esdrm.ipsantarem.pt

**Invited symposia****IS-SP02 Sports Nutrition Symposium - Prime, Perform and Recover: exploring nutrition strategies surrounding exercise sponsored by GSSI****ATHLETE PREPARATION: BEYOND THE BASICS**

HAWLEY, J.

*Mary MacKillop Institute for Health Research*

Advances in molecular biology during the past 20 years have allowed scientists to elucidate how endurance- and resistance-based exercise stimulate skeletal muscle remodelling (i.e., promote mitochondrial biogenesis and muscle hypertrophy). A growing field of interest directly arising from our understanding of the molecular bases of training adaptation is how nutrient availability alters the regulation of many contraction-induced events in muscle in response to exercise. Changes in energy availability (acute and chronic) and macronutrient composition alter the concentration of blood-borne substrates and hormones, causing marked perturbations in the storage profile of skeletal muscle and other insulin-sensitive tissues. In turn, muscle energy status exerts profound effects on resting fuel metabolism and patterns of fuel utilization during exercise, as well as acute regulatory processes underlying gene expression and cell signalling. As such, nutrient-exercise interactions have the potential to activate or inhibit many biochemical pathways with putative roles in training adaptation. This talk will focus on recent trends in athlete preparation that have employed dietary periodisation protocols to enhance training adaptation and improve performance in endurance sports.

**FRUCTOSE METABOLISM IN A FUNCTIONAL PERSPECTIVE. IMPLICATIONS FOR ATHLETES**

TAPPY, L.

*University of lausanne*

Substantial amounts of fructose are present in our diet. Either as free fructose in fruits, or as part of sucrose or high fructose corn syrup in drinks. Unlike glucose, fructose cannot be metabolized by most cells, and has first to be converted into lactate, glucose or fatty acids by enterocytes, hepatocytes and kidney proximal tubule cells, which all express specific fructose-metabolizing, gluconeogenic, and lipogenic enzymes. The specific metabolism of fructose may possibly exert reported detrimental effects in sedentary subjects due to production of hepatic lipids, increased intrahepatic fat accumulation and stimulation of VLDL secretion. During exercise, however, its particular metabolism may present some advantages for athletes. First, fructose and glucose are absorbed through distinct gut transporters, co-ingestion of glucose and fructose could increase total carbohydrate absorption and oxidation. Second, fructose is largely metabolized into glucose and lactate, resulting in a net local lactate release from splanchnic organs (mostly the liver). This hepatic to muscle lactate shuttle may be advantageous by providing lactate as an additional energy substrate to the working muscle. Following exercise, co-ingestion of glucose and fructose mutually enhance their own absorption and storage, and may thus contribute to whole body glycogen resynthesis.

**NUTRITION STRATEGIES TO MAXIMISE RECOVERY AND ACCELERATE RETURN TO PLAY**

PHILLIPS, S.

*McMaster University*

Injury in sport is often accompanied by disuse atrophy, which must be countered before a return to play. Inflammation, if present, also needs to be treated to provide an environment for a full return to play. Disuse atrophy is primarily due to a decline in muscle protein synthesis with a small contribution of increased proteolysis. In this presentation the evidence for nutritional mediation of disuse atrophy will be discussed in the context of several nutritional mediators including: protein, leucine, creatine, and n-3 polyunsaturated fatty acids. A brief word on recovery of connective tissue will also be made. All data will be taken from human studies and recommendations will be made for the practitioner for nutritional strategies to promote recovery and return to play as soon as possible after injury.

**Invited symposia****IS-PM05 Impact of exercise on vascular disease: benefits and mechanisms****PHYSIOLOGICAL MECHANISMS OF EXERCISE ON VASCULAR FUNCTION**

ADAMS, V.

*Heart Center Leipzig*

Over the last decade it became evident that physical exercise training programs for patients with cardiovascular disease exerts beneficial effects with respect to exercise capacity, thereby influencing cardiovascular mortality. Based on animal models as well as on several clinical studies, targets of the training intervention could be identified. Organs influenced by exercise training are beside the myocardium, the endothelium, the respiratory system including the diaphragmatic muscle and the peripheral skeletal muscle. In the vascular system nitric oxide (NO) is one of the main factor responsible for the regulation of the vascular function. The concentration of bioavailable NO is significantly reduced in patients with cardiovascular disease and exercise training has the potency to prevent this reduction. During the talk several mechanisms will be discussed which may be responsible for the beneficial effect of exercise training on the NO system. These effects include modulation of eNOS expression and activation by phosphorylation and modulation of NO by reactive oxygen species (ROS). Beside these direct effects on the eNOS/NO system exercise training also modifies the repair capacity of the endothelial cell layer. In this context the regulation of endothelial repair mechanisms, including endothelial progenitor cells and their modulation by adiponectin, will be discussed.

**MEASURING SUBCLINICAL ATHEROSCLEROSIS IN OBESE CHILDREN**

HANSEN, H.

*University of Basel*

The prevalence of childhood obesity is high and its association with future cardiovascular disease in adulthood is well established. Childhood obesity has been associated with increased adult risk of coronary heart disease and premature death. In children, the associations of overweight and obesity with higher blood pressure and cholesterol have been found to be comparable to those of adults. Therefore, the early detection of subclinical markers of atherosclerosis in childhood is a challenging task of high clinical relevance. Non-invasive vascular biomarkers enable the population-wide screening of cardiovascular risk. The evidence for obesity-associated early impairments of the vasculature in children is substantial. The assessment of large artery structure and function, for example by measurements of intima media thickness and arterial stiffness, has been shown to be a feasible and reproducible screening tool in children. Our research group and others have recently shown that retinal vessel analysis is a promising new diagnostic tool for the assessment of obesity-related subclinical atherosclerosis of the microvasculature in school children. The retinal microcirculation is affected early in the process of atherosclerosis and it offers a unique opportunity to analyse the effects of obesity on small brain vessels. Macro- and microvascular biomarkers represent the cumulative cardiovascular risk on target organ damage and are necessary diagnostic means to monitor and evaluate the effects of lifestyle intervention therapies in children. The proposed presentation will focus on methodological approaches and the clinical relevance of the above mentioned vascular biomarkers in children. Moreover, it will focus on the effects of physical activity behaviour and exercise on vascular structure and function in childhood.

**WALKING TRAINING IN PERIPHERAL VASCULAR DISEASE: CARDIOVASCULAR RISK, FUNCTION AND REGULATION**

FORJAZ, C.

*University of Sao Paulo*

Patients with peripheral arterial disease commonly experience intermittent claudication during walking, which impairs walking capacity, and consequently, decreases quality of life. In addition, they also present impaired cardiovascular function and regulation, which increase cardiovascular morbidity/mortality. Walking training is recommended as the first line of treatment for these patients because it has proved to increase walking capacity. However, in order to decrease mortality in this population, walking training should also produce cardiovascular benefits. Acute and chronic cardiovascular adaptations have been reported after walking in other populations, such as hypertensives, diabetic and cardiac patients. In the last years, our research group has studied systemic and local hemodynamic responses as well as cardiovascular autonomic modulation adaptations to walking in patients with intermittent claudication, and interesting results and limitations for walking benefits have been observed. The invited presentation will focus, initially, on the acute post-effects of walking exercise on cardiovascular function and regulation in patients with intermittent claudication, comparing responses after maximal and submaximal efforts. Next, walking training effects will be discussed, focusing on walking protocol, benefits and mechanisms of improvement. Contact: cforjaz@usp.br

## Oral presentations

### OP-PM09 Supplements: Protein, Creatine, Caffeine

#### CREATINE LOADING DOES NOT ATTENUATE MUSCLE DISUSE ATROPHY

BACKX, E.M.P.1,2,3, HANGELBROEK, R.W.1,2, SNIJDERS, T.2,3, VERDIJCK, L.B.2,3, DE GROOT, L.C.P.G.M.1,2, VAN LOON, L.J.C.2,3

*Maastricht University*1 Department of Human Nutrition, Wageningen University, Wageningen, The Netherlands; 2 Top Institute Food and Nutrition, Wageningen, The Netherlands; 3 NUTRIM School of Nutrition

**Introduction** Short term leg immobilization leads to rapid loss of muscle mass and strength. Creatine supplementation has been shown to increase lean body mass in active individuals and augment gains in muscle mass and strength during resistance type exercise training. **Objective** To investigate whether creatine loading can attenuate the loss of muscle mass and strength during short-term leg immobilization in healthy, young men. **Methods** Thirty healthy, young men (aged  $23 \pm 1$  y; BMI  $23.3 \pm 0.5$  kg·m<sup>-2</sup>) were randomly assigned to either a creatine (CR) or a placebo group (PLA). Subjects received placebo or creatine supplements (20 g/d) for 5 days before one leg was immobilized by means of a full-leg cast for 7 days. Muscle biopsies were taken before creatine loading, prior to and immediately after leg immobilization and after 7 days of subsequent recovery. Quadriceps cross-sectional area (CT scan) and leg muscle strength (1RM leg extension) were assessed before and after immobilization and after the recovery week. Data were analyzed using repeated measures ANOVA. **Results** Five days of creatine loading tended to increase muscle total creatine content from  $86 \pm 9$  to  $102 \pm 7$  mmol per kg dry muscle (mmol·kg<sup>-1</sup>) in the CR group ( $P=0.06$ ), while muscle creatine concentration did not change in the PLA group ( $88 \pm 4$  to  $90 \pm 3$  mmol·kg<sup>-1</sup>;  $P>0.05$ ). A decrease in quadriceps muscle mass was observed in the immobilized leg in both the CR and PLA groups ( $-465 \pm 59$ ;  $P<0.05$  and  $-425 \pm 69$  mm<sup>2</sup>;  $P<0.05$  respectively), with no differences between groups ( $P>0.05$ ). Leg muscle strength decreased in both the CR (from  $56 \pm 4$  to  $53 \pm 4$  kg;  $P<0.05$ ) and PLA group ( $59 \pm 3$  to  $53 \pm 3$  kg;  $P<0.05$ ), with no differences between groups ( $P>0.05$ ). When non-responders to creatine loading were excluded ( $n=6$ ), responders ( $n=8$ ; 70 to 106 mmol·kg<sup>-1</sup>) showed similar findings with no preservation of muscle mass or strength during immobilization when compared to the PLA group. **Conclusion** Creatine supplementation does not attenuate the loss of muscle mass and strength during a short period of leg immobilization. **Contact** Evelien.Backx@maastrichtuniversity.nl

#### CAFFEINE AND ITS INFLUENCE ON PERFORMANCE, HEART RATE VARIABILITY, BLOOD PRESSURE AND TIDAL VOLUME IN PARA- AND TETRAPLEGIC INDIVIDUALS COMPARED TO ABLE-BODIED CONTROLS

FLUECK, J., SCHAUFELBERGER, F., LIENERT, F., PERRET, C.

*Swiss Paraplegic Centre*

**Introduction:** Caffeine (CAF) ingestion leads to ergogenic effects in high-intensity and endurance exercise in able-bodied (AB) athletes. To date, it is unclear whether such an effect could be detected in wheelchair athletes as well due to impaired sympathetic nervous system activation of spinal cord injured individuals. The study investigated the effects of CAF on upper body performance in para- (P) and tetraplegic (T) compared to AB participants. Additionally, heart rate variability (HRV), blood pressure (BP) and tidal volume (VT) were assessed to gain more information about sympathetic activation. **Methods:** 17 AB (median [minimum; maximum]; VO<sub>2</sub>peak 39.9ml/min/kg [23.6; 57.6]), 10 P (VO<sub>2</sub>peak 34.4ml/min/kg [19.5; 48.8]) and 7 T participants (VO<sub>2</sub>peak 13.6ml/min/kg [8.6; 16.3]) participated in this double-blind, placebo-controlled and randomized study. Participants performed twice a 3min all-out arm crank test 1h after the ingestion of either 6mg/kg CAF or placebo (PLC). Plasma CAF, epinephrine (EPI) and norepinephrine (NOR) concentrations were analyzed pre- and post-ingestion. Pre- and 40min post-ingestion, HRV, VT during HRV measurement and BP were assessed. **Results:** There was no significant increase in peak and mean power over 3min after the ingestion of CAF in the three groups. The median for peak power showed an increase of 46W (AB), 21W (P) and 2W (T) after CAF compared to PLC. Performance in the first 30s to 60s of the test after CAF ingestion significantly increased in P ( $p=0.028$ ) but not in AB ( $p=0.44$ ) and T ( $p=0.61$ ). Plasma CAF concentration significantly increased in all three groups (AB:  $p=0.005$ ; P:  $p=0.008$ ; T:  $p=0.018$ ) post CAF ingestion. A significant increase from pre to post CAF ingestion in EPI was found in AB ( $p=0.002$ ) and in P ( $p=0.032$ ) but not in T ( $p=0.63$ ). Most HRV parameters did not change post CAF ingestion compared to PLC, whereas LF/HF ratio was significantly reduced in P ( $p=0.028$ ). VT significantly increased post CAF ingestion in AB ( $p=0.021$ ) and P ( $p=0.036$ ) but not in T ( $p=0.34$ ). Systolic and diastolic BP increased significantly post CAF ingestion in AB (SBP:  $p=0.003$ ; DBP:  $p=0.021$ ) and T (SBP:  $p=0.043$ ; DBP:  $p=0.042$ ) but not in P (SBP:  $p=0.09$ ; DBP:  $p=0.33$ ). **Discussion:** CAF seemed to enhance performance between 30 and 60s in P but not in AB and T. However, a clinically relevant increase in peak power occurred in AB and P. VT increased from pre to post CAF ingestion in AB and P possibly due to an increase in plasma EPI. Furthermore, CAF ingestion seems to elevate BP in all three groups. **Contact:** joelle.flueck@paraplegie.ch

#### RESISTANCE TRAINING REDUCES T HELPER CYTOKINE LEVELS BUT NOT CARDIOMETABOLIC RISK FACTORS IN HIV-INFECTED INDIVIDUALS RECEIVING ANTIRETROVIRAL THERAPY.

SOOKAN, T.1, ORMSBEE, M.J.1,2, ANTONIO, J.3, MAGULA, N.P.1, MOTALA, A.A.1, LALLOO, U.G.1, LIEBENBERG, L.1, MCKUNE, A.J.1,4

1. University of KwaZulu Natal, 2. Florida State University, 3. Nova South-eastern University, 4. Canberra University

**Introduction** A shift from T helper (Th) 1 to Th2 cytokine profile is associated with disease progression in HIV-infected individuals and has been linked to lipodystrophy (Drelichowska et al., 2015). Resistance training (RT) in combination with protein-containing nutrition has shown to improve strength and body composition. Therefore the aim of this study was to determine the effect of combined resistance training and whey protein on body composition, Th1 and Th2 cytokines and cardiometabolic risk in HIV infected individuals receiving ART. **Methods** Forty HIV-infected participants ( $40.8 \pm 7.7$  yrs,  $70.8 \pm 16$  kg, BMI  $30.9 \pm 7.2$  kg/m<sup>2</sup>) receiving ART ( $\geq 18$  months) were randomly assigned to either a whey protein/progressive resistance training (PRT) group ( $n=18$ ), placebo/PRT group ( $n=14$ ) or control group ( $n=8$ ). Participants received either 20g whey or placebo (maltodextrin) pre and immediately post each PRT session. Whole body RT was performed 2/week for 3 months with the loads progressing from 40-85% of one repetition maximum (1RM). Measurements including height, weight, waist and hip, body composition (DEXA) and 1RM testing were performed 48-72 hrs before (pre = T1) and after 3 months (T2) PRT

program and 3 months (T3) following the cessation of the PRT program. Additionally, venepuncture was done to look at systemic immune, inflammatory and cardiometabolic risk markers. Statistical analysis included two-way ANOVA with multiple comparisons (2 groups x 3 time points) in the PRT groups and one-way ANOVA with repeated measures in the control group. Alpha was set at  $p \leq 0.05$ . Results: There was a significant ( $p < 0.001$ ) main effect of time for the PRT groups and control group for the HOMA-IR index. Post-hoc testing demonstrated that the HOMA-IR index significantly increased from T1 to T2 ( $p = 0.002$ ) and from T1 to T3 ( $p < 0.001$ ) for the placebo/PRT and whey/PRT groups, respectively. The control group increased significantly ( $p < 0.001$ ) from a T1 value of 0.37 to 1.44 at T2 and ( $p = 0.002$ ) a T1 value of 0.37 to 1.23 at T3. There was a significant ( $p = 0.05$ ) main effect of time for the PRT groups for the Th2 cytokine IL-10, post hoc testing showed no significant time effect over the 3 time points. There was a significant main group effect for CD8% ( $p = 0.05$ ), IL-10 ( $p = 0.01$ ), IL-13 ( $p = 0.05$ ) and IL-12 ( $p = 0.02$ ). Post hoc testing showed a significant group effect with the placebo/PRT lower over the 3 time points for IL-10 ( $p = 0.008$ ) and IL-12 ( $p = 0.016$ ). Conclusion HIV serves as both a metabolic and an inflammatory challenge (Singh et al., 2016). Our study demonstrated that a PRT programme can decrease anti-inflammatory and pro-inflammatory cytokines possibly reflecting reduced systemic inflammation in HIV-infected individuals (Reuter et al., 2012). References DRELICHOWSKA, J., KWIATKOWSKA, W., KNYSZ, B. & WITKIEWICZ, W. 2015. HIV & AIDS Review, 14, 35-41. REUTER, M. A., POMBO, C. & BETTS, M. R. 2012. Cytokine & growth factor reviews, 23, 181-191. SINGH, S., SHARMA, A. & ARORA, S. K. 2016. Cytokine, 77, 135-144. Sookan@ukzn.ac.za

## CHRONIC INGESTION OF A LOW DOSE OF CAFFEINE INDUCES TOLERANCE TO THE PERFORMANCE BENEFITS OF CAFFEINE

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This study examined the effect of 4 weeks caffeine supplementation on endurance performance. Eighteen low habitual caffeine consumers ( $<75$  mg/day; age:  $21.2 \pm 1.8$  y; body mass:  $74.05 \pm 8.6$  kg;  $VO_{2peak}$ :  $51.38 \pm 8.73$  ml·kg<sup>-1</sup>·min<sup>-1</sup>) were randomly assigned to ingest caffeine (1.5 mg/kg–3 mg/kg; titrated) or placebo for 28 days. Groups were matched for measures of age, body mass and  $VO_{2peak}$  ( $P > 0.05$ ). Prior to supplementation all subjects completed one  $VO_{2peak}$  test, one familiarisation trial and two experimental trials (acute 3 mg/kg caffeine [CAF1] and placebo [PLA]). During the supplementation period a second  $VO_{2peak}$  test was completed on day 21 prior to a final acute 3 mg/kg caffeine trial (CAF2) on day 29. Trials consisted of 60 min cycle exercise at 60%  $VO_{2peak}$  followed by a 30 min workload challenge. All subjects produced more work during the CAF1 trial compared to PLA, with increases of  $38.4 \pm 19.9$  kJ ( $383.3 \pm 75$  kJ;  $344.9 \pm 80.3$  kJ,  $P = 0.001$ ) and  $21.4 \pm 13.1$  kJ ( $354.5 \pm 55.2$  kJ;  $333.1 \pm 56.4$  kJ,  $P = 0.004$ ) for the caffeine and placebo group, respectively. This response was no longer apparent following 4 weeks of caffeine supplementation (CAF1:  $383.3 \pm 75$  kJ; CAF2:  $358 \pm 89.8$  kJ,  $P = 0.025$ ), but remained in the placebo group (CAF1:  $354.5 \pm 55.2$  kJ; CAF2:  $351.8 \pm 49.4$  kJ,  $P > 0.05$ ). No between-group differences were observed in caffeine metabolism, hormonal concentrations or substrate oxidation ( $P > 0.05$ ). It appears chronic ingestion of a low dose of caffeine can result in the development of tolerance.

## CAFFEINE AND SALIVA STEROIDS IN YOUNG HEALTHY RECREATIONALLY TRAINED WOMEN: IMPACT OF REGULAR CAFFEINE INTAKE

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*Collegium Sciences et techniques - Pôle STAPS - Université Orléans*

Introduction Caffeine induces a lot of metabolic effects, but its impact on steroid hormone concentrations as well as on their diurnal pattern remained poorly known. The purpose of this investigation was therefore to determine the effects of acute caffeine intake on saliva cortisol and DHEA concentrations during a waking diurnal cycle in regular caffeine users (CU) and non caffeine users (NCU). Methods Nineteen healthy young recreationally trained females (physical activity for 4–6 h/week,  $19.5 \pm 0.3$  years,  $57.1 \pm 1.6$  kg) were recruited to participate in the study. Saliva samples were collected from at awakening, and then every 3 hours from 0900 to 2100 hours a day without any caffeine intake and a day with caffeine intake, i.e., 150 mg twice a day, respectively at 0730 and 1330. Results Diurnal decline for cortisol and DHEA was observed during the experimental days with and without caffeine for both NCU and CU subjects, without any significant alteration in their diurnal pattern by caffeine. However, morning but not afternoon caffeine intake induced a significant increase at 0900 in cortisol for all subjects ( $p < 0.01$ ) and in DHEA only in CU group ( $p < 0.05$ ). Discussion Acute caffeine intake, whatever the regular caffeine use, does not affect the circadian pattern of saliva metabolic steroids in healthy recreationally-trained women. To our knowledge, only few studies investigated short-term caffeine intake on DHEA response (Wedick et al., 2012, MacKenzie et al., 2007) but the acute effects of caffeine administration on DHEA have never been studied. Further studies are necessary to determine whether the marked transient increase in morning cortisol induced by caffeine, combined or not with DHEA increase, may have a clinical impact. References Wedick NM, Mantzoros CS, Ding EL, Brennan AM, Rosner B, Rimm EB, Hu FB, van Dam RM (2012). Nutr J, 11: 86. MacKenzie T, Comi R, Sluss P, Keisari P, Manwar S, Kim J, Larson R, Baron JA (2007). Metabolism 56: 1694–1698.

## ELECTROPHYSIOLOGICAL CHANGES IN THE BRAIN INDUCED BY CAFFEINE OR GLUCOSE NASAL SPRAY

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Introduction Since a direct link between the mouth cavity and the brain has been demonstrated for glucose (GLUC) and caffeine (CAF) (De Pauw et al., 2015), the question arises whether the nasal cavity also provides a direct link to the brain. Therefore, the aim of this study is to examine the influence of nasal sprays (NAS) containing GLUC, CAF or placebo (PLAC) on brain activity using the cognitive Stroop task and electro-encephalography (EEG). Methods Ten healthy male subjects (Age:  $22 \pm 1$  yrs) performed 3 experimental trials, separated by at least 2 days. Each trial included a 20s NAS period in which solutions PLAC, GLUC or CAF were provided in a double-blind, randomized order. The final [CAF] and [GLUC] was 15 and 80mg/ml, respectively. During each trial 4 cognitive Stroop tasks were performed; two familiarization trials, one pre and one post NAS trial. Reaction times and accuracy for different stimuli (neutral: NEUTR, congruent: CON, incongruent: INCON) were determined. EEG was continuously measured throughout the trials using 32 active electrodes at a sampling rate of 256Hz. Datasets were filtered, re-referenced to an average of all electrodes and cleaned before further processing. During the Stroop tasks pre and post NAS the latency (ms) and amplitude ( $\mu$ V) of the visually-evoked event-related potential component P300 was assessed. During NAS source localization using standardized low resolution brain electromagnetic tomography (sLORETA) was applied. This program provides information of altered electrocortical activity of brain areas within certain frequency ranges. Parametric tests were performed using SPSS version 22.0. Standardized LORETA applies statistical analyses at voxel level based on the Fisher's permutation test (Fisher,



1935) and a bootstrap method with 5000 randomizations. Results and discussion All NAS solutions activated the olfactory bulb and, consequently, the anterior cingulate cortex. Only CAF-NAS also increased (theta and beta) activity in frontal cortices, possibly due to the activation of nasal bitter taste receptors. Furthermore, GLUC-NAS increased the beta activity within the anterior insular cortex, but not in frontal brain areas. A reduced latency and increased amplitude of P300 are associated with enhanced information processing. P300 analysis showed that CAF-NAS reduced the P300 latency at F1 for NEUTR ( $p=0.005$ ). GLUC-NAS reduced the P300 latency at C3 for CON ( $p=0.024$ ). Furthermore, the P300 amplitude at F4 increased for CON ( $p=0.02$ ) and INCON ( $p=0.029$ ), and reduced for NEUTR ( $p=0.010$ ). Brain activity is clearly altered, but no effect on cognitive performance was demonstrated. References De Pauw K, Roelands B, Knaepen K, Polfliet M, Stiens J, Meeusen R. (2015). *J Appl Physiol*, 118(6), 776-82. Fisher RA. New York: Hafner, 1935.

## Invited symposia

### IS-BN03 HAMSTRING MUSCLE FUNCTION IN HUMAN MOVEMENT: IMPLICATIONS FOR HAMSTRING STRAIN INJURY DETECTION AND PREVENTION

#### HAMSTRING STRAINS IN TYPICAL TRAINING TASKS AND IN ISOKINETIC ECCENTRIC CONTRACTIONS OF DIFFERENT VELOCITIES

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*University of Bath*

Acute hamstring injuries remain the most prevalent muscle injuries in sport. Muscle strain injuries occur due to high active strain of the muscle (1). The circumstances which have the potential to produce this high active strain in the hamstrings in sprinting have been well documented (2). During late swing, when the hip is flexed, the hamstrings act to decelerate the shank. This results in lengthening of the muscle-tendon unit and therefore potentially reduced capacity for active force generation within the muscle fascicles. The precise timing of muscle injury is not yet clear, but it can be argued that if the lengthening of the muscle fascicles has been excessive then they are not able to generate sufficient force to resist the external force due to body weight when the foot contacts the ground, resulting in further lengthening of the muscle and damage. What has not yet been investigated in vivo is the way in which the active and passive elements of the hamstring muscles behave during eccentric contractions. In order to more fully understand the risk factors for hamstring injuries and the inciting event for injury it is imperative to understand the relative lengthening of the different elements of the muscle. Extensive study of the ankle plantarflexor muscles has revealed that the strain of muscle fascicles does not mimic that of the whole muscle-tendon unit: with the majority of the increase in length required for ankle dorsiflexion in running occurring in the compliant Achilles tendon, and the muscle fascicles shortening slowly (4). In this presentation I explore whether the same de-coupling of muscle fascicle and muscle-tendon unit occurs in the hamstring muscles. Due to their much longer muscle fascicles one might hypothesise that the strain of their muscle-tendon units is more driven by the length change of the fascicles than the tendon, but conversely the force generating capacity of the active component of the muscle should be sufficient to resist the force due to the inertia of the shank in late swing, and allow the required muscle-tendon unit lengthening to occur in the passive elements. We have used a combination of ultrasound, motion analysis and EMG to determine biceps femoris fascicle length and muscle-tendon unit length during isokinetic eccentric contractions at different velocities and some typical training tasks in order to explore the muscle's behaviour during controlled eccentric tasks. (1) Lieber RL, Frieden J. (1993). *J. Appl. Physiol.* 74, 520-6 (2) Thelen DG et al (2005). *MSSE* 37, 1931-8 (3) Lichtwark GA, Wilson AM. (2006). *J. Exp. Biol.* 209, 4327-88 m.p.mcguigan@bath.ac.uk

#### HAMSTRING STRAINS IN HIGH SPEED MOVEMENTS- IMPLICATIONS FOR INJURY PREVENTION

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*University of Jyväskylä*

Hamstring strain injuries (HSIs) are very common in sport, and the biceps femoris (BF) is the most frequently injured muscle. Activities involving large and/or fast hamstring strains present the greatest injury risk, e.g. soccer and sprinting. Importantly, the mechanism of HSI is poorly understood because hamstring length changes have not been directly studied in movements such as running, where injuries often occur. Thus, it is important to establish whether hamstring muscle fibres actually undergo lengthening during fast movements, and to assess whether these length changes are a possible source of HSIs. In theory, hamstring length changes can be studied with ultrasound imaging. However, this approach has severe limitations in fast movements, and where muscle deformations are substantial and occur in three dimensions. In this talk I will introduce our attempts to quantify BF strains in different tasks, and highlight the limitations of this method. I will also present multi-channel electromyography data showing how muscle activity varies along the length of hamstring muscles in different tasks. Finally, the relevance of these findings for injury mechanics and prevention will be discussed.

#### IMPACT OF NORDIC HAMSTRING VERSUS HIP EXTENSION EXERCISE ON BICEPS FEMORIS FASCICLE LENGTHS AND ECCENTRIC KNEE FLEXOR STRENGTH

SHIELD, A., BOURNE, M., WILLIAMS, M., TIMMINS, R., OPAR, D.

*Queensland University of Technology*

Introduction Recently we have shown that fascicle lengths in the biceps femoris long head (BFLH) and eccentric knee flexor strength are risk factors for hamstring strains in elite Australian soccer players (Timmins et al., 2015) so it was of interest to compare the effects of two common hamstring exercises on these variables. Methods We compared the effects of 10 weeks of Nordic hamstring (NH) to hip extension (HE) training on biceps femoris long head fascicle length, determined via B-mode ultrasound, and eccentric knee flexor strength, determined during the performance of the Nordic hamstring curl. We also assessed the effects of training on hamstring muscle volumes as determined via magnetic resonance imaging. Results Biceps femoris long head fascicle lengths increased from  $10.66 \pm 0.79$  to  $12.00 \pm 0.70$ cm ( $p<0.05$ ) after HE training and from  $10.55 \pm 0.87$  to  $12.76 \pm 1.15$ cm ( $p<0.05$ ) after NH training. No changes were observed in fascicle lengths in an untrained control (CON) group. Peak forces during the Nordic hamstring exercise increased significantly in both exercise groups (from  $320.1 \pm 83.9$  to  $430.6 \pm 91.4$ N and from  $362.4 \pm 40.2$  to  $459.7 \pm 42.2$ N in the HE and NH curl groups, respectively)

but were unchanged in the CON group (from  $346.6 \pm 57.9$  at baseline to  $336.3 \pm 73.0$  N after 10 weeks). BFLH volume increased significantly more after HE than NHE (mean difference = 6.72%, 95% CI = 0.32 to 13.11%,  $p = 0.037$ ) and CON groups (mean difference = 12.10%, 95% CI = 5.71 to 18.50%,  $<0.001$ ). NH training resulted in hypertrophy to the semitendinosus and bicep femoris short head whereas the HE resulted in more homogenous growth of all muscles. Discussion Given the recent findings that BFLH fascicle length and Nordic strength are risk factors for hamstring injury in elite Australian soccer players (Timmins et al., 2015) the current findings suggest that the hip extension exercise is likely to have injury preventative effects and may have particular value in restoring biceps femoris long head muscle size after injury. However, the greater muscle excursions in the hip extension did not result in greater fascicle length changes than the Nordic exercise, which provided a powerful stimulus for fascicle lengthening. References Timmins et al., (2015) Short biceps femoris fascicles and eccentric knee flexor weakness increase the risk of hamstring injury in elite football (soccer): a prospective cohort study. Br J Sports Med, Dec 16. doi: 10.1136/bjsports-2015-095362. Email: qj.shield@qut.edu.au

## Invited symposia

### IS-BN04 FATIGUE AND FATIGABILITY IN HEALTH AND DISEASE

#### THE ADJUSTMENTS THAT LIMIT FATIGABILITY IN HEALTHY YOUNG ADULTS

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Fatigue is a disabling phenomenon that emerges due to demands placed on both the nervous system and muscle fibres during sustained activity. Our understanding of the interactions between these two systems remains incomplete (Enoka & Duchateau, 2016). Although the central nervous system continuously adjusts the activation signal sent to the involved muscles during a prescribed task, the adjustments that occur during prolonged or repetitive motor actions disrupt this interaction and lead to task failure. In addition to changes in the motor system, some of the neural adjustments observed during fatiguing contractions involve modulation of afferent feedback that arises from metabolic and chemical changes within the muscle (see Taylor et al., 2016). A direct approach to determine the factors that influence the time to task failure is not possible in humans. Rather, the typical strategy is to compare that outcomes achieved with different experimental approaches. For example, one can compare the neural adjustments of two tasks that differ only by the type of control (Hunter et al., 2002). Another strategy is to manipulate factors located at cortical level by using magnetic or electrical stimulation (Abdelmoula et al., 2016) or by the administration of drugs that modify the concentration of some brain neurotransmitters (Klass et al., 2016). Changes in afferent feedback from the muscle can also be induced by mechanical (vibration) or electrical stimulation. As cortical and spinal factors are modulated during sustained activity, several concurrent approaches probing these two neural sites and the involved muscle groups have been used to provide insight on fatigue and fatigability. Collectively, the results of these studies indicate that although both cortical and spinal factors contribute to the decrease in performance, the relative influence of the two sets of factors on endurance time are task dependent. Nonetheless, changes at spinal level appear to play a key role in establishing the level of fatigability and likely explain why it becomes progressively more difficult to activate spinal motor neurones during long-lasting submaximal efforts. The purpose of this keynote presentation is to review current knowledge on the interaction between the nervous system and muscle during fatiguing contractions and to discuss the potential mechanisms that constrain time to task failure in healthy young adults. References Abdelmoula A, Baudry S, Duchateau J. (2016). Brain stimulation (in press). Enoka RM, Duchateau. (2016). Med Sci Sports Exerc (in press) Hunter SK, Ryan DL, Ortega JD, Enoka RM. (2002). J Neurophysiol, 88, 3087-3096. Klass M, Duchateau J, Meeusen R, Roelands B. (2016). Med Sci Sports Exerc, 48: PMID: 26784275. Taylor JL, Amann M, Duchateau J, Meeusen R, Rice C. (2016). Med Sci Sports Exerc (Submitted).

#### FATIGABILITY DIFFERS WITH AGING AND TASK DEMANDS

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Age-related changes within the neuromuscular system impact physiological adjustments during a fatiguing task in old adults. Consequently, there are age differences in fatigability of various skeletal muscle groups in the upper and lower limbs. Old adults are usually less fatigable than young adults for sustained and intermittent isometric contractions at submaximal and maximal intensities (1) primarily due to muscular mechanisms (5). The age difference in fatigability however, is diminished and even reversed when the task demands vary for different muscle groups and also with the age of the older adult. Three examples highlight the task and age dependence of fatigability among various muscle groups. 1) Advanced Age: The lesser fatigability of old adults during isometric contractions is observed in persons <75 years: thereafter, older adults are more fatigable than young adults for the ankle dorsiflexor muscles and the fatigability is associated with functional performance measures (sit to stand and endurance walk) (2). 2) Cognitive Challenge: Imposition of a cognitive challenge during a sustained isometric contraction reduces the age difference in fatigability for the elbow flexor muscles especially in women (3), highlighting the involvement of cortical centers during fatiguing contractions among older adults. 3) Contraction Velocity: The age difference in fatigability varies with contraction velocity. For slow-to-moderate velocity contractions, the age difference in fatigability is lessened and even diminished due to muscular mechanisms (4). Furthermore, healthy old adults (>60 years) are usually more fatigable than young adults when performing high-velocity contractions with the knee extensor muscles, but not the elbow flexor muscles (Seneff and Hunter, unpublished data). Fatigability of fast velocity contractions with knee extensor muscles among old adults is also associated with reduced walking endurance. This presentation provides evidence that the age difference in fatigability: depends on the details of the task, limb muscles, and age of the person; involves varying contributions of neural and muscular mechanisms; and has consequences for performance of functional tasks among older adults. References 1. Christie A, Snook EM, Kent-Braun JA. Med Sci Sports Exerc. 2011; 43(4):568-77. 2. Justice JN, Mani D, Pierpoint LA, Enoka RM. Exp Gerontol. 2014; 55:92-101. 3. Pereira HM, Spears VC, Schlinder-Delap B, et al. Clin Orthop Relat Res. 2015; 473(8):2568-77. 4. Yoon T, Schlinder-Delap B, Hunter SK. Exp Gerontol. 2013; 48(2):259-68. 5. Yoon T, Schlinder-Delap B, Keller ML, Hunter SK. J Appl Physiol. 2012; 112(5):849-58. Contact: sandra.hunter@marquette.edu

**FATIGUE CAN BE UNRELATED TO FATIGABILITY IN CLINICAL COHORTS**

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Introduction Despite the clinical significance of fatigue, little is known about the underlying pathophysiology and current treatments rarely produce meaningful reductions in fatigue (Kluger et al. 2013). Progress is hampered by imprecise terminology and the approaches used to quantify fatigue. Fatigue To accommodate the contemporary scope of conditions ascribed to fatigue, it is defined as a disabling symptom in which physical or cognitive function is limited by interactions between performance fatigability and perceived fatigability (Enoka & Duchateau, in press). As a symptom, fatigue can only be measured by self-report and can be quantified as either a trait characteristic or a state variable. The trait level of fatigue for individuals with multiple sclerosis (MS), for example, can be quantified with the Fatigue Severity Scale (FSS) questionnaire, whereas the state levels denotes the value "right now" and can be measured with a visual analog scale. Fatigability The functional significance of the level of fatigue reported by an individual is quantified as either the amount of work that produces it (performance fatigability) or the resting levels or rates of change in psychological factors and homeostatic variables that regulate the integrity of the performer (perceived fatigability). An elevated FSS score, for example, could be attributable to such factors as a mood disorder (e.g., depression), level of voluntary activation, or sleep disturbances. Fatigue in Multiple Sclerosis To identify those factors that contribute to the greater fatigue reported by individuals with MS, Steens et al. (2012) found that the level of fatigue in MS patients (FSS score) was associated with muscle strength (MVC force), a mood disorder (depression), performance fatigability (decline in MVC force during a sustained contraction), and the ability to sustain voluntary activation during a fatiguing contraction. Moreover, improvements in FSS score after strength training are associated with adaptations in mood and the mental component of quality of life (SF-36 questionnaire), but not strength gains (Dalgas et al. 2010). Although significant amounts of fatigue reported by individuals with MS can be explained by measuring various factors known to influence performance and perceived fatigability, much less is known about the relative roles of these factors in other neurological illnesses. References Dalgas U, Stenager E, Jakobsen J, Petersen T, Hansen HJ, Knudsen C, Overgaard K, Ingemann-Hansen T. (2010). *Mult Scler*, 16, 1478-1484. Enoka RM, Duchateau J. (in press). *Med Sci Sports Exerc*. Kluger B, Krupp LB, Enoka RM. (2013). *Neurology*, 80, 409-416. Steens A, de Vries A, Hemmen J, Heersema T, Heerings M, Maurits N, Zijdewind I. (2012). *Neurorehabil Neural Repair*, 26, 48-57. enoka@colorado.edu

**Invited symposia****IS-SH03 EVIDENCE-BASED PHYSICAL ACTIVITY POLICY****EVIDENCE-BASED PHYSICAL ACTIVITY POLICYMAKING IN HEALTH PROMOTION: WHAT IT IS AND HOW IT CAN BE DEVELOPED**

RÜTTEN, A.

*Friedrich-Alexander University Erlangen-Nuremberg*

Calls for basing physical activity (PA) policymaking on scientific evidence often neglect that there are three distinct types of evidence that need to be considered: evidence on (type 1) effective PA practice for health outcomes, (type 2) on effective practice of promoting PA, and (type 3) effective practice of PA policymaking. Moreover, synthesizing relevant knowledge for policymaking requires transcending the paradigm of evidence-based medicine. It should not only draw on scientific sources such as meta-analyses (scientific synthesis) but should also consider context (realist synthesis) and policymakers' experiences (pragmatic synthesis). Results of an analysis of the existing literature and of current WHO and EU PA policies indicate that all types of knowledge synthesis are currently used, albeit in a rather unsystematic fashion. Moreover, only to a limited extent does PA policymaking build on good practice criteria and develop intersector governance structures to implement policies based on these criteria. This presentation will suggest a set of criteria derived from existing scientific publications and international policy guidelines that may help further improve PA policymaking across Europe. In conclusion, evidence-based PA policymaking should build on all three types of evidence but give priority to the production of evidence to inform the policymaking process as such. It should systematically employ interactive approaches for a pragmatic synthesis of evidence to achieve its goals.

**THE PHYSICAL ACTIVITY POLICY AUDIT TOOL: WHAT, WHERE AND HOW?**

KAHLMEIER, S.

*University of Zurich, Epidemiology, Biostatistics, and Prevention Institute EBPI*

There have been recurrent calls for countries to develop a national policy approach to address physical inactivity. However, there is limited evidence on what components of national policy are effective. The Policy Audit Tool (PAT) was developed by the HEPA Europe Network to provide a standardized instrument to assess national policy approaches to PA and to facilitate the sharing of examples and experiences. PAT comprises 28 items covering policies across multiple sectors, targets and surveillance and policy implementation. It was tested in seven European countries during 2009-12 and implemented in 22 Countries in the Eastern Mediterranean Region in 2013-2014. In each country a primary contact person led data collection, ideally with support from a multi sector project team. PAT provides a structured assessment for countries to assess their current policy actions. Results indicate that PAT completion requires consultation with key stakeholders across multiple sectors. Engagement of government agencies and NGOs is desirable to collect insights from different perspectives. The findings can underpin and inform future policy development and implementation. International comparison provides useful insights and examples which can benefit both regional and global agenda. These results have informed improvements to the tool to produce PAT Version 2, which has been launched in 2015. An outline on next steps of the PAT project will be given.

**HUMAN POWERED MOBILITY SUPPORTING SUSTAINABILITY: ENERGY, ENVIRONMENT, AND EDUCATION**

TITZE, S.

*University of Graz*

Since 1995 the health-enhancing physical activity guidelines have focused on moderate-intensity physical activity in addition to vigorous-intensity physical activity. Concurrently, human powered mobility (HPM) has become acknowledged as an important domain contributing to meet the physical activity guidelines. From the public health perspective HPM expanded the reach of inactive populations substantially, because it can be incorporated into the daily life without much extra time and it is relatively safe. Furthermore, HPM alleviate congestion and lower air as well as noise pollution. In order to inform the policy makers which strategies are effective to increase HPM on a population level different study designs and methods are needed to answer the following questions: Why should HPM be promoted? How to best promote HPM with focus on the environment? How stable is HPM over time, does HPM replace other physical activity behaviors, and what is the potential role of physical education and health promotion education in relation to walking and cycling? In this presentation studies with diverse designs and measurement methods will be presented to inform about the above listed questions.

**Invited symposia****IS-SH04 SPORT WITH PEOPLE CROSSING BORDERS****BECOMING AT HOME ACROSS BORDERS? SPORT AND THE POLITICS OF BELONGING**

SPAAIJ, R.

*Victoria University and University of Amsterdam*

This paper builds on the sociology of belonging and home to examine recreational sport as a site where people with culturally and linguistically diverse backgrounds negotiate belonging. Belonging is conceptualised as a dynamic interplay between the politics of belonging and the personal, intimate experience of becoming 'at home' in a place or in particular collectivities. Drawing on five years of fieldwork at community sports clubs and events in Australia and the Netherlands, three key questions are addressed: What kinds of belonging are constructed by people with culturally and linguistically diverse backgrounds in sport? What social processes facilitate or impede these belongings? And what forms of boundary work are involved in the negotiation of these belongings? It is shown how the kinds of belonging that people with culturally and linguistically diverse backgrounds negotiate in sport are multi-layered and situational, and how they intersect with, and are shaped by, discourses, practices and structural forces of inclusion/exclusion. In doing so, this paper will advance current understanding of the role and significance of sport in processes of migrant belonging and refugee settlement.

**DANCE MOVEMENT THERAPY WITH REFUGEES**

KOCH, S.C., GREY, A.

*SRH University Heidelberg / Alanus University Alfter*

Dance Movement Therapy (DMT) is a nonverbal psychotherapeutic treatment method aiming to improve health related outcomes. In the work with refugees, DMT can help to cross language and cultural barriers and to establish trust. For torture victims, it can reintegrate the distorted body image, from a feeling of fragmentation to a reactivation of resources and a feeling of being whole again. For all refugees, it can support cultural adaptation, integration, and bring back joy, health, and satisfaction to a scattered life path. This session introduces DMT projects with refugees at SRH University of Heidelberg (Koch) and worldwide (Grey).

**SPORT AND EXERCISE THERAPY WITH PEOPLE FORCED TO CROSS BORDERS**

LEY, C.

*University Vienna*

People who were forced to cross borders due to torture and war show a particularly high prevalence of psychosomatic and psychosocial disorders. At the same time, numerous studies have shown the somatic and psychosocial health benefits of exercise and sport. These benefits are very relevant for traumatised refugees, torture and war survivors, however they are currently scarcely used and researched. In this regard, the project "Movi Kune – moving together" aims to address this gap, conducting since 2013 a series of intervention studies together with the care centre for torture and war survivors Hemayat in Vienna (Austria). The research analyses effect mechanisms in order to contribute to the understanding of the therapeutic processes and outcomes of sport, exercise and movement with torture and war survivors. This lecture focuses on the results regarding the self-experiencing processes through the active and bodily participation and the group-experiencing processes as specific aspects of the sport and exercise therapy; it also debates research challenges and complementary effects with other therapies, e.g. with art therapy. Finally it discusses the role of sport and exercise in the framework of trauma work with people forced to cross borders, highlighting concrete ways to cross disciplinary borders in research and to foster complementary work.



## Invited symposia

## IS-EX02 CSSS - ECSS exchange symposium: PHYSICAL ACTIVITY AND HEALTH PROMOTION (China)

**EXERCISE AS MEDICINE: FOCUS ON THE EFFECT OF INTERVAL-WALKING IN THE TREATMENT OF PATIENTS WITH TYPE 2 DIABETES**

PEDERSEN, B.K.

*Rigshospitalet and University of Copenhagen*

Type 2 diabetes mellitus (T2DM) is associated with metabolic dysregulation and chronic inflammation, and regular exercise provides a strong stimulus for improving both. It has been known for many years that peripheral tissue glucose disposal is increased and blood glucose is lowered in subjects with T2DM after an exercise session under carefully controlled, laboratory conditions. Furthermore, solid evidence that physical activity improves glycemic control in T2DM subjects, but only if the exercise is supervised. Given the global burden of T2DM, it is necessary to develop new exercise training regimes that can be incorporated in the daily life of this patient group. We have shown that 4 months of free-living interval-walking (IW) training improves glycemic control more than energy expenditure- and time duration-matched continuous-walking (CW) training in T2DM subjects. Moreover,  $\text{VO}_{2\text{max}}$  increased in the interval-walking group, whereas no changes were observed in the continuous-walking or control group. Body mass and adiposity (fat mass and visceral fat) decreased in the interval-walking group only. While waiting for the outcome of long-term randomized clinical training studies with hard end points, it should be emphasized that physical activity represents a natural strong anti-inflammatory and metabolism-improving strategy with minor side effects and that IW training may be a way to stimulate physical activity in patients with T2DM.

## Oral presentations

## OP-PM11 Molecular Biology &amp; Biochemistry

**RIBOSOME BIOGENESIS IN HUMAN SKELETAL MUSCLE WITH CONCURRENT TRAINING COMPARED WITH SINGLE-MODE RESISTANCE TRAINING**

FYFE, J.J.1, BARTLETT, J.D.1,2, HANSON, E.D.1,3, ANDERSON, M.J.1, GARNHAM, A.P.1, BISHOP, D.J.1, STEPTO, N.K.1

*Victoria University*

1: ISEAL, Victoria University, Australia; 2: Western Bulldogs Football Club, Australia; 3: University of North Carolina, USA Introduction: Previous work (1,3) suggests interference to resistance training (RT) adaptations following concurrent training is not mediated via attenuated post-exercise increases in translational efficiency (i.e., mTORC1 signalling). Recent information has emerged on the regulation of translational capacity (i.e., ribosome biogenesis) with RT-induced skeletal muscle hypertrophy (2). We examined markers of ribosome biogenesis in skeletal muscle after concurrent training, incorporating either high-intensity interval training (HIT) or moderate-intensity continuous training (MICT), vs. RT performed alone. Methods: 23 active men (mean  $\pm$  SD:  $\text{VO}_{2\text{peak}}$ ,  $44 \pm 11$  mL·kg<sup>-1</sup>·min<sup>-1</sup>) completed 8 wk (3 sessions/wk) of either 1) HIT cycling and RT (HIT+RT group, n=8), 2) MICT cycling and RT (MICT+RT group, n=7) or 3) RT only (RT group, n=8). After training, a single-bout exercise trial was performed to measure post-exercise molecular responses in skeletal muscle in a training-accustomed state. Vastus lateralis muscle biopsies were obtained at rest pre- and post-training, and 1 h and 3 h after the single-bout exercise trial. Results: Training-induced changes in markers of ribosome biogenesis, including expression of the 45S rRNA (ribosomal RNA) precursor (~75%), and mature rRNA species 5.8S (~125%) and 28S (~75%) were greater for both MICT+RT and HIT+RT vs. RT, mirroring the larger increases in total RNA content (~27-47%). A single bout of RT performed post-training further increased the phosphorylation of p70S6K1 Thr389 (~50%) and regulators of 45S rRNA transcription, TIF-1A Ser649 (~52-75%) and UBF Ser388 (~49-64%) vs. concurrent exercise. The training-induced increase in type I muscle fibre cross-sectional area was attenuated for HIT+RT vs. RT (~34%), but was not related to changes in total skeletal muscle RNA content. Discussion: Training-induced increases in rRNA expression and total RNA content were greater with concurrent training vs. RT alone, suggesting enhanced ribosome biogenesis. This was despite RT preferentially inducing skeletal muscle mTORC1 and ribosome biogenesis signalling compared with concurrent exercise, when performed in a training-accustomed state. Together, these data suggest skeletal muscle ribosome biogenesis is not impeded with concurrent training, and that altered ribosome biogenesis does not appear to mediate interference to RT adaptations after short-term (8 wk) concurrent training. References 1. Apro W et al. (2013). *Am J Physiol Endocrinol Metab.* 305(1):22-32. 2. Figueiredo VC et al. (2015). *Am J Physiol Endocrinol Metab.* 309(1):72-83. 3. Lundberg TR et al. (2012). *Med Sci Sports Exerc.* 44(9):1680-8. Contact: Jackson Fyfe (jackson.fyfe@live.vu.edu.au)

**RIBOSOME BIOGENESIS AND INDIVIDUAL RESPONSES TO STRENGTH-TRAINING OF LOW AND MODERATE VOLUME**

HAMMARSTRÖM, D., RØNNESTAD, B.R., BLOMSTRAND, E., WHIST, J.E., ELLEFSEN, S.

a, Lillehammer University College, Lillehammer Norway; b, GIH, The Swedish School of Sport and Health Sciences, Stockholm Sweden; c, Innlandet Hospital Trust, Lillehammer Norway.

Introduction Adaptive responses to a standardized strength training-program varies substantially between individuals. To maximize training efficacy, individualization is often necessary, typically achieved by manipulating exercise-training variables such as frequency, intensity and volume. Previous studies of effects of within-session training-volume on muscle hypertrophy and strength gains show benefits of multiple-sets per exercise [1,2], however without exploring an individual perspective. Recently, ribosome biogenesis was proposed as a key determinant for muscular hypertrophy [3]. The aim of the present study was to characterize individual variation in responses to 12 wk of strength-training of low and moderate training volumes, and to explore RNA abundance, a marker of ribosome abundance as a determinant for tolerance to increased training volume. Methods Thirty-four previously untrained male (n=16, (mean  $\pm$  SD) age  $24 \pm 4$  yrs, height  $183 \pm 6$  cm and weight  $76 \pm 11$  kg) and female (n=18,  $22 \pm 1$  yrs,  $168 \pm 7$  cm,  $64 \pm 10$  kg) participants completed a unilateral strength training-program three times per wk for 12 wks consisting of three exercises (leg-press, leg-curl and knee-extension)

of low (1-set per exercise, 1S) and moderate (3-sets per exercise, 3S) training volume allocated to either leg in a within-participant design. Knee-extensor 1RM and muscle cross-sectional area (CSA) assessed was determined before and after the intervention. Bilateral biopsies sampled at rest from m. vastus lateralis pre-training and after five sessions were used to determine total RNA abundance. Results 3S led to greater improvements than 1S in maximal strength ( $46.5 \pm 22.4\%$  vs.  $42 \pm 19.3\%$ ,  $p=0.007$ ) and muscle CSA ( $5.1 \pm 3.8\%$  vs.  $3.7 \pm 3.8\%$ ,  $p=0.006$ ). 24 out of 34 benefited more from 3S. This coincided with greater increases in total RNA after five training-sessions in the three-set leg in responders to 3S compared to responders to 1S ( $1.38 \pm 0.51$  vs.  $1.14 \pm 0.17$  fold-change from baseline,  $p<0.05$ ) with no differences in the one-set leg. Discussion This study demonstrates high inter-individual variations in adaptive responses to strength-training of different training-volumes. The results suggest that the ability to benefit from greater training volumes during a 12 wk training program is somehow connected with the ability to increase abundances of ribosomes during the initial part of the program. References 1. Rønnestad BR et al. (2007). J Strength Cond Res 21(1):157-63. 2. Krieger JW (2010). J Strength Cond Res 24(4):1150-1159. 3. Chaillou T et al. (2014). J Cell Physiol 229(11):1584-1594.

### PROLONGED EXERCISE DURING CALORIC RESTRICTION AMPLIFIES MITOPHAGY-SIGNALING IN THE EXERCISED MUSCLES AND INCREASES FAT OXIDATION

MARTIN-RINCON, M.1, PEREZ-LOPEZ, A.1,2, PEREZ-SUAREZ, I.1, MORALES-ALAMO, D.1, LOSA-REYNA, J.1, PONCE-GONZÁLEZ, J.G.1, DE PABLOS-VELASCO, P.L.1, HOLMBERG, H.C.3, CALBET, J.A.1

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**INTRODUCTION** Mitochondria are continuously damaged by ROS. To avoid disease, dysfunctional mitochondria must be recognized and targeted for degradation by a specific mode of autophagy, named mitophagy. Exercise stimulates mitochondrial biogenesis (PGC1 $\alpha$ ) and fusion (mitofusin, Mfn), as well as mitophagy (BNIP3) to enhance mitochondrial quality. PGC1 $\alpha$  is reduced and mitophagy increased with starvation. How exercise and starvation interact remains unknown in humans. Thus, we aimed to determine the impact of the amount of exercise in mitophagy during severe energy deficit in skeletal muscles (sm) submitted to two levels of exercise (8h/day and 45 min/d) or no-exercise. We hypothesized that exercise will blunt PGC1 $\alpha$  and enhance mitophagy responses to starvation. **METHODS** Fifteen overweight men underwent 4 days of caloric restriction (CR) (0.8 g/kg BW/day of either whey  $n=8$  or sucrose  $n=7$ ) and prolonged exercise (PE) (45min of one-arm cranking and 8h walking/day). Muscle biopsies from both deltoid and one vastus lateralis (VL) were taken before (PRE), after PE+CR and following 3 days of control diet (isoenergetic) and reduced exercise (CD); and sm AMPK, PGC1 $\alpha$ , SIRT3, MUL1, Mfn2 and BNIP3 expressions were analyzed by WB. Maximal fat oxidation (MFO) was determined by indirect calorimetry and body composition using DEXA. Statistical analysis was performed using repeated-measures ANOVA. **RESULTS** The energy deficit was 5000 Kcal/d during PE+CR. Compared to PRE, Mfn2 expression was reduced (-24%), and BNIP3 and MUL1 increased (93-97%) in VL after CD. In the exercised and non-exercised deltoid, Mfn2 and MUL1 did not change significantly, while BNIP3 was increased (+52%,  $P<0.05$ ). PGC1 $\alpha$  and SIRT3 (mitochondrial protein) were similarly reduced and Thr172-AMPK $\alpha$  phosphorylation increased, in both deltoid and VL. Responses were similar for the whey and sucrose groups. MFO was increased, and changes in MFO and BNIP3 were associated ( $r=0.21$ ,  $P=0.05$ ). **DISCUSSION AND CONCLUSIONS** Severe energy deficit was associated with reduced mitochondrial biogenesis and mitochondrial proteins in the three sm, regardless of the amount of exercise. Mitochondrial fusion was reduced and mitophagy stimulated, with this effect being greater in VL, indicating that a higher exercise amount during starvation amplifies the mitophagic response in the exercised sm. Increased mitophagy was associated with increased MFO. Protein ingestion did not attenuate mitophagy stimulation during starvation. Exercise did not attenuate the reduction in mitochondrial biogenesis elicited by starvation. Grant: MINECO PI14/01509

### LOAD-INDUCED TYROSINE 397 PHOSPHORYLATION OF FOCAL ADHESION KINASE WITH RESISTANCE TRAINING IS MUSCLE REGION AND CONTRACTION-TYPE SPECIFIC

FRANCHI, M.V., RUOSS, S., SMITH, K., ATHERTON, P.J., NARICI, M.V., FLÜCK, M.

University of Nottingham

We previously showed that concentric (CON) vs. eccentric (ECC) type of exercise (matched for relative maximum load) leads to muscular hypertrophy through different anatomical adaptations. (1,2). Since FAK activation, measured by the proxy of Y397 phosphorylation (i.e. pY397-FAK), increases within minutes after muscle contraction and in proportion to muscle tension, we assessed whether the differences in muscle architectural responses to ECC and CON resistance training (RT) were associated with changes FAK content and in the specific Y397 phosphorylation of FAK (i.e. pY397-FAK / FAK). We hypothesized that the concentration and Y397 phosphorylation of FAK in response to training differ between contractions and between mid and distal muscle regions, reflecting distinct architectural adaptations. Four healthy young subjects ( $25.3 \pm 7.2$  years, BMI,  $24.3 \pm 3.6$ ) carried out unilateral CON and ECC RT on a leg press machine i.e. each leg performing 4x8-10 reps at 80% CON or ECC 1-RM, 3xwk., for 4-wks (as per 3). Vastus lateralis (VL) muscle biopsies were collected within 60-90 minutes post exercise from the mid-belly and distal (4 cm above the myotendinous junction) portions of the VL muscle at 0 and 4 weeks of RT and analyzed for concentrations of FAK, pY397-FAK and pY397-FAK/FAK. Results were analyzed with a repeated ANOVA with Bonferroni's post hoc test. Correlations were tested with linear regression analysis. Although training produced similar hypertrophic responses (muscle thickness CON: +8.4 %; ECC: +7.6 %), these were attained through distinctly different architectural adaptations after ECC and CON training (i.e. greater fascicle length in response to ECC whereas greater increase in PA following CON RT) (3). The different anatomical changes with the two types of RT were reflected by exercise-specific and region-specific ( $p<0.05$ ) alterations in specific Y397 phosphorylation of FAK post exercise and FAK concentration with RT. This difference was associated with an enhanced level of pY397-FAK / FAK in the distal compared to the mid-belly region post eccentric exercise ( $P<0.05$ ), CON did not affect FAK concentration and specific Y397 FAK phosphorylation. At 4 weeks, FAK concentration positively correlated with Lf ( $r=0.65$ ) and MT ( $r=0.58$ ), whereas a negative correlation was found with PA ( $r=-0.57$ ), suggesting that FAK could be linked to muscle remodeling mechanisms in response to different mechanical stimuli. Changes in pY397-FAK- concentration correlated with the work performed during maximal voluntary contraction ( $r=0.62$ ). Collectively, the data highlight that the specific Y397 phosphorylation of FAK in the VL muscle is modified by training in proportion to the impacting force and region subjected to the highest degree of loading. Site-specific changes in pY397-FAK, and FAK content may play an important role in architectural adjustment of knee extensor muscle in response to CON vs. ECC training. 1)Reeves et al. Exp Phys 2009 2)Franchi et al. Acta Phys 2014 3)Franchi et al. Phys Rep 2015

**INTERLEUKIN-15 RECEPTOR-ALPHA UPREGULATION IN SKELETAL MUSCLE BY EXERCISE AND CALORIC RESTRICTION**

PEREZ-LOPEZ, A.1,2, PEREZ-SUAREZ, I.2, MARTIN-RINCON, M.2, MORALES-ALAMO, D.2, LOSA-REYNA, J.2, RODRIGUEZ-GARCIA, L.2, PONCE-GONZÁLEZ, J.G.2, DE PABLOS-VELASCO, P.L.2, HOLMBERG, H.C.3, CALBET, J.A.L.2

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**INTRODUCTION** Overexpression of interleukin-15 (IL-15) has revealed the lipolytic, antiadipogenic and anabolic effects of this myokine. In skeletal muscle, IL-15 may act by binding to IL-15R $\alpha$ , which seems to exert independent functions from those attributed to IL-15. Interestingly, deficiency of IL-15R $\alpha$  or IL-15 overexpression in mice increased muscle oxidative capacity and fatigue resistance by eliciting AMPK/SIRT1/PGC1 $\alpha$  signaling. However, IL-15R $\alpha$  protein expression has not been studied in human skeletal muscle. Thus, we aimed to assess the potential role of skeletal muscle IL-15/IL-15R $\alpha$  in the metabolic adaptations to exercise. **METHODS** Muscle biopsies were obtained from both deltoids and one vastus lateralis muscles of 15 overweight men to analyze skeletal muscle IL-15, IL-15R $\alpha$ , AMPK, PGC1 $\alpha$  and SIRT1 expressions by Western blot in three experimental phases: PRE, before; PE+CR, after 4 days of prolonged exercise (45min of one-arm cranking followed by 8h walking each day) and caloric restriction (0.8 g/kg BW/day of either whey (n=8) or sucrose (n=7)); CD, following 3 days of control diet (isoenergetic) and reduced exercise. Maximal fat oxidation (MFO) was determined by indirect calorimetry and body composition using DEXA. **RESULTS** Whole-body fat and lean mass were reduced 2.8 and 1.0 kg at CD, respectively (P<0.05). After PE+CR, the MFO of control arm, trained arm and leg muscles were elevated by 42%, 35% and 73%, respectively, remaining elevated at CD in all muscles (P<0.05). IL-15R $\alpha$  protein expression increased by 8 and 11%, and Thr172-AMPK/Total AMPK by 27 and 56%, after PE+CR and CD, respectively. PGC1 $\alpha$  protein and mRNA expressions decreased by 17% and 26% at CD (P<0.05). SIRT1 and IL-15 were not significantly altered. No significant differences were observed among muscles or due to the ingested solutions. Finally, changes in IL-15 and IL-15R $\alpha$  were associated with changes in MFO (r=0.21 and 0.28; P<0.05), and the expression of IL-15 and IL-15R $\alpha$  were inversely related to the proportion of myosin heavy chain type I (r=-0.70 and -0.93; P<0.05) and PGC1 $\alpha$  (r=-0.71 and -0.79; P<0.05). **DISCUSSION** Skeletal muscle IL-15R $\alpha$  was upregulated by prolonged exercise and this response was associated with elevated MFO in both exercised and non-exercised muscles. Thus, enhanced IL-15/IL-15R $\alpha$  signaling may be involved in the metabolic adaptation of exercised and resting human skeletal muscles to a negative energy balance. The inverse relationship between PGC1 $\alpha$  and IL-15R $\alpha$  may reflect involvement of IL-15/IL-15R $\alpha$  in the regulation of mitophagy and protein breakdown. Grant: MINECO PI14/01509

**FIBRE-TYPE DEPENDENT ACTIVATION OF HUMAN MUSCLE CA<sup>2+</sup> AND ATP-SENSITIVE SIGNALLING PATHWAYS BY EXERCISE IS MODIFIED BY ISCHAEMIA: ROLE IN FIBRE-TYPE SPECIFIC GENE REGULATION**

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Skeletal muscle function is preserved or improved by exercise training. This may in part be ascribed to repeated, transient bursts in gene expression that accompany consecutive bouts of exercise (2). Activity-induced oscillations in cytosolic Ca<sup>2+</sup> and ATP turnover have been linked to the activation of signalling cascades regulating muscle adaptation (1, 3). These cellular signals can be manipulated during exercise by decreasing muscle perfusion (ischaemia) or arterial oxygen saturation (hypoxia). These exercise models were used to examine the association between fibre-type dependent regulation of Ca<sup>2+</sup> and ATP-sensitive signalling pathways and fibre-type specific gene transcription. Eight trained males (26  $\pm$  5 y and 57.4  $\pm$  6.3 mL·kg<sup>-1</sup>·min<sup>-1</sup>) completed three interval running sessions with (IT) or without ischaemia (CT), or in hypoxia (HT), in a randomised, crossover fashion separated by 1 week. A muscle sample was collected from both the ischaemic and control leg in IT, and from the dominant leg in CT and HT, before (Pre) and after exercise (+0h, +3h). Muscle fibres (n = 2600) were fibre-typed and grouped into type I and II fibres for immunoblotting to determine the phosphorylation of CaMKII, AMPK, ACC, MAPK and phospholamban (PLB), and for RT-PCR to quantify changes in expression of mitochondrial (PGC-1 $\alpha$ ) and ion transport (Na<sup>+</sup>-K<sup>+</sup>-ATPase) genes. p-ACC<sup>Ser221</sup>/ACC increased in type II fibres at +0h in all conditions (p < 0.05); in type I fibres there was a greater increase at +0h in the ischaemic leg compared to CT, HT, and the control leg. p-PLB<sup>Thr17</sup>/PLB increased in type II fibres in the ischaemic (p < 0.05), but not control, leg in IT. No change in this ratio was found in type II fibres after CT and HT, whilst it increased in type I fibres after all conditions (p < 0.05). Both p-CaMKII  $\gamma$ /δThr287/CaMKII and p-CaMKII  $\beta$ /MThr287/CaMKII was higher in type II vs. type I fibres at Pre and +0h (p < 0.05). p-CaMKII  $\gamma$ /δThr287/CaMKII in type II fibres decreased after CT (p < 0.05), but not after IT and HT, whilst p-CaMKII  $\beta$ /MThr287/CaMKII remained unchanged. Phosphorylation of p44/42 (Erk1/2) MAPK<sup>Thr202/204</sup>/MAPK increased (p < 0.05) in both fibre types at +0h, with no differences between conditions. We demonstrate that contraction-stimulated activation of human muscle Ca<sup>2+</sup> and ATP signalling pathways is fibre-type dependent and can be modified by ischaemia. This is likely to induce differential exercise-induced gene transcription in type I and II fibres, which may be important to the overall muscle adaptive response to exercise training. Fibre-type specific gene expression is currently being analysed and will also be presented. 1. Kristensen et al. Human muscle fibre type-specific regulation of AMPK. J Physiol, 2015. 2. Perry et al. Repeated transient mRNA bursts precede increases in transcriptional and mitochondrial proteins. J Physiol 588: 4795-4810, 2010. 3. Rose et al. Exercise increases Ca<sup>2+</sup>-calmodulin-dependent protein kinase II activity. J Physiol, 553: 303-309, 2003.

**Oral presentations****OP-PM15 Performance & Water****THE RELATIONSHIP BETWEEN POWER THRUST AND POWER DRAG IN ELITE SHORT DISTANCE SWIMMERS**

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**Introduction** At constant average speed (v), a balance between thrust force (F<sub>t</sub>) and drag force (F<sub>d</sub>) should occur: F<sub>t</sub>-F<sub>d</sub> = 0 (Toussaint et al. 1992); hence power thrust (P<sub>t</sub> = F<sub>t</sub> v) should be equal to the power needed to overcome drag forces at that speed (P<sub>d</sub> = F<sub>d</sub> v); the aim of this study was to measure P<sub>t</sub> (full tethered swims) and to estimate P<sub>d</sub> in active conditions (at sprint speed) and to compare these values. **Methods** Ten front crawl elite swimmers (male; 23.5  $\pm$  3.4 years; expertise 93.1 %  $\pm$  2.4 of 50 m world record) participated to the study; their sprint speed was measured during a 30 m all-out trial. F<sub>t</sub> was assessed during a 15 s full-tethered effort (Keskinen et al. 1989);

passive towing measurement were performed to determine speed specific drag in passive conditions ( $kP$  = passive drag force /  $v^2$ ); drag force in active conditions ( $F_d = kA v^2$ ) was calculated assuming that  $kA = 1.4$  kP (Gatta et al. 2015). Results Average sprint speed was  $2.20 \pm 0.07$  m·s<sup>-1</sup>;  $kA$ , at this speed, was  $34.7 \pm 2.5$  N·m<sup>-2</sup>·s<sup>-2</sup>. A strong correlation between power thrust ( $399 \pm 56$  W) and power drag ( $374 \pm 53$  W) was observed:  $P_d = 2.35 + 0.929 \cdot P_t$ ,  $R^2 = 0.953$ ,  $N = 10$ ,  $p < 0.001$ . The Bland-Altman level of agreement was generally less than  $\pm 1.96$  SD, the mean difference ( $\pm$  SD) between methods was  $25.8 \pm 12.2$  W. Discussion In this study, the swimmer power for propulsion was calculated as a product of force and velocity using two different methods. This evaluation shows that the power thrust values have a high degree of agreement with the (active) power drag values and this support the use of the full tethered test as an accurate, reliable test to compute the power propulsion of a swimmer. References Gatta G, Cortesi M, Fantozzi S, Zamparo P (2015) Hum Mov Sci, 39, 41-54. Keskinen KL, Tili LJ, Komi PV (1989) Scand J Sports Sci, 11, 87-92. Toussaint HM, De Groot G, Beek PJ (1992) Sports Med, 13, 8-24.

## WINTER SWIMMING - HEALTHY OR HAZARDOUS?

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**INTRODUCTION** WS is swimming in natural water at a temperature ( $T_w$ ) under 8 °C. WS has been known for many years as a non-competitive event. Recently, however, competitions in WS have been organized. Swimming produces heat. However it also causes vasodilatation in the body surface area and in active muscles and also cold water streams along the body. That's why the body cooling is greater. Protection against heat losses is possible in two ways: A extension of the isolative ability of the body and B thermogenesis. A. Vasoconstriction appears in skin and subcutaneous tissue and in inactive muscles. During the long-term cold adaptation higher subcutaneous fat thickness occurs. B. Thermogenesis is possible due to muscle activity and shivering. The most effective form is the non-shivering thermogenesis induced due to NE. Cooling a muscle causes its worse function. Both muscle shortening velocity and power decrease and the muscle fatigue arises earlier. The cold activates the sympathetic nervous system. NE increases the BP, FFA mobilization and leukocytosis. The pituitary – adrenal axis is also activated. Thyroid hormones are necessary for the development of the cold adaptation. NE reduces blood flow also in kidneys and GF falls (1). **HEALTH RISKS** Hypothermia is divided into mild ( $T_r$  32-35°C), middle ( $T_r$  30–32°C), and severe (below 30°C). Hypothalamus begins to lose its ability to regulate body temperature. It is completely lost when  $T_r$  falls below 29°C. In severe hypothermia the hospitalisation is necessary. Humans die when their  $T_r$  falls to 24 - 25°C. Cooling of the heart tissue leads via sinus node to a progressive decline of HR followed by arrhythmias and cardiac arrest (4). The face cooling acts similar changes via the diving reflex. Accidents and serious disorders in WS during race appear mostly independently on the grade of hypothermia. During the last decade a case of stroke and a case of coronary artery disease during competition were recorded in CR. **THE POSITIVE INFLUENCE** WS is an instrument for the prevention of illnesses from cold. Enhanced immunity against respiratory infection diseases developed in subjects, who regularly shower or bath in cold water. The cause lies in a higher level of plasmatic IgA (3). WS results in increased stimulation of immune system. Organism manages then easily common situations rising as a result of a relatively slight and short-term cold exposure (2) **REFERENCES** 1. Wilmore JH, Costill DL (1999) Physiology of Sport and Exercise. Human Kinetics. 2. Zeman V, (2006). Cold adaptation in man. Prague. Galen. 3. Zeman V, Sramek P, Ulicny B, et al. (1993). Med Sport Boh Slov 2, 66-71. 4. Zindler M, Dudziak R, Bunike S, (1973). Medizin, Band 11, Berlin, VEB Verlag. Supported by Ministry of Health, CZ 006698 CONTACT [vaclav.zeman@lfp.cuni.cz](mailto:vaclav.zeman@lfp.cuni.cz)

## PRIMING EFFECTS OF WATER IMMERSION ON PAIRED ASSOCIATIVE STIMULATION INDUCED NEURAL PLASTICITY IN THE PRIMARY MOTOR CORTEX

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**Introduction** Recent studies have reported cortical activation during water immersion (WI). Our previous study have shown decreased specific inhibitory circuit in the primary motor cortex (M1) modulated by cholinergic neural activity, represented by short-latency afferent inhibition (SAI) during WI (Sato et al., 2013). In terms of neural plasticity, the history of neural activity determines the sign and magnitude of subsequent synaptic plasticity (Abraham, 2006). It is possible that WI would have homeostatic aftereffects on cholinergic activity, as stronger SAI is observed after WI compared to that at baseline. In such cases, priming WI might enhance and prolong long-term potentiation (LTP)-like plasticity induced by paired associative stimulation (PAS). **Methods** We performed two experiments in 16 healthy participants to better understand the effects of priming WI on PAS-induced plasticity and its neural substrate. WI was performed for 15 min prior to PAS. PAS consisted of 180 electrical stimuli of the left median nerve at the wrist paired with a single pulse transcranial magnetic stimulation (TMS) over the hotspot of the left abductor pollicis brevis muscle at a rate 0.2 Hz at rest. In experiment 1, we measured corticospinal excitability by using single pulse TMS before and after priming WI and immediately, at 15 min, and at 30min after PAS. In experiment 2, SAI was demonstrated by using paired-pulse TMS protocol before, immediately, at 5 min, 10 min, 20 min, 30 min, and 40 min after WI to clarify the homeostatic aftereffect of WI on cholinergic neural activity. **Results** Repeated measures analysis of variance revealed a significant interaction between "priming" and "time" [ $F(2.44,36.56) = 7.82$ ,  $p < 0.05$ ] as well as between reliable main effects of "priming" [ $F(1,15) = 38.03$ ,  $p < 0.05$ ] and "time" [ $F(1.843,27.51) = 5.42$ ,  $p < 0.05$ ]. Post hoc comparisons revealed that after PAS session, motor evoked potential (MEP) amplitudes in the priming WI trial were significantly higher than that in the control ( $p < 0.05$ ). Additionally, post hoc comparisons revealed that MEP amplitudes significantly increased 15 min and 30 min after PAS only in the priming WI trial ( $p < 0.05$ ). **Discussion** The present results have shown that priming WI enhanced PAS-induced LTP-like plasticity. Several pharmacological studies have found that cholinergic activation enhances LTP-like plasticity induced by PAS (Kuo et al. 2007). Therefore, one possible explanation for the present results would be homeostatic increased cholinergic activity as an aftereffect of WI. **References** Abraham WC (2006). Nature Rev Neurosci, 9, 387-399 Kuo MF, Grosch J, Fregni F, Paulus W, Nitsche MA (2007). J Neurosci 27(52), 14442-14447. Sato D, Yamashiro K, Yoshida T, Onishi H, Shimoyama Y, Maruyama A (2013). Clin Neurophysiol 124(9), 1846-1852. Contact [daisuke@nuhw.ac.jp](mailto:daisuke@nuhw.ac.jp)

## EFFECTS OF ACUTE UNDERWATER IMMERSION ON REFLEX EXCITABILITY

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**Introduction** Water as an exercise medium creates a unique environment for both training and rehabilitation purposes (Thein and Brody 1998), but the neurophysiological effects of water immersion are poorly understood. This is at least partly due to the methodological



difficulty of implementing underwater electrical stimulation and recording. **Methods** We have custom-built a water tank to enable recording of underwater reflex responses during prolonged water immersion. The setup allows a high degree of control of relevant factors such as posture, muscle activity, electrical stimulation and other possible external factors that could affect the Hoffmann reflex. After recording a high resolution recruitment curve on dry land, 23 stimuli were given within a certain range to obtain H-reflex and M-responses. Stimulation output and inter-stimulus interval (ISI) were randomized based on previous recommendations (Brinkworth et al. 2007; Zehr 2002). One hour of dry land and 1 hour of water immersion have been compared - a total of 10 recruitment curves were obtained during 2 hour long sessions. The test session was repeated after 1 week. In order to determine spinal excitability changes, the following parameters have been analyzed: peak-to-peak amplitude of the maximal reflex and muscle response (Hmax; Mmax), H/M ratio; latencies of the reflex and muscle responses (Hlat; Mlat), slope of the ascending part of the H-reflex recruitment curve (Knikou 2008). **Results** To date, 3 healthy subjects have been tested (mean age:  $25.6 \pm 2.9$  years; height:  $177.0 \pm 2.1$  cm; body mass:  $69.3 \pm 1.7$  kg), and a further 13-16 will be tested in the near future. Results so far indicate that in general, maximal H/M ratio increases immediately after water immersion. Repeatability was also high, with mean differences between time points of 3.0% in the H/M ratio and 0.3% in maximal muscle response in the dry condition. **Discussion** To date, no study has examined neuromuscular changes during prolonged water immersion. Our results show highly repeatable underwater recording with both EMG and H-reflex methodology. In the future, further investigation of neuromuscular changes in an aquatic environment will be conducted with different populations (e.g. elderly, stroke, and spinal cord injured patients). **References** Brinkworth, R. S. A., M. Tuncer, K. J. Tucker, S. Jaberzadeh, and K. S. Türker. 2007. *Journal of neuroscience methods* 162(1-2): 1-7. Knikou, Maria. 2008. *Journal of Neuroscience Methods* 171(1): 1-12. Thein, J. M., and L. T. Brody. 1998. *The Journal of orthopaedic and sports physical therapy* 27(1): 32-41. Zehr, E. Paul. 2002. *European Journal of Applied Physiology* 86: 455-68. Contact Zsolt Jozefiak - jozefzsol@gmail.com

### ESTIMATING PEAK OXYGEN UPTAKE BASED ON POSTEXERCISE MEASUREMENTS IN SUPRAMAXIMAL SWIMMING

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**Introduction** In swimming, different approaches using postexercise measurements have been used to estimate peak oxygen uptake ( $\dot{V}O_{2peak}$ ), e.g. single time-bin measurements (Costill et al. 1985),  $\dot{V}O_2$  backward extrapolation (BE) (Léger et al 1980), and heart rate (HR)- $\dot{V}O_2$  modelling (Chaverri et al. 2015). To assess the validity of postexercise measurements in estimating  $\dot{V}O_{2peak}$ , we compared  $\dot{V}O_{2peak}$  measured during supramaximal swimming with that estimated using various commonly adopted techniques. **Methods** 31 elite swimmers performed a 200-m supramaximal swim where  $\dot{V}O_2$  was measured breath-by-breath (K4 b2, Cosmed, Italy) and HR beat-by-beat (CardioSwim, Freelap, Switzerland), 1 min before, during, and 3 min post-exercise.  $\dot{V}O_{2peak}(20-0)$  was the average of the last 20 s of effort used as a criterion. The following postexercise measures were compared: 1) first 20-s average [ $\dot{V}O_{2peak}(0-20)$ ]; 2) linear and semilogarithmic BE of the first 20 s [BE(20) and LOG(20)], first 30 s, and 3x20-s, 4x20-s and 3 or 4x20-s averages; and 3) predicted  $\dot{V}O_{2peak}$  using mathematical modelling [ $p\dot{V}O_2(0-20)$ ]. RM-ANOVA and post-hoc Bonferroni tests compared exercise  $\dot{V}O_{2peak}$  and estimated values. Pearson's  $r^2$  was used to assess correlation and for double cross-validation (DCV) analysis. **Results** Criterion exercise  $\dot{V}O_{2peak}(20-0)$  ( $3531 \pm SD 738$  ml·min<sup>-1</sup>) was different from all estimated parameters investigated ( $p < 0.001$ ) except  $p\dot{V}O_2(0-20)$  (mean diff. 1.1%,  $p > 0.99$ ), BE(20) (2.4%,  $p = 0.39$ ), and LOG(20) (2.6%,  $p = 0.30$ ). Additionally,  $p\dot{V}O_2(0-20)$  was strongly correlated with exercise  $\dot{V}O_{2peak}$  ( $r^2 = 0.962$ ; DCV:  $r^2 = 0.977$  and  $r^2 = 0.955$ ,  $p < 0.001$ ). **Discussion** Our results confirmed the  $\dot{V}O_{2peak}$  underestimation reported by Chaverri et al., 2015 when using a single time-bin post-exercise measure (e.g. 20 s, Costill et al. 1995), and the overestimation reported by Lavoie et al. (1983) when BE was used in supramaximal swimming. We conclude that the new modelling procedure based on postexercise  $\dot{V}O_2$  and HR measurements provides the most valid and accurate procedure for estimating  $\dot{V}O_{2peak}$  in supramaximal swimming whilst avoiding the estimation bias produced by other methods. **References** Chaverri D, Schuller T, Iglesias X, Hoffmann U, Rodríguez FA. (2015). *Int J Sports Physiol Perform.* [PMID:26356150]. Costill DL, Kovaleski J, Porter D, Kirwan J, Fielding R, King D. (1985). *Int J Sports Med*, 6, 266-270. Lavoie J-M, Léger LA, Montpetit RR, Chabot S. (1983). *Biomechanics and Medicine in Swimming*, 222-227. Human Kinetics, Champaign, Illinois. Léger LA, Selinger V, Brassard L. (1980). *Med Sci Sports Exerc*, 12, 24-27. Contact chaverri.diego@gmail.com

## Oral presentations

### OP-SH02 Psychology: Sport Performance

#### GOLD IN EDUCATION AND ELITE SPORT: A FLEMISH PERSPECTIVE ON THE COMPETENCES OF ELITE PUPIL-ATHLETES AND STUDENT-ATHLETES.

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**Introduction.** Elite athletes face challenges in different domains (i.e. athletic, psychological, social, academic and financial) during their dual 'elite sport and study' career (DC)<sup>o</sup>. To cope with these challenges, athletes require a set of competences in order to optimize their preparation for, and development throughout their DC<sup>o</sup>. **Aim.** While past research generally used a qualitative approach to identify the competences required for a successful DC<sup>o</sup>, this study used a quantitative approach to identify the competences (i.e. skills, attitudes, knowledge, experiences) athletes require to optimally prepare, manage and finalize their 'education and elite sport' pathway. **Method.** The online survey of the Erasmus+ Sport project 'Gold in Education and Elite Sport', which focused on i) the importance and possession of a predefined list of 38 DC competences on a 5-point scale, and ii) the importance and use of these competences in 7 specific challenging DC situations ('DC scenarios'), was presented to 891 Flemish 15-25 year-old athletes combining elite sport and study. SPSS was used for descriptive and comparative analyses, and MPlus was used for Exploratory Structural Equation Modelling (ESEM). **Results.** 524 athletes (59%) responded to the survey (mean age  $17.6 \pm 2.3$  years; 61% male athletes vs. 39% female athletes; 74% pupils vs. 26% students). While all competence items were rated as important to very important ( $4.3 \pm .70$ ), scores for possession were significantly lower ( $3.6 \pm .87$ ;  $p < .001$ ) with the largest difference between importance and possession found in management of mind and emotion (e.g. coping with stress, using setbacks as positive stimulus) and life management competences (e.g. efficient use of time; conscientious pro-active planning). On average, student-athletes experienced more scenarios than pupil-athletes (respectively 4.3 and 3.4;  $p < .001$ ). For each of

the 7 scenarios, a set of transferable competences (useable across multiple scenarios) and specific competences (needed in a specific challenging situation) was defined. Further detailed results (i.e. scenarios, inter-individual differences and the ESEM results) will be presented. Discussion. A set of competences and scenarios relevant for a DC was identified. The use of 'scenarios' guaranteed context-specificity and the identification of transferable and specific competences. DC-support providers should be aware of these transferable and specific competences in order to proactively assist and empower athletes during their DC pathway. \*Wylleman, P., Reints, A., & De Knop, P. (2013). A developmental and holistic perspective on athletic career development. In P. Sofiaradou & V. De Bosscher (Eds.), *Managing High Performance Sport* (pp. 159-182). New York, NY: Routledge. \*\*MacNamara, Á., & Collins, D. (2010). The role of psychological characteristics in managing the transition to university. *Psychology of Sport and Exercise*, 11(5), 353-362.

## EGO DEPLETION AND GLUCOSE INGESTION DURING ATHLETIC PERFORMANCE

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**Introduction** According to the strength model of self-control (Baumeister et al., 1998), self-control becomes diminished when an individual regulates his/her behaviours, a state known as ego depletion. Consequently, the individual will have a reduced capacity to perform any subsequent behaviour that requires self-regulation. This study explored whether depletion effects occur in the performance of a gross motor skill endurance task that requires self-regulation in well-trained athletes. Furthermore, the study examined the potential for glucose supplementation to moderate the ego depleting effect. **Methods** Fourteen endurance trained cyclists completed four simulated 16 km time trials on an electromagnetically braked cycle ergometer. Prior to each time trial, participants completed an easy Stroop task or a difficult Stroop task that required self-control. They also received either a glucose-based drink or placebo. Participants' performance time and heart rate were recorded throughout the time trials. **Results** Multilevel growth curve analysis revealed a significant two-way interaction for glucose and self-control ( $b = -29.43$ ;  $p = 0.036$ ). When a placebo drink was consumed, participants performed worse in the time trial following exertion of self-control, compared to when no self-control was required. This effect was not observed when a glucose drink was consumed ( $b = -7.76$ ;  $p = 0.438$ ). A significant three-way interaction revealed that ego depletion effects became significant after 80% of the trial had been completed ( $b = 20.20$ ;  $p = 0.037$ ). **Discussion** The results indicate that initial self-control exertion can negatively affect subsequent performance in well-trained endurance athletes as they perform highly practiced behaviour. In addition, the results suggest that the supplementation of glucose during a physical sports task that requires self-regulation can negate the ego depleting effect. However, this moderating effect may only manifest in longer duration endurance performances. The results provide support for the viability of utilising the strength model of self-control to understand self-regulation failures within athletic performance environments. The findings help understand the relationship between cognitively demanding acts and subsequent highly practiced endurance performance. **References** Baumeister R, Bratslavsky E, Muraven M, Tice D (1998). *J Pers Soc Psychol*, 74, 1252-1265. Contact R.Boat@lboro.ac.uk

## NARCISSISM AND PERFORMANCE UNDER STRESS: EVERY PIECE OF NARCISSISM MATTERS

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**Introduction** Narcissists thrive under stress as stressful environments provide the narcissist with an opportunity for personal glory (Wallace & Baumeister, 2002). Previous work in this area has only focused on narcissistic grandiosity as a typical trait of arrogance and entitlement seeking. However, evidence has highlighted that grandiosity is multidimensional (containing adaptive and maladaptive components), and the influence of each of these in relation to performance is unknown. Therefore, the aim of the study was to provide a more detailed understanding of the narcissism-performance relationship by examining the potential interaction effect between adaptive and maladaptive narcissism. **Method** Sixty experienced male basketball players ( $M_{age} = 21.87$ ,  $SD = 2.13$ ) completed measures of narcissistic grandiosity (NPI-16) and performed a free throw task under low (individual session) and high stress (group competition). We measured anxiety in each condition using the CSAI-2R. **Results** Moderated regression analyses revealed a significant interaction between adaptive and maladaptive components of grandiose narcissism ( $\Delta R^2 = .06$ ,  $F = 5.14$ ,  $\beta = .28$ ,  $p = .03$ ). Adaptive narcissism was positively related to performance only when maladaptive narcissism was high ( $\beta = .78$ ,  $p < .01$ ); maladaptive narcissism was positively related to performance only when adaptive narcissism was high ( $\beta = .42$ ,  $p = .08$ ). **Discussion** Every piece of narcissism is essential to achieve the highest performance under stress though different dimensions of narcissism contribute differently. This finding may advance our understanding of individual differences' influence on performance. Future research would do well to clarify these effects and identify the potential underlying mechanism. **References** Wallace, H. M., & Baumeister, R. F. (2002). The performance of narcissists rises and falls with perceived opportunity for glory. *Journal of Personality and Social Psychology*, 82(5), 819-834.

## WHAT SUPPORTS PEOPLE WITH MENTAL HEALTH PROBLEMS TO PARTICIPATE IN SPORT CLUB PROGRAMMES? A QUALITATIVE APPROACH

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**Introduction** Quality of life among people with mental health problems can be improved through physical activity (Rosenbaum et al., 2014). In an Austrian pilot study, the majority of people with mental health problems reported that they are less active than they would like to be. Although sports clubs are widespread in Austria, it is assumed that their structures are inappropriate for this vulnerable group. Therefore, we studied among people with mental health problems and their trainers whether structures in sport clubs meet the needs of this target group. **Methods** For this study, individuals of the target group were eligible if they stayed at least once in a psychiatric hospital and attended the "Pro Move" physical activity program run by a mental health NGO at least once a month since 2013. Semi-structured interviews were undertaken with 15 people (2 women) with a mean age of 36.7 ( $SD=11.8$ ) and a mean body mass index of 27.6 ( $SD=5.6$ ) and 11 trainers of European sport club associations who offer sport programs for that target group were asked to complete a questionnaire. The data were transcribed and relevant paragraphs were assigned to categories related to structures in sport club by using a Grounded Theory approach (Strauss & Corbin, 2010) **Results** Trainers considered two options of how to structure physical activity programs for people with mental problems. The first option was that sport clubs should offer courses provided specifically for this target group. This is also preferred by many of the interviewed persons with mental health problems, as they reported experiencing an increased feeling of well-being and understanding in the own peer group. The second option was that people with mental health problems should participate in open courses eligible for the general population. For the target group this is feasible only if there is an existing

atmosphere of trust and well-being, which is strongly connected to the mental health literacy of trainers. Discussion In Austria, there is a gap between the readiness of people with mental health problems for physical activity and the provision of appropriate measures by sport clubs. Therefore, it is suggested that a case manager who is educated in sport and social care, is placed in sport clubs. Alternatively, regular meetings among the participants with mental health problems who attend a sport club programme should be established together with social care worker and the trainer. References Rosenbaum S, Tiedemann A, Sherrington C, Curtis J, Ward PB (2014). The Journal of Clinical Psychiatry, 75(09), 964-974. Strauss A, Corbin J (2010). Grounded theory. Grundlagen qualitativer Sozialforschung. Weinheim: Beltz.

### A LONGITUDINAL EXAMINATION OF ELITE ATHLETE WELL-BEING

CLANCY, R., HERRING, M.P., CAMPBELL, M.

*University of Limerick*

**Introduction** Elite athletes operate in demanding environments that consistently stretch their physical, psychological and emotional limits, and increase susceptibility to maladaptive behaviours/outcomes (e.g., disordered eating, burnout), reinforcing the need for ongoing psychological monitoring. Subjective measures of mood and mental health can be particularly useful tools, which may be indicative of future performance and provide guidance for titrating training load. Thus, this study characterised the mood and mental health profile of elite athletes, longitudinally examined these outcomes and their interrelations, and explored potential moderators (e.g., type of sport, gender, and age). **Methods** Elite team sport athletes (N=136) aged 18-37 years ( $23.21 \pm 4.56$ ) with an average of  $12.77 \pm 5.13$  years sport experience were assessed using psychometric inventories over a 13-week period (compliance = ~94%). The sports represented were basketball, Gaelic football, field hockey, hurling, rowing, rugby, and soccer. Outcomes included the Profile of Mood States-Brief and Quick Inventory of Depressive Symptomatology (QIDS), administered weekly, and the Pittsburgh Sleep Quality Index (PSQI) and the trait subscale of the State-Trait Anxiety Inventory (STAI-Y2), administered every four weeks. Missing data was accounted for using Last Value Carried Forward imputation. **Results** The average Total Mood Disturbance (TMD) was 4.3 (SD=8.7), which is lower than that of similarly-aged Americans ( $26.1 \pm 15.9$ , Yeun & Shin-Park, 2006). 18.4% of athletes were classed as having mild depression across the 13 weeks (QIDS=6.3). 39.7% and 7.4% of athletes were categorised as poor quality sleepers (PSQI>5) and highly trait anxious (STAI-Y2>50), respectively. Nine of the ten athletes who were highly trait anxious and 19/25 athletes with mild depression were also poor sleepers. There was a significant difference in TMD for Gaelic ( $1.4 \pm 7.6$ ) and non-Gaelic ( $5.6 \pm 8.7$ ) sports ( $t(134)=2.62$ ,  $p \leq 0.01$ ). There were no significant differences by gender or five-year age group for any outcome. **Discussion** Measures of mood and mental health change and influence each other among elite athletes over a 13-week period. Monitoring such outcomes appears to be informative, as those with maladaptive behaviours (e.g., poor sleep quality) can be identified for intervention. Subjective measures of mood and mental health outcomes are easy to administer and may prove useful to guide training load adjustments and indicate future performance among team sport athletes. References Yeun, E. J., & Shin-Park, K. K. (2006). Verification of the profile of mood states-brief: Cross-cultural analysis. Journal of Clinical Psychology, 62(9), 1173-1180. Contact [rachel.clancy@ul.ie](mailto:rachel.clancy@ul.ie)

### MENTAL TOUGHNESS IN PARALYMPIANS

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*Newman University Birmingham*

**MENTAL TOUGHNESS IN PARALYMPIANS 1:** NUB (Newman University, Birmingham) Mental Toughness (MT) has been described as a unidimensional construct that can vary across contexts and is important for performance, goal progress, and thriving despite stress (Gucciardi et al., 2015). Martin et al. (2011) reported that athletes with disabilities demonstrate stronger resiliency and self-efficacy skills than able-bodied athletes. It can be assumed that athletes with disabilities have had to overcome potentially far more hardship than non-disabled counterparts, particularly in their non-sporting life. These experiences may provide insight into the development of MT. The aim of this study was to investigate MT and its development in disability sport by exploring the perceptions and experiences of Paralympic athletes. **Methods** A purposeful sample of elite Paralympic athletes (n=5) and coaches (n=1) were selected. The participants all competed at London 2012. Using semi-structured interviews in accordance with Smith et al. (2009), all participants were questioned about their perceptions and experiences of MT and its development in Paralympic athletes. Interviews were transcribed verbatim. Data were analysed thematically using Interpretive Phenomenological Analysis with trustworthiness established using bracketing and member checking. **Results** A number of characteristics associated with MT for Paralympic athletes were identified, including: confidence, hardiness, optimism and the use of specific mental skills. Overcoming daily life challenges, demonstrating independence and the ability to deal with pain were seen as important in MT development. **Discussion** Findings highlight that critical incidents and personal adversity has facilitated the development of key mental characteristics. One possible reason is many athletes with disabilities have experienced a major life trauma, and as such may differ from athletes without disabilities on various coping skills, levels of optimism, or other important self-perceptions (Martin et al., 2011). It is conceivable that athletes with disabilities may rely on mental skills developed without formal input, perceived innate psychological strengths and affective strengths (e.g. optimism) to facilitate training and performance. Our findings highlight the association between the adaptive development of personal characteristics and overcoming physical and mental setbacks over a sustained time period, similar to previous findings (Gucciardi et al., 2015). Overall, the findings suggest that athletes would benefit from exposure to demanding situations to develop superior coping skills and MT. References Gucciardi, D.F., Hanton, S., Gordon, S., Mallett, C. J., & Temby, P. (2015). J Pers 83, 26-44. Martin, J. J., Malone, L.A. and Hilyer, J. C. (2011). J Clin Sport Psychol, (5), 197-210. Smith, A.J., Flowers, P. and Larkin, M. (2009). London: Sage Publications Contact [Alexander.Powell@newman.ac.uk](mailto:Alexander.Powell@newman.ac.uk)

## Oral presentations

### OP-SH25 Children & Physical Exercise

#### EFFECT OF A SIX WEEK ACTIVE PLAY INTERVENTION ON PRESCHOOL CHILDREN'S FUNDAMENTAL MOVEMENT SKILL COMPETENCE: A CLUSTER-RANDOMISED CONTROL TRIAL

FOULKES, J.D.1, KNOWLES, Z.1, FAIRCLOUGH, S.J.2, STRATTON, G.3, O'DWYER, M.4, RIDGERS, N.D.5, FOWEATHER, L.1

*Liverpool John Moores University*

1: LJMU (Liverpool, UK), 2: SU (Swansea, UK), 3: EHU (Ormskirk, UK), 4: ECI (Dublin, Ireland), 5: DU (Victoria, Australia) Introduction The development of fundamental movement skill (FMS) competence promotes positive trajectories of physical activity, fitness and weight status (Robinson et al., 2015). However, evidence suggests that preschool children have low competency (Foulkes et al., 2015). This study examined the effectiveness of an active play intervention on FMS amongst 3- to 5-year-old children from deprived communities in NW England with the aim to inform local policy and educational practices. Methods In a cluster randomised controlled trial, 12 preschools were randomly assigned to either control (n=6) or intervention (n=6) groups. The intervention was implemented by a Local Authority, involving the training of preschool educators and provision of a 6-week Active Play programme; control schools followed usual practice. Data were collected at baseline (T0), post-intervention (T1) and at 6-month follow-up (T2). FMS were assessed using the Children's Activity and Movement in Preschool Study Motor Skills Protocol (Williams et al., 2009). Data were analysed using 2-level multi-level modelling (school, child), adjusted for baseline values of the outcomes and potential confounders. Differences in intervention effects by sex were also explored. Results Of 240 eligible children at baseline, 162 (68%) completed FMS assessments and were included in the final analyses (age Mean =  $4.64 \pm 0.58$ ; 53.1% boys). Participant numbers decreased to 133 (55.4%) at T1 and 113 (47.1%) at T2. There were no significant differences between groups for total (T1:  $\beta=1.45$ , 95% CI -0.34 to 3.24; T2:  $\beta=0.31$ , 95% CI -1.31 to 1.93), object-control (T1:  $\beta=1.01$ , 95% CI -0.22 to 2.24; T2:  $\beta=0.48$ , 95% CI -1.07 to 2.03) or locomotor (T1:  $\beta=0.46$ , 95% CI -0.90 to 1.82; T2:  $\beta=0.12$ , 95% CI -0.93 to 1.17) scores. Conclusions This is the first study to examine the effectiveness of an intervention to promote FMS competency among young children from England. The results suggest that this Active Play intervention may have needed to run for longer and/or with a greater frequency of session delivery in order to be effective. Further, preschool staff may require additional training and support to promote FMS development. References Foulkes, JD, Knowles, Z, Fairclough, SJ, Stratton, G, O'Dwyer, M, Ridgers, ND, & Fowweather, L. (2015). Percept Mot Skills, 121(1), 260-283. Robinson, LE, Stodden, DF, Barnett, LM, Lopes, VP, Logan, SW, Rodrigues, LP, & D'Hondt, E. (2015). Sports Med, 45(9), 1273-1284. Williams, HG, Pfeiffer, KA, Dowda, M, Jeter, C, Jones, S, & Pate, RR. (2009). Meas Phys Educ Exerc Sci, 13(3), 151-165. Contact J.D.Foulkes@2007.ljmu.ac.uk

#### EFFECTS OF SCHOOL BASED EXERCISE INTERVENTION ON MOTOR PERFORMANCE, BLOOD PRESSURE AND ARTERIAL COMPLIANCE IN CHILDREN

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Introduction: It is widely accepted, that sedentary lifestyle impairs motor performance (MP) and increases blood pressure (BP) in the young. Even though increased BP may lead to structural changes in vessels already at early age (Berenson et al., 1998), research assessing exercise effects on vascular function in children are sparse. The present study aimed to evaluate the effectiveness of an exercise intervention (EI) on MP and BP but moreover on established markers of arterial compliance (AC). Methods: 105 students (mean age  $8.2 \pm 0.6$  yr; 51% girls; BMI  $17.8 \pm 3.0$  kg/m<sup>2</sup>) were randomized into intervention (IG) (N = 51) and control (CG) (N = 54) group. During a 37-week experimental period the IG received an additional EI (2x45min per week) on top of the regular school physical education class (3x45min per week). Apart from a MP-test ('CHECK!'), peripheral (pBP) and central (cBP) blood pressure, augmentation pressure (AP) and aortic pulse wave velocity (aPWV) were assessed non-invasively using Mobil-O-Graph (24 PWA monitor, IEM Stolberg, GERMANY). Multilevel linear models with random effects for schools and classes were used to analyze the effectiveness of the EI. Differences between the mean change of the outcome variable in the IG and CG were adjusted for confounders (age, sex, height and the variable at baseline). Results: There was a significant difference in the mean improvement in endurance performance ( $62.02 \pm 168.09$  m;  $p < .001$ ), AP ( $-2.34 \pm 7.47$  mmHg;  $p = .007$ ) and aPWV ( $-1.95 \pm 0.718$  m/s,  $p = .037$ ) throughout intervention period, favoring IG. Furthermore the EI induced a significant decrease in peripheral ( $-4.34 \pm 11.84$  mmHg) and central ( $-3.93 \pm 8.94$  mmHg) systolic BP, AP ( $-1.67 \pm 3.73$  mmHg) and aPWV ( $-0.18 \pm 0.35$  m/s) in the children. Discussion: Already in children a school based EI had beneficial effects not only on endurance performance but moreover on aPWV and AP, as important determinants of left ventricular function and coronary blood flow (Gatzka et al., 1998). These positive effects may be due to an exercise induced improvement in endothelial function and vasoactive substances (Beck, et al., 2013). Based on the findings it seems advisable to increase regular physical activity in early childhood to positively influence cardiovascular risk profile. Future research should focus not only on BP but moreover on parameters of AC displaying higher prognostic value for cardiovascular morbidity (Roman et al., 2007). References Beck DT, Martin JS, Casey D, Braith W. (2013). Am J Hyp., 26 (9), 1094-1102. Berenson G, Sirinivasan S, Newman W. 3., Tracy R. & Wattigney W. (1998). N Engl J Med., 338, 1650-1656. Gatzka CD, Cameron JD, Kingwell BA, et al. (1998). Hypertension, 32, 575-578. Roman M, Devereux R, Kizer J, Lee E, Galloway J, Ali T, et al. (2007). Hypertension, 50 (1), 197-203. Contact sascha.ketelhut@sport.uni-halle.de

#### TRAINING IN THE MATRIX: INTRODUCING A COMBINED PROGRAM FOR YOUTH SOCCER PLAYERS DEVELOPMENT

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INTRODUCTION High-intensity technical actions heavily influence the outcome of soccer matches. While performance factors are traditionally trained separately, we proposed a program combining technique and agility (combination of strength, speed, balance and coordination, (Sheppard and Young (2006)) for youth players' development. We assessed the effect of this program on motor and technical skills. METHODS The program was structured on a 14x12-m matrix of elastic tapes (lifted at 25 cm) that provides a constraints-driven reference for movement timing and techniques. Practices were aimed to develop game-like high-intensity technical actions with the ball.



Twenty U12 sub-elite male soccer players ( $41.8 \pm 7.1$  kg,  $1.55 \pm 0.08$  m) from the same club were randomly assigned to an experimental (EG) and a control group (CG). A repeated-measures design was used: the EG was exposed to 20-40 min/session of differentiated training (22 weeks, 38 sessions) while the CG continued the traditional training. Shuttle Dribbling Test (SDT, Huijgen et al. (2010)) and the Loughborough Soccer Passing Test (LSPT, Ali (2011)) were performed before and after the differentiated training. Medians and interquartile ranges (IQR) of percentage change between measurements, correlation coefficients ( $r$ ) with individuals' stature increments and Cohen's  $d$  effect size were computed. RESULTS The stature increment between measurements was 3.5 (IQR 0.1) cm for the CG and 3.8 (0.2) cm for the EG ( $d=0.11$ ). In the SDT, the EG improved by 4.1%, while the CG performance decreased by 0.6% ( $d=0.97$ ); in the LSPT, EG improved by 6.8% while the CG by 0.3% ( $d=0.78$ ). Performance and stature changes were moderately-to-low correlated (CG vs. EG):  $r=0.35$  vs.  $-0.17$  (SDT);  $r=0.41$  vs.  $0.18$  (LSPT). DISCUSSION The matrix was designed to stress dynamic balance, quick changes-of-direction, and specific agility/coordination skills: the program produced higher performance improvements, compared to traditional training, in 180°-changes-of-direction and in a controlling and passing dynamic task. It seemed to balance the losses in coordination caused by the adolescent motor awkwardness (Quatman-Yates et al., 2012). The program acts simultaneously on the physical, technical and perceptual corners of soccer performance, thus optimizing the training process. Despite more age/proficiency levels have to be considered, the methodological implications of this study could be beneficial for youth training effectiveness. REFERENCES Ali A (2011). Scand J Med Sci Sports, 21, 170-183 Huijgen BCH, et al. (2010). J Sports Sci, 28, 689-698. Quatman-Yates CC, et al. (2012), Br J Sports Med, 46, 649-655. Sheppard and Young (2006), J Sports Sci, 24, 919-932. CONTACT [matteo.zago@unimi.it](mailto:matteo.zago@unimi.it)

## DETERMINANTS OF ORGANIZED PHYSICAL ACTIVITY PARTICIPATION DURING THE TRANSITION FROM CHILDHOOD TO ADOLESCENCE IN GERMANY: THE NATIONWIDE KIGGS COHORT STUDY

MANZ, K., KRUG, S., SCHIENKIEWITZ, A., FINGER, J.

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Introduction Organized physical activities (OPAs) are characterized by high intensity levels and can thus be more beneficial for health than other types of physical activity (1). However, studies suggest that OPAs decline from childhood to adolescence and determinants of OPA change are widely unknown (2). Therefore, this study aims at investigating changes in OPA participation during the transition from childhood to adolescence and the role of factors influencing OPA change. Methods This nationwide cohort study uses data from the cluster-randomized German Health Interview and Examination Survey for Children and Adolescents (KiGGS). Participants aged 6 to 10 years at KiGGS baseline (2003-2006) and 12 to 16 years at KiGGS Wave 1 (2009-2012) were included ( $n = 3790$ ) in the study sample. The KiGGS response rate for the above mentioned age group was 70% and the KiGGS Wave 1 re-participation rate 74%. Weighted prevalence proportions were calculated for the OPA participation categories maintenance (reference), dropout, commencement, and abstinence. Multinomial logistic regression analysis was used to analyze the role of sex, age, socioeconomic status (SES), migrant background, family form, health status, motor fitness, media use, and residential area as influencing factors of OPA participation between KiGGS baseline and KiGGS Wave 1. Results The weighted prevalence was 48.5% (CI-95%: 46.2-50.8) for OPA maintenance, 12.3% (10.8-14.0) for commencement, 20.5% (18.7-22.4) for dropout and 18.7% (16.8-20.8) for abstinence. The predictor analysis indicates that being a girl and having a low motor fitness as well as having a low SES consistently predicted the abstinence, dropout and commencement of OPA participation. Conclusion To reduce the decline in OPA participation during childhood, especially girls and children from low SES families should be supported to participate in OPA or to maintain their OPA. The early promotion of motor fitness could be a promising approach. References 1. Marques A, Ekelund U, Sardinha LB. Associations between organized sports participation and objectively measured physical activity, sedentary time and weight status in youth. Journal of science and medicine in sport / Sports Medicine Australia. 2015. 2. Vella SA, Cliff DP, Okely AD. Socio-ecological predictors of participation and dropout in organised sports during childhood. The international journal of behavioral nutrition and physical activity. 2014;11:62. Contact [manzk@rki.de](mailto:manzk@rki.de)

## Oral presentations

### OP-SH20 Sport Consumers, Events & Tourism

## HOW INTERNATIONAL SPORT EVENTS SUPPORT URBAN DEVELOPMENT? EFFECTS OF EYOF 2017 AND POSSIBILITIES OF GYŐR

MATE, T., ANDRAS, K.

*Széchenyi István University and Corvinus University of Budapest*

In the summer of 2017, for the first time it will be held in Hungary an international sports event represent several sports, which belongs to the Olympic events. The presentation is addressed to answer the question, how international sport events support urban development. Can be increase sport economic activity in City of Győr thanks to the effects of the EYOF? How new sport facilities can be operated sustainable and optimised economically? The main appearance of sports economics today are the international sport events. The central product of professional sport is variety of sports and sport events [András, 2011]. Important international sport events (e.g. Olympic Games, World Cups) from sports economics point of view has impacts to all the sport markets (consumer market, players market, market for broadcasting rights, sports sponsorship market, merchandising market). [András, 2003]. These international sport events have specific impacts not only on their own markets, but also on the host country / city's economy. Furthermore, in many cases can be discover such impacts that are not primarily economic, but are closely related to the economy. EYOF is an incentive factor in urban development, open up new opportunities for the City of Győr as a catalyst of investments. World-class sports facilities will be built and with the construction of the Olympic Centre neighborhood rehabilitation will be established. The purpose is sustainability, long-term and 100% utilization of facilities and optimization of operation. The biggest heritage of international sport event is facility development. In our study we present the experiences of utilization and facility management of sport facilities, based on our research carried out with online questionnaire. The research collects experiences of utilization and facility management of sport facilities from 8 cities of 7 countries (Central-Eastern Europe, Visegrád 4 Countries, neighbouring countries of Hungary extended to twin cities of Győr). We give the answer to the questions as follows: who is the operator and owner of sport facilities, level of capacity utilization of sport facilities, what is the primary function of sport facilities, how the users are paying for the usage of sport facilities? There is special attention dedicated to the topic from the fact that Hungary is competing to organize the Olympics Games in 2024. The application is based on the country's outstanding sport successes and the

experiences collected during several international sport events organized and held successfully in recent years. We can say that Hungary is world-class in organization of international sports events. The study aims to show how international sport events become developing power of the host country/cities. References: Krisztina András [2011]: The operating model of professional football. Competition of sports. Hungarian Sports Science Papers - III. Competition of sports, 2011, Page 18- 42. Krisztina András [2003]: Business elements in sports, with football as an example PhD. dissertation tundi.mate@gmail.com

### THE LEGACY OF THE FIFA WORLD CUP 2014 FACILITIES: WHITE ELEPHANTS OR FACILITIES FOR ENTERTAINMENT AND SPORTS?

ROCCO JR, A., MAZZEI, L.

*School of Physical Education and Sport - USP*

Introduction Brazil built and/or remodeled 12 football stadiums to host the FIFA World Cup (WC) 2014. The total invested in these arenas was around 1.956 trillion Euro. One and a half year after from the WC, the press reported that 8 of these 12 stadiums have losses in their operations. The aim of this paper is to evaluate the perspective of legacy for the 12 facilities built for the WC. Methods To achieve the aim, a questionnaire to evaluate the fans-consumers perception were applied in three different moments during 2014: a) before the WC in the "old" Brazilian stadiums; b) during the WC, in the stadiums used in the event; and, c) third, in the stadiums WC facilities, but during the local competitions, managed by Brazilian football organizations. The SPSS was used for descriptive analyses to identify the differences among the three moments. Content Analysis in news published by the press were also used to evaluate the legacy perspective of the WC facilities. Results A total sample of 11,052 people were answered the questionnaire in of the three moments. The main results were: in the first/third moments do not matter the quality of services offered of the facilities and event, but emotional aspects (related to football clubs) that make fans-consumers went to the stadiums. The entertainment was the main issue identified fans-consumers perception during the WC. It was identified high satisfaction rates and 93.19% said they would like to return to the facilities stadium, which can explained by the experienced lived during the second moment. Discussion Paramio et al. (2008) draw attention to the fact that the post-modern stadiums, arising from 1990, were born to be more functional and improve their design, the safety, accessibility and comfort for the spectators and especially the possibilities of economic exploitation of the facilities, including the promotion of others activities than football. All of the results clearly suggest that the new sports facilities and the quality of services collaborate to further football "entertainment" in the worldwide context. It is the "McDonaldization of society" (Ritzer, 2010). Although the public enjoyed the experience of the WC stadiums, in four cities these spaces are not feasible, in another four the combination sport x entertainment x world-class cities needs to be extremely efficient and only with efficient management can enable a sustainable operation in the Brazilian football facilities. The political choices of the host cities before the WC did not allow to Brazil to get the coherence that should exist between world-class cities, world-class stadiums and world-class events. References Paramio, J.L.; Buraimo, B.; Campos. C. (2008). From Modern to Postmodern: the development of football stadia in Europe. September 2008. Ritzer. G. (2010). The McDonaldization of Society. London: SAGE.

### RESEARCH ON THE STRUCTURAL COMPONENTS AND FUNCTION ROUTE OF THE TECHNOLOGICAL INNOVATION OF SPORTING GOODS MANUFACTURER

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*China Institute of Sport Science*

Companies achieve competitive advantage through acts of innovation. Used literature research, interview method, questionnaire method, interpretative structural modeling, structural equation model to analyse the structural components and function route of the technological innovation of sporting goods manufacturer. It was found that the technological innovation of sporting goods manufacturer is a systemic behavior, a result of many factors' combined action. These components include research and development department, production department, sales department, universities, research institutes, intermediaries, governments, upstream firms, financial institutions, consumers, trades, sports event organizations, athletes, associations, original equipment manufacturers, medias, dealers and other firms. The structural modeling of components is a three-level hierarchical structure, the Level II contains research and development unit, manufacture unit and commercialization unit, some components of Level III have multifunction. The components increase the technological innovation output performance through promoting the running effect of research and development unit, manufacture unit and commercialization unit.

11:30 - 12:45

## Plenary sessions

### PS-PL02 Promoting physical activity – environmental and economic health approaches

#### URBAN ENVIRONMENTS - KEY DETERMINANT IN PROMOTING ACTIVE LIVING

BULL, F.

*The University of Western Australia*

Promoting physical activity is a global priority. In 2013 a global target for all countries was agreed, namely to increase population level of physical activity by 10% by 2025. How will we achieve this goal? A key determinant of participation is the urban environment, it can enable or hinder the opportunities to be active. Research from Australia and elsewhere provides clear evidence on the key features of a supportive 'healthy and active' environment. These include safe accessible infrastructure for walking and cycling, adequate open spaces and sporting facilities, quality public transport and appropriate diversity of destinations within walking and cycling distances. Findings from research will be presented to showcase how we can design cities and communities to be active spaces for people of all ages and tools to use in sharing this evidence. Our greatest challenge is achieving large scale implementation of what we know and effectively

engaging sectors outside of health and sports, such as transport and planning. Working in partnerships is necessary to ensure evidence is used to inform policy and create programs so we can achieve active healthy communities for future generations.

### THE WHO HEALTH ECONOMIC ASSESSMENT TOOL – IN WHAT WAY CAN IT SUPPORT PHYSICAL ACTIVITY AND SUSTAINABILITY?

RACIOPPI, F., RUTTER, H.2, CAVILL, N.3, KAHLMEIER, S.4, SCHWEIZER, C.1, FOSTER, C.5, GOETSCHI, T.4, KELLY, P.6, OJA, P.7, WOODCOCK, J.8, SOMMER, H.8, DINSDALE, H.9

1. World Health Organization (WHO) Regional Office for Europe, Copenhagen, DK, 2. London School of Hygiene and Tropical Medicine, UK, 3. Cavill Associates, UK, 4. Uni of Zurich, Switzerland, 5. Oxford

**Introduction** With nearly one million deaths per year attributable to physical inactivity in the 53 countries of the WHO European Region, this risk factor has become a leading public health priority. Regular cycling and walking are highly effective in reducing the risk of premature mortality and morbidity from the broad range of non-communicable diseases related to physical inactivity. If accompanied by a modal shift that reduces motorized transport levels, cycling and walking can provide additional co-benefits by reducing emissions of air pollutants, greenhouse gases and noise, alleviating congestion, improving road safety, and contributing to a better quality of urban life. Since promoting cycling and walking depends on policy decisions taken mostly by local authorities in charge of urban transport and land use planning, there is a need to support them in appreciating the magnitude of the benefits that could be delivered by cycling and walking, including in economic terms. **Methods** The WHO Health Economic Assessment Tools (HEAT) for walking and cycling (WHO, 2014) were developed to estimate the economic value of reduced premature mortality that results from regular walking or cycling. HEAT are available online, based on best available evidence, and open to further developments as new knowledge becomes available. They are specifically designed to meet the needs of an audience that may have limited access to the extensive set of inputs that would be required by complex assessment models in terms of epidemiological, transport-related and economic data, and/or limited experience of how to perform these assessments. At the same time, the HEAT allow for more advanced implementations, if data and expertise are available. **Results** Since 2007, nearly 100 applications of the HEAT have been documented applied globally by cities, national governments, researchers, practitioners and active mobility advocates, including 14 government or policy guidance documents and 28 academic papers. **Discussion** In the context of the 2030 Sustainable Development Agenda, cycling and walking can contribute to the achievement of sustainable development goals related not only to health, but also to “making cities and human settlements inclusive, safe, resilient and sustainable”. The HEAT support the key actors for the promotion of cycling and walking in this endeavour.

**13:00 - 14:00**

### Conventional Print Poster

#### PO-CPP-02 Biomechanics 2

### KINEMATIC STEP-PARAMETERS AND TRIPLE JUMP PERFORMANCE IN FEMALE YOUTH ATHLETES

JAITNER, T., VAN HAREN, A., HAHN, D.

TU Dortmund University; RUB Bochum University

**INTRODUCTION** Especially in youth athletes, the step in triple jumping is considered to be crucial since it rather serves as a transition phase between hop and jump than as a major contributor to the overall distance (Hay, 1993). This is further supported by observations that during the step youth athletes do not perform a jump but a running step, which is in accordance with the suggestion of Hay and Miller (1985) that a more accentuated step results in a greater overall distance. Therefore, the aim of this study was to investigate the relationship between kinematic step-parameters and step-distance as well as their contribution to the overall performance. **METHODS** Distances and contact times of hop, step and jump as well as flight times of hop and step were recorded from 129 jumps of 32 female youth triple jumpers using Optojump next™ (Microgate, Italy) during regional and national championships. Mean approach velocity ( $v_a$ ) was determined between 6m and 1m before take-off. Actual overall distance, phase distances and phase ratios (% of overall distance) were determined according to Hay (1993). Step flight ratio and the change in horizontal velocity from hop to step ( $\Delta v$ ) were also calculated. Several correlation coefficients between the kinematic parameters obtained were determined according to Pearson and Spearman depending on normal distribution. **RESULTS** Mean and SD for  $v_a$ , overall and phase distances reached  $7.7 \pm 5\text{m/s}$ ,  $10.69 \pm 63\text{m}$ ,  $3.89 \pm 31\text{m}$  (hop),  $2.62 \pm 48\text{m}$  (step), and  $4.18 \pm 39\text{m}$  (jump), respectively. Mean phase ratios were  $36 \pm 2\%$  (hop),  $24 \pm 4\%$  (step),  $39 \pm 4\%$  (jump). Step flight ratio achieved  $49 \pm 13\%$ , while  $\Delta v$  was  $-1.5 \pm 3.8\text{m/s}$ . Overall distance showed moderate correlations to  $v_a$  ( $r = .443$ ) and step-distance ( $r = .548$ ) but a strong correlation to hop-distance ( $r = .841$ ). Further did step-distance inversely influence jump-distance ( $r = -.61$ ). Step-parameters phase ratio,  $\Delta v$ , flight ratio were highly to moderately related to step distance ( $r = .944$ ,  $-.565$ ,  $.684$ ) but could not predict overall triple jump performance ( $r \leq .4$ ). **DISCUSSION** According to our results, hop distance had the greatest influence on triple jump performance. However, also the step significantly affected overall distance, and kinematic step parameters revealed that a good step is mainly characterized by a high phase ratio but also by a reduction in velocity from hop to step and a high flight ratio. This points towards a jump-accentuated step rather than representing a running step used as transition phase from hop to jump. In future, multi-regression analysis is needed to explain the more complex interaction of the parameters that contribute to greater performances. **REFERENCES** Hay, J.G. (1993). J. Biomech., 26, Suppl. 1, 7-21. Hay, J.G. & Miller, J.A. (1985). IJSB, 1, 185-196.

## EFFECTS OF MUSCLE FORCES ON HORIZONTAL AND VERTICAL VELOCITIES OF THE BODY MASS CENTER DURING FORWARD AND VERTICAL JUMPING

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**Introduction** To jump higher or farther, an athlete needs to produce greater velocity of the center of body mass until take-off. Because most of this velocity is produced by the muscles of the lower limbs, information about how these individual muscles accelerate the body mass center is useful to understanding the mechanism of jump motions. The purpose of this study was to estimate the effects of muscle forces on the horizontal and vertical velocities of the body mass center during forward and vertical jumps. **Methods** Vertical (VJ) and forward squat jumps (FJ) were simulated using a forward dynamic model of the musculoskeletal system, and induced acceleration analysis was performed to quantify the velocity of the mass center produced by each muscle force. The musculoskeletal system used in this study consisted of four rigid segments (head-arms-trunk, thighs, shanks, and feet) connected with hinge joints. In this model, six muscle-tendon complexes (gluteus maximus, rectus femoris, vasti, hamstrings, gastrocnemius, and soleus) were implemented. A Hill-type muscle model consisting of a contractile element, a series elastic element, and a parallel elastic element was used to represent each of these six muscle-tendon complexes. Activation dynamics of the muscles were modeled based on Bobbert & van Zandwijk (1999). Stimulation of each muscle was increased toward its maximum of 1.0, then decreased toward its minimum of 0. The object functions for motion optimization were set as height and horizontal distance of the mass center for VJ and FJ, respectively. The stimulation onset and offset times of each muscle were optimized using a genetic algorithm. **Results & Discussion** The horizontal and vertical velocities of the mass center at the instant of take-off were 0.05 m/s and 2.65 m/s for VJ and 0.93 m/s and 2.28 m/s for FJ. In both VJ and FJ, most vertical velocity was produced by the soleus and gastrocnemius. During VJ and FJ, the hamstrings, soleus, and gastrocnemius accelerated the mass center forward, while the rectus femoris and vasti accelerated backward. A marked difference was observed in the forward velocity produced by the hamstrings (VJ, 0.80 m/s; FJ, 1.45 m/s). This difference between VJ and FJ appeared to be because the hamstrings were the main contributor to forward acceleration, but also slightly accelerated the mass center downward. These results suggest that the hamstrings play an important role in increasing forward velocity and adapting the direction of the mass center's velocity during jumping. **References** Bobbert MF, van Zandwijk JP. (1999). *Biol. Cybern.* 81, 101–108. Contact suzuki@sports.osaka-cu.ac.jp

## THE EFFECT OF ANKLE TAPING ON ANKLE DYNAMICS DURING LANDINGS ON AN INCLINED SURFACE

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**Introduction** Ankle taping is commonly used to reduce the incidence of ankle sprains (Verhagen et al., 2000). There are no consistent results regarding the efficacy of taping on modifying ankle joint dynamics. The purpose of this study was to determine the effect of ankle taping on ankle joint kinematics and kinetics by analyzing external moment derived from two component of ground reaction force (GRF) during drop landings on an inclined surface. **Methods** Twenty-five healthy adults participated in this study. The participants landed on a force platform which was inclined at 25 degrees from a height of 0.3 m. Their landing movement were captured using a eight-camera motion capture system. Stirrups and figure eight taping techniques were used. After the taping trials, the taping straps were disconnected and the participants were repeated exact same landing trials in this condition as control trials. Dependent variables included the average magnitude of the external inversion ankle moment of force from initial foot contact to the end of the first peak of GRF, the effective lever arm length to medio-lateral and vertical GRF components, and the ankle inversion angle at the peak ankle inversion moment were calculated and compared between the two trials. **Results** In the taping trials, the average inversion moment was significantly smaller ( $p < 0.01$ ) than that of the control trials. There was no significant difference in the effective lever arm length to the vertical GRF component. However, medio-lateral GRF at the peak ankle inversion moment, was significantly smaller ( $p < 0.05$ ) in the taping trials. The resultant ankle inversion angle at the peak ankle inversion moment was also significantly smaller ( $p < 0.05$ ) in the taping trials. **Discussion** Ankle taping could work to prevent ankle joint inversion during landing, due to smaller ankle inversion moments and joint angles under taped conditions. If ankle taping alters the foot orientation relative to the ground and shortens the effective lever arm to medio-lateral GRF during landing, this may subsequently reduce the external inverting moment of force at the ankle. **References** Verhagen EA, van Mechelen W, de Vente W (2000). *Clin J Sport Med*, 10(4), 291–296.

## FOOT PRESSURE ANALYSIS OF THE GRAB, TRACK AND KICK START TECHNIQUES IN SWIMMING

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**Foot Pressure Analysis of The Grab, Track and Kick Start Techniques in Swimming** **Introduction:** The goal of swimming race is to complete the required distance in the least amount of time. Swimmers start performance is vital to win the race. The purpose of the current study was to investigate plantar pressure values and start performance parameters for grab, track, and kick-start techniques from the Omega OSB11 starting block. **Method:** Nineteen male from the Turkish national swimming team (age  $16.84 \pm 1.68$  years, height  $179.9 \pm 5.8$  cm, body mass  $57.9 \pm 7.1$  kg) volunteered to participate in this study. The Swimmers were instructed to perform three different start techniques (grab, track and kick start) and finish the start performance at 15-m distance. The participants completed a warm up similar to their pre-race routine and they performed two trials for each start technique. Trials were recorded with two digital video cameras. Start efficiency times were recorded by a touchpad positioned at 15 m distance from starting block and electronic time system (Omega, ARES21, Switzerland) for grab-start, track-start and kick-start techniques. Foot plantar pressure data were collected using an F-Scan VersaTek wireless system (Tekscan, Inc. South Boston, MA) during three different start techniques. Prior to data collection F-scan sensors (model: 3000E; resolution: 3.9 sensors/cm<sup>2</sup>) were calibrated and data was taken with the 100 Hz sampling rate. Peak and average pressure data were analyzed by using the F-Scan Mobile Research software. **Results:** Statistical comparisons were made among plantar pressure values of three different start techniques and also 15 m swimming performance using one-way ANNOVA. The average and peak foot pressure values (N/cm<sup>2</sup>) were significantly lower for kick-start position (mean:  $12.68 \pm 2.3$ ; peak:  $16.45 \pm 3.4$ ) than both track (mean:  $16.58 \pm 3.4$ ; peak:  $21.0 \pm 3.7$ ) and grab-start (mean:  $19.42 \pm 2.8$ ; peak:  $23.58 \pm 4$ ) positions ( $p=0.00$ ) during push of phase in the front leg. Similarly, the average and peak foot pressure values were significantly less for kick-start position than both track and grab-start positions ( $p=0.00$ ) during push of phase in the rear leg. Although, there were no significant differences in time to 15m, distance of entrance among swimming start techniques, kick start technique was faster and also resulted in longer distance of entry than the other start techniques ( $p>0.05$ ). **Discussion:** At kick start technique, although the foot pressure was lower than the other start techniques during push off phase, distance of entry was



longer and the time of the 15 m swimming is shorter. However, this study results are conflicting with another study. Slowson SE et al. (2013) stated that swimmers generating higher than average peak forces were more likely to produce a better overall start performance. In our study, low levels of average peak pressure resulted in better start performance. Future works should be applied to explain relationship between foot pressure, block time, distance of entry and muscle strength. Suzun17@yahoo.com

### **REDUCED ACTIVATION IN ISOMETRIC MUSCLE ACTION AFTER LENGTHENING CONTRACTIONS IS NOT ACCOMPANIED BY REDUCED PERIPHERAL FATIGUE**

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**Introduction:** When an active muscle is stretched the resulting post-eccentric steady-state force is greater than an isometric force at corresponding muscle length and activation. Further, for a given force less muscle activation is required after active stretch. The characteristics of this activation reduction (AR) within so-called residual force enhancement (RFE) were associated with reduced metabolic costs [1, 2]. This study focused on long lasting effects of RFE mechanisms and aimed to identify if stretch-induced AR persists over sustained contractions resulting in a positive influence on the development of peripheral and/or central fatigue. **Methods:** Knee extension torque of  $n=16$  subjects was measured and EMG data of mm. vastus lateralis, rectus femoris, vastus medialis were recorded (4kHz). A 60s fatiguing isometric muscle action was performed at an intensity level of 60% of maximum voluntary contraction (MVC). After 4h rest, a second 60s fatiguing isometric contraction was performed that was preceded by an active stretch ( $20^\circ$ ;  $60^\circ\text{s}^{-1}$ ). Each fatiguing task was preceded and followed by MVCs. The interpolated twitch technique was used to analyze voluntary activation (VA) and peripheral fatigue. Baseline parameters contained MVC torques, VA and the resting twitches (RT). For endurance trials force and EMG data were analyzed over 5 time windows every 10s. Repeated measures ANOVA served for statistics. **Results:** We found no significant differences of baseline values before endurance tasks but significant AR after stretch contractions ( $\sim 90\%$  of isometric EMG). After fatiguing trials MVC torque and RTs were significantly reduced ( $\sim 70\%$  of baseline) but there were no differences between contraction conditions. **Conclusion:** Results of AR are in accordance with previous work [2]. Although there was reduced activation for maintaining a given amount of force, preceding stretch did not reduce influence of peripheral fatigue, measured immediately after fatiguing trials. It is known that mechanisms associated with RFE operate as long as the muscle is kept active. It may be speculated that reduced activation was possible due to passive structural connections, such as titin, that support maintenance of muscle force. However, these mechanisms do not persist after deactivation and therefore may not have influenced fatigue tests. **References:** 1. Seiberl, W., et al., Feedback controlled force enhancement and activation reduction of voluntarily activated quadriceps femoris during sub-maximal muscle action. J Electromyogr Kinesiol, 2012. 22(1): p. 117-23. 2. Jourmaa, V. and W. Herzog, Energy cost of force production is reduced after active stretch in skinned muscle fibres. Journal of biomechanics, 2013. 46(6): p. 1135-1139. wolfgang.seiberl@tum.de

### **OXYGEN CONSUMPTION OF GASTROCNEMIUS MEDIALIS MUSCLE DURING SUBMAXIMAL VOLUNTARY ISOMETRIC CONTRACTIONS WITH AND WITHOUT PRECEDING STRETCH**

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**Introduction** Activation reduction (AR) within the context of residual force enhancement stands for a lower muscle activity in the isometric steady state after an active stretch compared to a purely isometric contraction at the same muscle length and a given force. AR is associated with a potential reduction of metabolic cost during the contraction and Jourmaa and Herzog (2013) showed energetic advantages during force production after active stretch for skinned muscle fibers. However, to date it is unclear if these results can be transferred to in vivo human muscle function. Therefore, the aim of this study was to measure oxygen consumption during isometric contractions of gastrocnemius medialis (GM) with and without the presence of AR. **Method** Subjects ( $n=7$ ) performed submaximal voluntary isometric plantar flexions (30% MVC, 60s) at  $15^\circ$  dorsi flexion with and without a preceding  $30^\circ$  amplitude stretch ( $w=60^\circ\text{s}^{-1}$ ). Ankle joint torque during contractions was measured using an isokinetic dynamometer and muscle activity of the triceps surae was obtained by EMG. A near infrared spectroscopy system (NIRS) was used to quantify oxygen consumption of GM. To exclude blood volume changes throughout the contractions an external pressure cuff was used to fully occlude the lower leg. **Results** Sustained torque and ankle angle data revealed no differences between contraction conditions during the isometric steady state ( $p > 0.05$ ). There was a significant overall AR up to  $7.8\% \pm 5.2\%$  for the summed triceps EMG, and  $20.5\% \pm 11.7\%$  for explicitly measured GM after active stretch compared to the pure isometric contraction. Oxygen consumption of GM showed no statistical difference ( $p = 0.082$ ), despite a decrease of  $6.2\% \pm 6\%$  regarding the mean slopes of the oxygenated and deoxygenated hemoglobin after active stretch, as a representative of oxygen consumption per unit of time. **Discussion** The observed AR is in accordance to previous published results (Seiberl et al. 2012). However, reduced activation did not lead to energetic benefits in terms of oxygen consumption. These results were not expected as hypotheses were based on previous work of Jourmaa and Herzog (2013). This may be due to used methods. The NIRS system only reflects small parts of the GM muscle and therefore only provides an incomplete reflection of the energy consumption of the whole triceps group. This may explain the differences regarding beneficial energetic effects of AR and muscle oxygenation. **References** Jourmaa V. and Herzog W. (2013). J. Biomech 46, 1135-1139 Seiberl W. et al. (2012). J. Electromyogr Kinesiol 22, 117-123 Contact Florian.Paternoster@tum.de

## **Conventional Print Poster**

### **PO-CPP-06 Health & Fitness 2**

#### **ASSOCIATIONS OF SLEEP DURATION, BODY COMPOSITION AND AEROBIC FITNESS IN YOUTH**

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Adolescence is the second most rapid period of body growth and development after infancy and therefore they need a lot of sleep. However, it can often be difficult for adolescents to obtain enough sleep because they tend to go to bed late and wake up early, due to

changes in biological clock and lifestyle. Short sleep duration has been associated with higher body mass index (BMI), higher body fat percentage and increased risk of obesity in studies, especially in children and adults. However, less is known about this relationship between sleep duration and body composition in adolescents. Therefore, the aim was to examine the relationship between sleep duration and body composition in Icelandic youth as well as the relationship between sleep duration and the feeling of getting enough sleep. This was a cross-sectional study of 262 (55% girls) Icelandic youth, aged 17.5 to 19.0 years. Body composition was assessed with measurements of height, weight, BMI, waist circumference (WC), waist to height ratio (WHtR), and body fat percentage. Sleep duration and the feeling of getting enough sleep were assessed by questionnaire, and average sleep duration score was calculated from the ratio between sleep on weekdays and weekends. Aerobic fitness was estimated by a graded exercise test on a cycle ergometer. Hierarchical multiple linear regression was performed to evaluate the relationship between body composition variables and sleep duration, after controlling for peak oxygen uptake (VO<sub>2peak</sub>) and leisure time behavior. The primary findings of this study were that sleep duration during weekdays, when adjusted for VO<sub>2peak</sub> and leisure time behavior, was negatively associated with body composition in boys only, but sleep was only associated with body composition in girls in the unadjusted model. Of all body composition measures WC had the strongest association with sleep duration. Both boys and girls who thought they did not get enough sleep were more often classified as sleeping six hours or less compared to those who felt they slept enough. In addition, those sleeping six hours or less also had more unfavorable body composition measurements compared to those who slept longer, indicating that six hours or less sleep may not be enough for this age group. This study indicates that sleep has small but important association with body composition and the association between shorter sleep duration and body composition is complex, and it may vary between the sexes in late adolescence.

#### **REDUCED HbA1c AFTER 12 WEEKS OF HIGH-INTENSIVE AEROBIC INTERVAL TRAINING AMONG TYPE 2 DIABETICS.**

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**Background:** The effectiveness of high-intensity aerobic interval training (HAIT) to reduce risk factors associated with type 2 diabetes (T2D) remains to be established. This study investigated the effects of HAIT on maximal oxygen uptake (VO<sub>2max</sub>), glycated Hemoglobin type A1c (HbA1c), fat oxidation rate (FatOx), work economy (WE), body weight (BW) percent body fat (%BF), energy expenditure (EE) during exercise, lactate threshold (LT) blood pressure (BP) and blood lipid profile (triglycerides, HDL, LDL, total cholesterol) among individuals with type 2 diabetes. **Methods:** 19 sedentary men and women diagnosed with T2D completed 12 weeks of supervised high-intensity outdoor training three times per week. The interval training program consisted of 4 x 4 minutes at an intensity between 85-95% Hfpeak. **Results:** After the HAIT intervention, VO<sub>2max</sub> was increased by 21% (from 25.6 ml·kg<sup>-1</sup>·min<sup>-1</sup> to 30.9 ml·kg<sup>-1</sup>·min<sup>-1</sup>, p < 0.01), and HbA1c reduced by 8% (from 7.78% to 7.2%, p < 0.01). Reductions were also found in BW (p < 0.01), %BF (p < 0.01), waist circumference (p < 0.01), hip circumference (p < 0.01), diastolic BP (p < 0.01). Velocity at LT (p < 0.01) was also increased. There was a tendency towards an improved FatOx at 60% VO<sub>2max</sub> (from 0.368 to 0.420 g·min<sup>-1</sup>, p = 0.065). No changes were found in WE or blood lipid profile. **Conclusion:** The results from this study showed that HAIT was an effective exercise strategy to improve aerobic fitness and reduce risk factors associated with type 2 diabetes.

#### **REPEATED SPRINT EXERCISE TRAINING IN NORMOBARIC HYPOXIA IMPROVES CARDIO-METABOLIC FUNCTION IN OBESE YOUNG WOMEN**

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**Background** No studies investigate whether low-volume HIE in hypoxia including repeated sprinting exercise (RSE) has an extra effect on body composition and metabolic risk factors. **METHODS** A single-blind randomized controlled experimental design was used to conduct a 5-week repeated-sprint exercise intervention in hypoxia or normoxia. 24 obese young women completed all 20 sessions either in hypoxic (RSH, N=11) or normoxic high-intensity interval exercise training (RSN, N=13). The RSE protocol comprised 8 s of sprinting and 12 s of rest for a maximum of 60 repetitions for 20 min. Body composition measured by DEXA and blood samples were assessed at pre- and post-intervention in the follicular or luteal phase of menstrual cycle. Physical activity and food diary were estimated during the study. **RESULTS** There were no within- and between-group differences in daily energy intake and physical activity at pre-, during-, and post-intervention times (p > 0.05). Five weeks of RSE resulted in significant improvements in absolute and relative VO<sub>2peak</sub> and maximal O<sub>2</sub> pulse in both groups (p < 0.01). The increments of VO<sub>2peak</sub> and maximal O<sub>2</sub> pulse in RSH (~20%) were twice as much as in RSN (~10%) (p < 0.05, d = 0.88-0.95). There were no significant improvements in weight, BMI, total or regional body composition, TC, HDL-C, LDL-C, and leptin after hypoxic or normoxic training and no differences between groups. There was a trend to decrease in TG in RSH (p = 0.051) and the decrement tended to be significant than RSN training, either (RSN -22.8 ± 36.0%, RSH 6.8 ± 31.7%, p = 0.054, d = 0.87). For the subjects in RSH, the changes in VO<sub>2peak</sub> were moderately related to the changes in total FM (r = -0.64, p < 0.05), leg FM (r = -0.74, p < 0.01) and Trunk FM (r = -0.50, p = 0.121), while significant correlations were found between the changes of maximal O<sub>2</sub> pulse and the changes of total FM (r = -0.70, p < 0.05), leg FM (r = -0.64, p < 0.05), and Trunk FM (r = -0.64, p < 0.05). In contrast, low and no significant correlations (r = -0.03 to -0.25) between VO<sub>2peak</sub>/maximal O<sub>2</sub> pulse and total and regional fat mass in the subjects of RSN. Changes of blood lipids and serum leptin didn't correlate with the changes of cardiovascular fitness and body composition (p > 0.05). **DISCUSSION** 20 sessions in five weeks of hypoxic and normoxic repeated-sprint exercise training improved cardiorespiratory fitness but had no effect on body composition, TC, HDL-C, LDL-C and circulating leptin levels in sedentary obese young women, whereas hypoxic RS training had larger enhancements in VO<sub>2peak</sub>, maximal peak O<sub>2</sub> pulse and TG than normoxic RS did. We did not observe significant improvements in RSH and RSN group as well as an additive effect on body composition caused by RSH. The changes of VO<sub>2peak</sub> and maximal peak O<sub>2</sub> pulse were negatively associated with the changes of total and regional fat mass in RSH but not in RSN, suggesting that hypoxia seems to play a crucial role in improving body composition.

## EFFECTS OF CONCURRENT STRENGTH AND ENDURANCE TRAINING ON PHYSICAL PERFORMANCE IN PATIENTS WITH PARKINSON'S DISEASE

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1: Faculty of Physical Education and Sports Comenius University; 2: Institute of Experimental Endocrinology, BMC, SAS; 3: Slovak Medical University; 4: Faculty of Medicine, CU; Bratislava, Slovakia Introduction Parkinson's disease (PD) is a neurodegenerative disease characterized, among others by postural instability, rigidity, tremor and hypokinesia. Structured physical activity programs have been shown to have a positive effect on muscle strength, endurance and functional tasks/performance in PD patients (Combs et al., 2013; Paul et al., 2014). The combination of endurance and resistance exercise may result in synergy training effect (Shulman et al., 2013). This study aimed to identify the effects of concurrent supervised strength and endurance training on physical performance in PD patients. Methods Two groups volunteered in this study: PD group (6/2, F/M, 64±7.43 years) and Control group (8/3, F/M, 68±8.38 years). The 12-week training consisted of two concurrent strength-endurance sessions and one endurance-coordination session/week. Both groups performed the same program. Physical performance was measured before and after intervention: 1RM (leg-press), maximal isometric knee extension and flexion, Rockport Walk Test, 10 Meter Timed Fast (10mF) and Comfortable (10mC) Speed Walking tests, Five Times Sit and Stand Test and static postural stability in a different mode (open eyes, closed eyes and semi-tandem). The repeated ANOVA was used for main effect of training and the Mann-Whitney U-test for between group comparisons. Results In both groups, physical performance was improved in 1RM ( $p<0.05$ ), Rockport Walk Test ( $p<0.001$ ), 10mC ( $p<0.001$ ) and Five Times Sit and Stand Test ( $p<0.05$ ) following 12-weeks training. No significant differences were recorded in other tests. No significant between-group differences were reported in any measured parameters. Discussion The 12-week concurrent strength-endurance training was effective in improving physical performance in PD patients. The improvements were comparable to healthy controls. We suggest that supervised physical intervention combining strength, endurance and coordination may be an effective supportive strategy in treatment of Parkinson's disease. SAS – NSC Joint Research Cooperation grant, VEGA 2/0191/15 REFERENCES Combs S, Diehl M, Chrzastowski C, Didrick N, McCain B, Mox N, Staples W, Wayman J. NeuroRehabilitation 2013; 32:117–24. Paul S, Canning C, Song J, Fung, Sherrington. Clin Rehabil 2014;28:275–88. Shulman L, Katzel L, Ivey F, Sorkin J, Favors K, Anderson K, Smith B, Reich S, Weiner W, Macko R. JAMA Neurol. 2013;70:183–90

## RELATIONSHIP OF PHYSICAL FITNESS, VITALITY, AND COGNITIVE FUNCTION WITH PHYSICAL ACTIVITY PATTERNS IN INSTITUTIONALIZED ELDERLY INDIVIDUALS

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Introduction It has been reported that daytime physical activity patterns, such as walking and sitting time, are associated with physical fitness in institutionalized elderly individuals (Ikezoe et al., 2013). However, the effect of vitality and cognitive function on physical activity patterns remains unclear. The aim of this study was to examine the relationship of physical fitness, vitality, and cognitive function with physical activity patterns in institutionalized elderly individuals. Methods The subjects comprised 27 elderly individuals (8 men and 19 women, mean age 83.2 years) who resided in a nursing home. The subjects were able to ambulate independently and did not have an unstable physical condition or severe dementia. Physical activity patterns, such as walking, standing, sitting, and lying total time in 24 hours, were assessed using the two tri-axial accelerometers (A-MES; Solid Brains Inc.). The number of steps taken in 24-hours was also measured. Physical activity data were collected for two days. Activities of daily living-related vitality and cognitive function were assessed by vitality index (VI) and Mini-Mental State Examination (MMSE), respectively. Physical fitness measures included muscle strength (hip extension, knee extension, and plantar flexor), balance (one-legged standing time and TUG), muscle power (five-time chair stand), agility (stepping test) and muscle endurance (30-s chair stand). Stepwise regression analysis was performed with physical activities as dependent variables and VI, MMSE, and physical fitness as independent variables. Results Mean total times in 24-hours were as follows: walking 159.7 ± 72.8 min (11.1%), standing 83.1 ± 58.3 min (5.8%), sitting 455.8 ± 137.7 min (31.7%), and lying 741.4 ± 177.4 min (51.5%). The number of steps was 3945.8 ± 3307.8. Stepwise regression analyses identified plantar flexor strength for walking time ( $\beta = 0.425$ ) and stepping test for the number of steps ( $\beta = 0.583$ ). No factor affected the standing, sitting, and lying times. Discussion This study showed that plantar flexor strength and agility were independent determinants of time spent on walking and number of steps, which suggests that ambulatory activity in institutionalized elderly individuals may be more related to physical fitness than vitality and cognitive function. On the other hand, our findings showed no associations of physical fitness, vitality, and cognitive function with total times of standing, sitting, and lying. Reference Ikezoe T, Asakawa Y, Shima H, Kishibuchi K, Ichihashi N. (2013). Arch Gerontol Geriatr, 57, 221-225. Contact: kamiya.midori.33n@st.kyoto-u.ac.jp

## EFFECTIVENESS OF SUPERVISED EXERCISE PROGRAM FOR CARDIAC PATIENTS IN A "PALESTRA SICURA" CERTIFICATED FITNESS CENTER

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Esercizio Vita Center

INTRODUCTION Emilia-Romagna (Region of Italy) encourages a network of certificated gyms and fitness centers ("Palestra Sicura") for supervised exercise programs for people affected by chronic diseases, including cardiovascular diseases. Exercise is prescribed by the Sports Medicine Centers of the Public Healthcare System and supervised by II level degree exercise professionals in the "Palestra Sicura" gym. Aim of the study was to verify the additional benefit of a 1 yr supervised exercise program against a non-supervised exercise program. The supervised program was performed in the "Palestra Sicura" Esercizio Vita (Ferrara, Italy). METHODS Patients (age 70.8 ± 3.4 yrs) were tested for clinical purpose at the local Sports Medicine Center with Bruce stress test for estimation of VO<sub>2</sub>peak (Bruce; 1972) and with a percentually-regulated walking test performed on a treadmill (1KTWT, Chiaranda et al; 2013). "Palestra Sicura" exercise professionals collected data of 7 consecutive cardiac patients (age 70.8 ± 3.4 yrs) through at a 3-steps test: at the beginning of a non-supervised exercise program (T0), at the time of referral to the palestra sicura (TR) and after 12 months of supervised exercise program (TC). A physical activity questionnaire has been delivered both at TC e TR (Ainsworth et al; 2011). Paired t-tests were performed to test significant differences among T0 and TR and TR and TC. RESULTS No patient dropped out before the end of the supervised exercise program. Physical activity level increased from 12.3 ± 6.1 mets/week to 24.3 ± 8.3 met/week ( $p<0.005$ ). Walking speed at the 1KTWT test was 3.5 ± 0.8 at T0, 3.6 ± 0.7 at TR and significantly increased to 4.4 ± 1.1 at TC ( $P<0.01$ ) VO<sub>2</sub>peak estimation by Bruce test METmax estimated by Bruce Stress Test

was  $5.7 \pm 1.2$  at T0,  $5.9 \pm 0.9$  at TR and significantly increased to  $6.5 \pm 1.4$  at TC ( $P < 0.01$ ), while no significant variation in HR max was observed. DISCUSSION A significant improvement in functional capacity and physical activity level was seen during the 12 months supervised program with respect to the previous non-supervised program. The observed improvement in walking speed of 0.8 km/h was associated to a 50% reduction of risks of death. The network of fitness centers with II level degree exercise specialist may increase the efficiency of exercise-based secondary prevention program. REFERENCES Ainsworth BE, Haskell WL, Herrmann SD, Meckes N, Bassett DR Jr, Tudor-Locke C, Greer JL, Vezina J, Whitt-Glover MC, Leon AS. (2011) *Med Sci Sports Exerc.* 43(8):1575-81. Chiaranda G, Bernardi E, Codecà L, Conconi F, Myers J, Terranova F, Volpato S, Mazzoni G, Grazi G. (2013) *BMJ Open.* 3(10):e003446. CONTACTS michele.felisatti@gmail.com

## LOCATION ANALYSIS OF REHABILITATION SPORT PROGRAMS AND THEIR REACHABILITY - SERVICES FOR THE ELDERLY PUBLIC AND THEIR HEALTH CARE IN RURAL AREAS

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Background: Emerging and progressing chronic diseases are known to be significantly enforced by physical inactivity. In regards to the negative development of kinetic behavior and its consequences, there has been a strenuous effort to increase sportive and physical activities among all age groups. Sport associations have therefore established a use of adequate instruments to effectively attend to the process of "healthy aging" and specifically release the health care system (§43 (I) SGB V i. V. m. §44 (I) SGB IX). In this context we investigated the care system coverage of ambulant rehabilitation sports (aRS) in Westmecklenburg/MV. Methods: Using ArcGIS (Fa.ESRI) we analyzed in detail several locations in the region of Westmecklenburg/MV and their reachability. We prepared cartographic data on the reachability by car and by public transport (ÖPNV) at different times of day. Result: The ÖPNV reachability analysis clearly shows great difficulty to fairly reach the offered rehabilitation sport programs in this region. 47,7 % of the population need more than 60 min and 18,6 % need more than 90 min driving time to make use of a 45-minute offer in the morning hours. Using the offered programs in the evening hours is additionally difficult: 33,3 % of the Westmecklenburg population need more than two hours for the way back home. On the other hand, regional metropolises of Westmecklenburg and their immediate environs have an overall good reachability provided there are any sport offers to use. Discussion: The results underline the necessity to further extend aRS-offers. Both urban as well as rural areas lack a sufficient quantity of rehabilitation sport offers.

## AEROBIC EXERCISE TRAINING CHANGES IN BRACHIAL ARTERY SHEAR PATTERNS IN MIDDLE AGED AND OLDER ADULTS

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Introduction: Hemodynamic shear stress is the frictional force of blood on the arterial wall. Shear stress demonstrates a typical pattern (i.e., antegrade and retrograde shear). Elevation in antegrade shear stress is associated with anti-atherogenic effects on the endothelium. In contrast, elevation in retrograde shear stress may be potentially pro-atherogenic effects. Aging causes to decreased antegrade shear rate and increased retrograde shear rate in peripheral conduit arteries. The change in shear patterns with aging may participate in development and progression of atherosclerosis. Aerobic exercise training is an effective strategy to prevent atherosclerotic cardiovascular disease. However, the effect of aerobic exercise training on peripheral conduit arteries shear patterns in middle aged and older adults has not been investigated. The purpose of this study was to determine whether aerobic exercise training changes in brachial artery shear patterns in middle aged and older adults. Methods: Thirty-nine middle aged and older adults were divided into 2 groups: an exercise group ( $n = 26$ ) and a control group ( $n = 13$ ). Subjects in the exercise group completed 12 weeks of aerobic exercise training (65%–80% of maximal heart rate, 40–60 min/day, 3–6 days/week). Before and after each intervention, resting brachial artery shear rate was evaluated in all participants. Results: The baseline brachial antegrade shear rate, retrograde shear rate and most other key dependent variables did not differ between the 2 groups. In the exercise group, brachial antegrade shear rate significantly increased after exercise intervention ( $P < 0.01$ ), and retrograde shear rate significantly decreased ( $P < 0.05$ ). Conclusion: We found that aerobic exercise training changes in brachial artery shear patterns in middle aged and older adults. The result of this study suggests that the change in shear patterns by aerobic exercise training may have a beneficial effect in prevention of atherosclerotic disease.

## EFFECTS OF EXERCISE ON ISOPROTERENOL-INDUCED CARDIAC DAMAGE IN RAT LINKED TO BRAIN FUNCTIONS

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Introduction A bidirectional relationship was found between myocardial infarction (MI) and depression in patients, furthermore comorbidity worsens prognosis. Alterations in neuroimmune processes are suspected to play a role in this link. Studies on rats also confirmed this phenomenon and opened new aspects in finding the exact underlying mechanisms in the brain immune system. In clinical practice currently no treatment is applied that targets both conditions at once, although exercise has already been shown to be beneficial for both conditions separately. Moreover, the accompanying depression in MI needs special and novel exercise treatment protocol. Objectives To investigate the future options in movement therapy, rats were used to study (1) whether isoproterenol-induced cardiac damage can mimic MI by leading to neuroinflammation, behavioral and cognitive changes; and (2) whether exercise can affect these parameters and improve health condition. Methods Female Wistar rats (11 months) were injected with either isoproterenol hydrochloride (ISO); a non-selective  $\beta$ -adrenoceptor agonist (in 70mg/kg dose) or saline s.c. on two consecutive days. Both groups were divided into sedentary and exercise subgroups undergoing 4 weeks of moderate intensity treadmill running. Cardiac function was assessed with echocardiography. Depressive-like behavior was measured by open field (OF) and sucrose preference tests, while cognition with novel location (NL) and novel object recognition tests. Neuroinflammation was estimated by microglia activation histologically. Results Cardiac dysfunction after ISO injection was confirmed by lower ejection fraction, which was slightly counterweighted by exercise. ISO enhanced hyper-ramification type of microglial activation in the hippocampus. Behaviorally ISO treatment had no influence on hedonic behavior of depression type, but exercise decreased anxiety in the OF. Regarding cognition ISO interfered with NL performance. Exercise appeared to counteract most of the ISO-induced effects in a variable extent. Conclusions Cardiac dysfunction after repeated ISO injection influenced microglial activa-



tion in the brain probably leading to an increased immunoreactivity. Immune changes could variably be coupled to behavior: no clear change in depression but a detrimental kind of effect on spatial recognition was observed. Continuous aerobic exercise partly affected cardiac function in this setting, and seemed to counteract to depressive symptoms evoked by ISO treatment.

### EXERCISE PROGRAMS TARGETING POSTMENOPAUSAL WOMEN: A NEW NETWORK OF INTERVENTION

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**INTRODUCTION** Only a minority of the population, who suffers from chronic diseases, is currently meeting the recommended levels of physical activity. An Italian regional network of certificated gyms (from Emilia Romagna) has been created in order to combine clinical approaches with strategies aimed at fighting against this problem. These centers provide services for people with or without doctors' prescriptions (DGR n. 1154/2011). The purpose of this study is to analyze the adherence and compliance to ExP administered to postmenopausal women, provided by local start-up "Esercizio Vita" center. **METHODS** 86 postmenopausal women ( $68.4 \pm 7.8$  yrs) who followed the ExP for the prevention of fall risk (ACSM 2012), were recruited. The sample was followed throughout 18 months (T0-T18) and analyzed for adherence (Wilson et al., 2009); compliance (Insull, 1997); functional assessment 6MWT, Sit And Reach, Berg Scale; type of submission. Finally, subjects had to answer a telephonic questionnaire. **RESULTS** Adherents at the ExP represented 44.2 % of the sample. They have been divided into: compliants (23.7%) and partially compliants (76.3%); no one was non-compliant. Significant improvements were seen in the flexibility of adherents and compliants ( $p = 0.0392$ ) and in the balance of adherents and partially compliants ( $p = 0.0026$ ). The main sending mode was word of mouth (51.2%), except for elderly and low performing subjects (12.8% of the sample) where the main sending mode were doctors' prescriptions (45.5%). The reasons for prolonged periods of non-physical activities were: family commitments (42.6%), health issues (31.1%) and logistic problems (26.3%). **DISCUSSION** As demonstrated in literature, significant improvements were observed in balance and flexibility in adherent postmenopausal women. The importance of this study was to analyze territorial response regarding adherence to ExP in the population who suffers from chronic diseases. We consider that these first signs show how these certificated and combined strategies (clinical and fitness) influence both the public and personal opinion about physical activity. Further studies are needed. **REFERENCES** Deliberazione di Giunta Regionale n.1154 dell' 1 agosto 2011. Piano della Prevenzione 2010-2012 della Regione Emilia-Romagna - "La prescrizione dell'attività fisica": primi indirizzi per l'attuazione del progetto "Palestra sicura: prevenzione e benessere". Wilson K., Brookfield D. (2009) International Journal of Sport and Exercise Physiology. 6, 89-100. Insull, W. (1997) Journal of Internal Medicine. 241:317. David P. Swain, Clinton A. Brawner (2012), ACSM's Resource manual for guidelines for exercises testing and prescription. **CONTACT** mariangela.trentini91@gmail.com

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### PO-CPP-10 Health & Fitness 3

### WORK ABILITY AND WORK-RELATED PHYSICAL ACTIVITY OF EMPLOYEES REGARDING AGE AND OCCUPATION IN A MEDIUM-SIZED BUSINESS

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**Introduction** Work-related physical activity (PA) and work ability are of growing importance in modern working society. There is evidence for age- and job-related differences regarding PA and work ability. This study analyses work ability and work-related PA of employees in a medium-sized business regarding age and occupation. **Methods** The total sample consists of 148 employees with 116 male (78.4%) and 32 female (21.6%) subjects and a mean age of  $40.85 \pm 10.07$  years. 100 subjects (67.6%) are white-collar workers (WC), and 48 (32.4%) are blue-collar workers (BC). Work ability is measured using the Work Ability Index (WAI). The present study obtained data on the employees PA via the Global Physical Activity Questionnaire (GPAQ). The statistical analysis is carried out with SPSS 21.0. **Results** Analysis of WAI shows higher levels of work ability for WC compared to BC ( $p < .001$ ). Further significant differences were revealed for work-related PA with BC reaching a higher level than WC ( $p < .001$ ). Concerning age no significant differences were found neither for work ability nor work-related PA. Overall, more than half of all subjects meet the current guidelines for physical activity of 2.5 hours per week set up by the American College of Sport Medicine (Haskell et al., 2007). However WC are less able to meet activity guidelines than BC. **Discussion** The present study shows significant differences in work ability and work-related PA regarding occupation. Other research indicates that work ability varies between occupations (Tuomi et al., 2001). The comparison of the age groups shows a similar percentage of low active employees throughout all age groups. Further, older employees with an age between 50 and 65 reveal the lowest percentage of high active employees. This matches other findings (Allender et al., 2008). As a conclusion elder employees are not necessarily less active, yet the present study underlines the evidence so far that elder employees have a higher probability of not meeting current activity guidelines. The results indicate that nearly half of all WC and 75% of BC meet the activity guidelines **References** Haskell WL, Lee IM, Pate RR, Powell KE, Blair SN, Franklin BA. et al. (2007). Med Sci Sports Exerc. 39(8), 1423–1434. Tuomi K, Huuhtanen P, Nykyri E, Ilmarinen J (2001). Occup Med. 51(5), 318–324. Allender S, Foster C, Boxer A (2008). J Phys Activ Health. 5(1), 104–116.

### EXERCISE, LIFESTYLE AND HEALTH HABITS OF YOUNG ADULTS

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**Introduction** This project examined the lifestyle, health habits and risk factors of young adults at Qatar University. It explored the clustering and differences in dietary habits, body mass index (BMI) and physical activity (PA) amongst male and female students, both Qatari and non-Qatari. Low levels of physical inactivity and poor dietary practices have been reported amongst youth living in the Arabian Gulf countries predisposing them to health problems (Al-Nakeeb, 2012 & 2014). **Methods** Seven hundred and thirty two students aged 18–25 year completed a self-reported questionnaire designed to quantify healthy and unhealthy dietary habits. In addition, an objective measure of participants' BMI was calculated and classified for overweight and obesity according to age and gender-specific cut-off points of

the International Obesity Task Force criteria (Cole, et al. 2000). The total energy expenditure per week was calculated based on the metabolic equivalent (MET-min) values of reported activities (Ainsworth, et al. 2000). Results Both males and females had a high prevalence of being overweight and/or obese with low levels of PA, according to well-established international standards. Three clusters were identified based on the students' lifestyle and dietary habits. Cluster 1 (high risk factors), included those who engaged the least in healthy dietary practices and consumed the unhealthiest foods, participated in less PA and had the highest BMI. Cluster 2 (moderate risk factors), included those with considerably more habits falling into the moderate category, engagement in the most PA, the least TV and computer viewing time and had the lowest BMI. Cluster 3 (low risk factors), included those who engaged the most with the four healthy dietary practices, the least with the four unhealthy dietary practices and participated in moderate PA per week. Discussion The findings from this study reaffirm the notion that health practices tend to occur in clusters rather than in isolation (Swinburn, et al., 2011). The study provides valuable data that could be used by policy makers, university management and faculty alike to address issues concerning the health and wellbeing of students, such as limiting the progression of CVD diseases and improving the health of future generations in Qatar. This could be achieved through intervention strategies that lead to changing the built environment and affecting behavioural modification of student's lifestyle and health habits. References Ainsworth, B.E., et al. (2000) *Med. Sci. Sport Exerc.* 32, s498–s516. Al-Nakeeb Y, et al. (2014) *Open J Prev Med* 4: 193-203. Al-Nakeeb Y, et al. (2012) *Intl J Environ Res Public Health* 9: 1409-1506. Cole TJ, et al. 2000. *Br Med J* 320 (7244): 1240-1243. Swinburn BA, et al., (2011) *Lancet* 378: 804-814. Contact alnakeeb@qu.edu.qa Do not insert authors here

### EFFECTS OF ONE- AND TWO-HANDED BACKHAND STROKES ON BONE MINERAL DENSITY AND CONTENT OF THE DISTAL RADIUS IN POSTMENOPAUSAL TENNIS PLAYERS

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**Introduction:** Previous studies showed that long-term unilateral tennis activity had a positive effect on the bone mineral content (BMC) and density (BMD) of the dominant arm. Hence, the inter-arm asymmetry of bone mass can be observed. Backhand groundstrokes in tennis can be divided into one- and two-handed, but only two-handed backhand strokes induce the bone of non-dominant arm to response the mechanical loading. Therefore, the aim of this study was to evaluate the effect of using one- and two-handed backhand strokes on the BMD and BMC of the postmenopausal tennis players. **Methods:** Bone area, BMC and BMD of the lumbar, hip and distal radius were measured by DXA in postmenopausal women of one-handed backhand tennis players (OTG;  $59.2 \pm 6.1$  years), two-handed backhand tennis players (TTG;  $58.2 \pm 4.4$  years) and swimmers as a control group (SG;  $57.1 \pm 5.0$  years) ( $n=14$  per group). **Results:** There were no significant differences between groups on dominant or nondominant arm of any bone variables. At the ultra-distal radius (trabecular), OTG and TTG had significantly greater inter-arm difference of BMC (13.5 % & 11.8 %) and BMD (14.0 % & 10.4 %) than SG (1.9 % & 1.7 %;  $p<.05$ ). At the mid-distal radius (cortical), OTG had greater inter-arm difference of BMC (13.4 %) and BMD (9.9 %) than SG (3.4 % & 0.4 %), and greater than TTG (3.5 %,  $p<.05$ ) in BMD. At the 1/3 distal radius (cortical), OTG had greater inter-arm difference of BMC (11.4 %) than TTG and SG (4.4 % & 2.9 %, respectively,  $p<.05$ ). Moreover, OTG had higher inter-arm difference of grip strength than TTG and SG (21.6 %, 10.2 % & 10.4 %, respectively,  $p<.05$ ). Furthermore, TTG had significantly higher BMC and BMD of lumbar and femoral neck than SG, and both OTG and TTG had higher BMD of inter-trochanter than SG ( $p<.05$ ). **Conclusion:** Using two-handed backhand strokes is associated with enhanced BMC and BMD of the nondominant arm, lumbar and hip, which may effectively help to maintain bone mass or attenuate bone loss of specific sites and reduce the risk of future fractures.

### GENDER DIFFERENCES IN FACTORS AFFECTING DEPRESSIVE STATE IN JAPANESE UNIVERSITY STUDENTS

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Osaka University

**PURPOSE** Recently, in Japan, lifestyle has shifted to night type. The tendency is remarkable in university students. In addition, depressive tendency has been becoming prominent in this age. Also, it is concerned that physical activity decreases and physical fitness becomes lower. Therefore, it is meaningful to examine relationships among the factors. In this study, we studied the influences of physical activity, physical fitness, daily sleepiness on degree of depressive state and their gender differences in Japanese university students. **METHODS** One-hundred and twenty-five undergraduate students participated in this study (77 men and 48 women). We measured physical activity level using an accelerometer (Lifecorder [Lc], Kenz, Nagoya, Japan) for 2 weeks. The Lc measured the daily number of steps (steps per day), 24-energy expenditure (kJ per day), and energy expenditure of exercise (kJ per day). To evaluate the level of endurance fitness, Maximal oxygen uptake ( $VO_{2max}$ ) was calculated by an indirect method using a cycle ergometer. The  $VO_{2max}$  was predicted by the nomogram of Åstrand and Ryhming, a modality that is generally used to predict the  $VO_{2max}$ . Depressive tendency and daytime sleepiness was evaluated with questionnaire, PHQ9 (Kroenke et al., 2001) and JESS (Japanese version of the Epworth Sleepiness Scale) (Takegami et al., 2009), respectively. **RESULTS** The mean of PHQ9 score, sleepiness score, the number of steps, and  $VO_{2max}$  were  $5.3 \pm 3.4$ ,  $10.5 \pm 3.7$ ,  $9955.6 \pm 3293.3$  steps, and  $43.6 \pm 7.1$  ml/kg/min., respectively. A decision tree analysis revealed a gender difference in factors correlated with degree of depression. In male, the degree of depression was positively correlated with activity time and physical fitness, while, in female, there was a significantly positive correlation between the degree of depression and sleepiness. **DISCUSSION** Our results show that increasing physical activity level and physical fitness increases the degree of depression in male, while, in female, sleepiness has a large influence. Taken together, we concluded that biological mechanism for increasing depression probably is different between men and women. **REFERENCES** Kroenke K, Spitzer RL, Williams JB.(2001). *J Gen Intern Med*, 1, 606-13. Takegami M, Suzukamo Y, Wakita T, Noguchi H, Chin K, Kadotani H, Inoue Y, Oka Y, Nakamura T, Green J, Johns MW, Fukuhara S. (2009). *Sleep Med*, 10, 556–565.

### EFFECTS OF METHODS FOR WARM-UP PRIOR TO BENCH PRESS EXERCISE ON IEMG, MEF AND THE NUMBER OF REPETITIONS IN PECTORALIS AND TRICEPS

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**Introduction** The purpose of this study was to find out the effect of different way to warm up prior to bench press resistance exercise on iEMG, MEF and number of repetitions in pectoralis and triceps. **Methods** Male college students who experienced resistance training for about 1 years were recruited. Three method after warming up(Non Warm-Up, Stretch Warm-Up, Resistance Exercise Warm-Up) on a bench press was performed. iEMG and MEF during bench press exercise were analyzed. For statistical significance, we used t-test and

one way ANOVA. Results First, iEMG in pectoralis major during bench press exercise was recorded the highest when measured after resistance exercise warm-up, and that of non-warm-up was the lowest ( $p<.001$ ). Second, iEMG in triceps during bench press exercise was recorded the highest when measured after non-warm-up, and that of resistance warm-up was the lowest ( $p<.001$ ). Third, pectoralis major's MEF during bench press exercise was found to be the greatest after no warm-up session, but to be the lowest resistance exercise warm-up ( $p<.001$ ). Fourth, triceps's MEF during bench press exercise was found to be the greatest after resistance warm-up session, but to be the lowest after no warm-up session ( $p<.001$ ). Fifth, the number of repetition was the highest during bench press exercise after resistance exercise warm-up session, but the lowest after no warm-up session. Conclusion As a result, warm-up session prior to bench press exercise can lead to higher iEMG in pectoralis major and lower MEF in triceps and therefore can play very important role in performing a number of repetitions. \* a1004m@naver.com

### EFFECTS OF AEROBIC INTERVAL TRAINING AND MODERATE CONTINUOUS TRAINING ON CARDIAC, MUSCULAR, AND CEREBRAL HEMODYNAMICS SUPPRESSED BY SEVERE HYPOXIA IN HUMANS

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Background: Aerobic interval training (AIT) is a more effective modality for improving aerobic fitness than is traditional moderate continuous training (MCT). However, severe hypoxic exposure disturbs vascular hemodynamics. This study investigates how interval and continuous exercise regimens influence hemodynamics and oxygenation in cardiac, muscle, and cerebral tissues during severe hypoxic exposure in humans. Methods: Sixty healthy sedentary males were randomized to engage either aerobic exercise training (AIT, 3-minute intervals at 40% and 80%VO<sub>2</sub>max, n=20) or moderate continuous training (MCT, sustained 60%VO<sub>2</sub>max, n=20) for 30 minutes/day, 5 days/week for 6 weeks, or to a control group that did not receive exercise intervention (CTL, n=20). Hemodynamic responses to hypoxic exercise (HE, 100 W under 12%O<sub>2</sub> for 30 min) were determined before and after various regimens. A noninvasive bio-reactance device was adopted to measure cardiac hemodynamics, whereas a near-infrared spectroscopy was employed to assess perfusion/O<sub>2</sub> extraction in frontal cerebral lobe ( $\Delta$ [THb]FC / $\Delta$ [HHb]FC) and vastus lateralis ( $\Delta$ [THb]VL / $\Delta$ [HHb]VL), respectively. Results: Following the 6-week intervention, the AIT group had a larger improvement in aerobic capacity than the MCT and CTL groups. Moreover, AIT exhibited higher levels of cardiac output,  $\Delta$ [THb]FC,  $\Delta$ [THb]VL, and  $\Delta$ [HHb]VL during exercise, compared to MCT did. Although acute HE decreased oxygenation of the FC, none of the 6-wk interventions influenced the cerebral perfusion and oxygenation during HE. However, AIT, but not MCT, ameliorated the suppression of cardiac stroke volume and the VL hyperemic response and re-oxygenation rate by acute HE. Conclusions: AIT effectively improves cardiopulmonary fitness and increases resistance to disturbance of cardiac hemodynamics by severe hypoxia, concurrence with enhancing O<sub>2</sub> delivery/utilization in skeletal muscles but not cerebral tissues. References: 1. Fu TC, Wang CH, Hsu CC, Cherng WJ, Huang SC, Wang JS. Suppression of cerebral hemodynamics is associated with reduced functional capacity in patients with heart failure. *Am J Physiol Heart Circ Physiol.* 2011;300:H1545-55. 2. Fu TC, Wang CH, Lin PS, Hsu CC, Cherng WJ, Huang SC, Liu MH, Chiang CL, Wang JS. Aerobic interval training improves oxygen uptake efficiency by enhancing cerebral and muscular hemodynamics in patients with heart failure. *Int J Cardiol.* 2013;167:41-50. ert authors here

### COMPARISON OF YOUNG ADULTS BODY BALANCE AND PHYSICAL ACTIVITY

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Introduction Physical inactivity levels are rising in many countries with major implications for the prevalence of non-communicable diseases and the general health of the population worldwide (WHO, 2010). The aim of this research is to evaluate relationship between level of physical activity, type of sports and maintenance of body balance. Methods 96 young adults of both sexes were included in this study, their ages ranged between 17 and 21 years. All study participants were interrogated by special questioner and their body balance maintenance was tested with "Fall risk test" on Biodex Balance System (BBS). The main aim of test was evaluated the maintenance of body balance. The person under investigation must keep body mass center in the middle of unstable Biodex platform, when instability level decreased from 8 to 1. The test was performed three times for each person, one time duration was 40seconds. Results The analysis of the relationship between overall stability index (OSI) and sport type showed that the young adults with aerobic physical activity had better (lower) OSI than persons, who exercised team sports( $p<0.05$ ). Also we found that participants with aerobic physical activity had lower OSI than physically inactive young adults ( $p<0.05$ ). Our study results showed that women OSI was better than men ( $p<0.05$ ). However, there were no statistically significant differences between physically active and inactive people. The strong relationship was found between person's height and OSI ( $p<0.01$ ). Discussion BBS allows evaluating three stability indexes: anteroposterior index, mediolateral index and OSI. Other studies show, that OSI is the most reliable of all three mentioned above (Karimi et al., 2008; Oh et al., 2011). For this reason, present investigation estimates OSI results. The main result of this study there is no differences between active and inactive young adults, however important to say that balance is residual phenomenon which depends on long – term and type of physical activity. Our study as other researchers (Greve et al., 2013) showed better women's maintenance of balance than men's because of neuromuscular and neurophysiological factors. Furthermore, study revealed that relation between height and balance maintenance became more difficult, because of the higher position of center of mass (Alonso et al., 2012). References Alonso AC, LunaNM, Mochizuki L, Barbieri F, Santos S, Grevel JM.Clinics (Sao Paulo). 2012 Dec;67(12):1433-41. Greve JM, Cu? M, Dülgero?lu D, Brech GC, Alonso AC. *Biomed Res Int.* 2013;2013:850424. Karimi N, Ebrahimi I, Kahrizi S, Torkaman G. *Pak J Med Sci.* 2008;24(3):372-7. Oh KY, Kim SA, Lee SY, Lee YS. *Ann Rehabil Med.* 2011 Dec;35(6):873-9.

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## PO-CPP-14 Nutrition 1

**CALORIC RESTRICTION IMPROVED AGING RESULTED DECLINE OF TESTOSTERONE SECRETION BY DECREASING OXIDATIVE STRESS IN TESTICULAR TISSUES OF MALE RATS**

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The previous reports have demonstrated that diet food could affect human physiological and reproductive system, including testosterone production, sperm motility and quantity. Testicular tissue composed a lot of fat and fatty acids, high-fat diet is one component to induce inflammation and oxidative stress which cause to damage testicular function. The purpose is to explore whether calorie-restricted diet could slow down the aging-resulted degenerate of testis in rats. Four and sixteen-month-old Sprague Dawley (SD) male rats were randomly divided into two groups and fed with normal diet (N) and caloric restriction diet (CR) for fourteen weeks. On the age of seven-month (adult) and nineteen-month (old), rats were sacrifice. The blood was collected to measure plasma testosterone by using enzyme immunoassay (EIA). The testicular tissues were collected, weighted, and homogenized to measure the activities of antioxidant enzymes and production of lipid peroxidation and glutathione with commercial kits. All data were analyzed with one way analysis of variance (ANOVA). Where a significant main effect was observed, Duncan's post-hoc analysis was used to locate differences between means. Statistical significance was accepted at  $p < 0.05$ . The results showed that calorie restriction significantly limited the gain of body weight in both age. Either N or CR, aging resulted significant decline ( $p < 0.05$ ) of reproductive tissue weight, including testis, epididymis and seminal vesicles. Fed with normal diet, old rats showed significant lower plasma testosterone than adult rats, and CR enhanced secretion of testosterone in old rats ( $p < 0.05$ ). Testicular MDA was significant increased by ageing in N but not in CR. As fed with normal diet, aging significantly ( $p < 0.05$ ) decreased the activities of SOD, GPx and GSSG, but significantly ( $p < 0.01$ ) increased the activity of catalase. Calorie-restriction diet improved the activity of SOD ( $p < 0.05$ ), but not altered the activities of catalase, GPx, and GR. The production of GSH was lower in old rats than adult rats, diet did not alter the aging effect on GSH production. In conclusion, both of age and caloric restriction have could effect on reproductive system. Caloric restriction decreased reproductive tissue weight but enhanced testosterone secretion by improving activity of SOD and decreasing production of lipid peroxidation. Maybe caloric restriction could work as an effective strategy to delay onset of aging.

**EFFECT OF THE DIETARY SUPPLEMENT SP® ON EXERCISE PERFORMANCE**

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Introduction Super Performance (SP®) is a dietary supplement containing a mixture of substances shown to have some exercise performance enhancing effects (e.g. caffeine, carbonate, branched chain amino acids). Anecdotal reports from athletes suggest the effectiveness of the supplement. However, no scientific data exist so far. Thus, the aim of the study was to investigate the effect of SP® on exercise capacity. Methods Nine sport students performed 3 cycle exercise tests to exhaustion, each separated by 1 week. The first test was considered a familiarization test. In a random order half of the participants performed the second test with SP® supplementation (intake of 40g SP®, 24 and 1 hour before each test) and half with a placebo substance (same amount). During test 3, the order was vice versa (cross-over setting). The cycle test started by 100 watt and workload was increased by 50 watt every 3 minutes. During each test a gas analyses was performed and lactate concentration was determined at the end of each stage. Results SP® supplementation, when compared to placebo, improved maximal power output ( $299 \pm 28$  vs.  $292 \pm 27$  watt, respectively;  $p < 0.05$ ), increased maximal lactate concentration ( $13.4 \pm 2.3$  vs.  $10.9 \pm 2.1$  mmol/L, respectively;  $p < 0.05$ ), and power output at the individual threshold (Dmax) ( $226 \pm 24$  vs.  $220 \pm 21$  watt, respectively;  $p < 0.05$ ). Power output at the 4 mmol/l threshold was reduced ( $220 \pm 33$  vs.  $229 \pm 32$ ;  $p < 0.05$ ) during the SP® trial. Changes in maximal power output of the cycle tests were positively associated with changes in the maximal lactate concentration ( $r = 0.801$ ,  $p = 0.017$ ). Discussion SP® supplementation increased power output during an incremental exercise test. It seems reasonable to speculate that central and peripheral factors linked to caffeine, carbonate, and branched chain amino acids ingestion might be responsible for the observed performance improvements (Kreider et al., 2010). References Kreider RB, Wilborn CD, Taylor L, Campbell B, Almada AL, Collins R, et al. (2010). J Int Soc Sports Nutr, 7, 7. Contact Hannes.Gatterer@uibk.ac.at

**EFFECT OF DEHYDROEPIANDROSTERONE SUPPLEMENT COMBINED WITH WHOLE-BODY VIBRATION TRAINING ON EXERCISE PERFORMANCE AND BIOCHEMICAL PROFILES**

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Introduction Whole-body vibration (WBV) is a well-known light-resistance exercise by automatic adaptations to rapid and repeated oscillations from a vibrating platform, which is also a simple and convenient exercise for older adults. Dehydroepiandrosterone (DHEA) is secreted primarily by the adrenal gland and is the most abundant sex steroid. However, the potential benefits of WBV and DHEA supplementation on athlete to changes in body composition, exercise performance, and fatigue are currently unclear. The objective of the study is to investigate the beneficial effects of WBV training and DHEA supplementation on body composition, exercise performance, and physical fatigue-related and biochemical responses in C57BL/6 mice. Methods Male C57BL/6 mice were randomly divided into 4 groups: Sedentary control group with vehicle (SD), DHEA supplementation (5 mg/kg, DHEA) group, WBV group and WBV with DHEA supplementation group (25 mg/kg, DHEA+WBV) for 6 weeks and followed by 6 weeks WBV of 5 days per week. Exercise performance was evaluated by forelimb grip strength and exhaustive swimming time as well as by changes in body composition and anti-fatigue activity levels of serum lactate, ammonia, glucose, and creatine kinase (CK) after a 15-min swimming exercise. The biochemical parameters were at the end of the experiment. Results In our study, mice supplementation of DHEA increase the serum testosterone, muscle mass and have anti-fatigue activity; Whole body vibration (WBV) training increase muscle strength and serum glucose level. However, DHEA supplement combined with WBV training was just slightly increase muscle strength and glycogen. Discussion In the result we find DHEA can enhance the serum testosterone, muscle mass and have anti-fatigue activity and WBV also can increase muscle strength and serum glucose level. But it is interesting that DHEA+WBV just slightly increase muscle strength and glycogen. We doubt that supplementation of DHEA should



need more strengthen training program to achieve the better results. Due to DHEA usually are used to increase muscle mass, strength, and energy. We think it have high potential to improve the aging symptoms, however aging symptoms is very complicated. We will try to find another optimal exercise treatment to solve the problems. For the future study we will modified our WBV training program with resistance training to achieve our expected results. References Chen, Y. M., Tsai, Y. H., Tsai, T. Y., Chiu, Y. S., Wei, L., Chen, W. C., & Huang, C. C. (2014). Fucoidan supplementation improves exercise performance and exhibits anti-fatigue action in mice. *Nutrients*, 7(1), 239-252. Lin, C. I., Huang, W. C., Chen, W. C., Kan, N. W., Wei, L., Chiu, Y. S., & Huang, C. C. (2015). Effect of whole-body vibration training on body composition, exercise performance and biochemical responses in middle-aged mice. *Metabolism*, 64(9), 1146-1156.

### CAFFEINE SUPPLEMENTATION HAS NO EFFECT OVER PERFORMANCE IN YOUNG ELITE FOOTBALL PLAYERS

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**Introduction:** Caffeine has been used as an ergogenic aid in sports performance for at least two decades (Tarnopolsky et al 2010). Studies have hypothesized that due to its stimulant properties on the central nervous system it can be used as an enhancing aid which may improve athletic performance and decrease muscle fatigue. The aim of this study was to observe the effect of the consumption of caffeine on performance in young elite football players before, throughout a 45 min match and after, simulating the end of the first half of a match and observe their performance status for the second half. **Methods:** In a randomized single-blind design, the players ( $16.4 \pm 0.5$  years,  $69.1 \pm 7.5$  kg,  $175.6 \pm 6.6$  cm,  $13.7\% \pm 3.0\%$  body fat) recruited from the national junior chilean team, were given either a capsule of 3 mg · kg<sup>-1</sup> b.w. of caffeine or placebo (dextrose) 60 min prior to the match. Match activities was assessed with a GPS system and 5 m (acceleration), 15 m (flying time), and 20 m (maximal velocity) sprints and an agility test was measured with timing gates and photocells before and 5 minutes after the 45 min match. Heart rate was monitored throughout the 45 min game. **Results:** No differences ( $P > 0.05$ ) was observed between the caffeine and placebo group regarding total distance covered ( $4850.6 \pm 231$  vs.  $4976 \pm 386.4$  m), sprint number ( $143.2 \pm 10.8$  vs.  $161.4 \pm 22.0$ ), repeated sprints ( $143.2 \pm 11.1$  vs.  $153.9 \pm 24.1$ ), maximal heart rate ( $198.9 \pm 6.7$  vs.  $197.6 \pm 8.0$ ), high intensity zones (zone 5 and 6:  $280.5 \pm 34.5$  vs.  $237.6 \pm 60.5$  m and  $178.7 \pm 65.6$  vs.  $157.6 \pm 59.1$  m, respectively). Acceleration, flying time, maximal velocity, and the agility test showed no differences between groups, before or after the match ( $P > 0.05$ ). **Discussion:** Caffeine administration did not show an ergogenic effect in young elite football players for acceleration, flying time, velocity, agility, or any match activities. Our study is in agreement with the results observed by Pettersen et al. 2014, where no effects in performance was observed in young football players after the consumption of caffeine. Our results conclude that the consumption of 3 mg · kg<sup>-1</sup> b.w. caffeine has no effect in preserving performance after 45 min of a football match. **References** Tarnopolsky, M.A. (2010). Caffeine and creatine use in sport. *Annals of Nutrition and Metabolism*, 57 (Suppl.2), 1-8. Svein Arne Pettersen, Peter Krusturup, Mads Bendiksen, Morten Bredsgaard Randers, Joao Brito, Jens Bangsbo, Yun Jin & Magni Mohr (2014) Caffeine supplementation does not affect match activities and fatigue resistance during match play in young football players, *Journal of Sports Sciences*, 32:20, 1958-1965. Contact: karen.mackayp@gmail.com

### DIETARY CAFFEINE INGESTION ENHANCES PERFORMANCE IN AMATEUR MARATHONERS.

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**Introduction** Caffeine stimulates lipolysis, which promotes the uptake of fatty acids during exercise, which may improve the performance in endurance sports such as marathon. However, little is known about the effects of caffeine intake on performance in amateur marathoners. Hence, the main aim of this study was to verify if caffeine intake could be associated with improvements in a marathon performance of amateur athletes. **Methods** Twenty two healthy voluntary unprofessional athletes who participated in 2014 Madrid Marathon were recruited for this study. Finally, the marathoners who managed to finish the race were 16 athletes. Food and drink intake was assessed using a weighed diet record during seven consecutive days of week before of competition with an electronic kitchen scale (HR2395, Philips, Netherlands). All participants were instructed to register all food and beverages in as much detail as possible and to weigh the amounts to the nearest one gram. All the dietary records were analyzed using the nutrient analysis software DIAL V.2 to examine the caffeine intake. In addition, each participant performed a maximal incremental test to exhaustion on treadmill (HP Cosmos Vyasis LE 300 CE; Germany) connected to a gas analyzer (Jaeger Oxycon Pro, Hoechberg, Germany) and heart rate (HR) monitor (Polar S610, Kempele, Finland) to measure VO<sub>2</sub>max and HRmax, respectively. The test started at a speed of 7 km/h and the increase was of 0,1 km/h every 6 seconds (1 km/h every minute). The participants were divided in two groups in accordance with their time race by percentile 50 (fast and slow runners), with cut-point at 3h 33min. **Results** Mean total intake of caffeine in all participants was  $33.9 \pm 21.7$  mg/day. Fast runners showed higher caffeine intake ( $43.3 \pm 25.4$  mg/day) compared to slow runners ( $23.5 \pm 10.6$  mg/day) (+89%;  $p < 0.05$ ), even after accounting for VO<sub>2</sub>max or age as covariate ( $p = 0.03$  and  $p = 0.08$ , respectively). Caffeine intake was negatively associated with the marathon time race ( $r = -0.5$ ,  $p < 0.05$ ), showing a possible benefit of caffeine on performance. The fast runners showed 14% higher VO<sub>2</sub>max in absolute terms versus slow runners ( $p < 0.05$ ), but not in relative values. Absolute VO<sub>2</sub>max was associated negatively with time race ( $r = -0.6$ ,  $p < 0.05$ ), but not with caffeine ingestion. **Discussion** Caffeine intake is associated with better performance in the race. In concordance, Hodgson et al.(2013) and Graham and Spriet (1991) showed respectively that 5 mg/kg and 9 mg/kg ingestion of caffeine 1 h prior to exercise improved endurance exercise performance.

### EFFECTS OF COMBINING BEEF, WHEY OR CARBOHYDRATE SUPPLEMENTATION WITH RESISTANCE TRAINING ON BODY COMPOSITION, AND MARKERS OF HEALTH IN COLLEGE ATHLETES.

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**Introduction** Beef is a nutrient-rich, high-quality protein containing all the essential amino acids in proportions similar to those found in human skeletal muscle. The current study aimed at comparing the impact of an oral supplementation with hydrolysate beef protein, whey protein isolate and carbohydrate on body composition, and general markers of health in college athletes. **Methods** Thirty-three resistance-trained males and females ( $26.4 \pm 7.1$  years) were randomly assigned to 1 of 3 groups: hydrolysed beef protein (B n=12), whey protein (W n=9), or non-protein isoenergetic carbohydrate (maltodextrin; CHO n=12). All had to take 20 g of the proteins or carbohydrate, mixed with 250 ml of orange juice, once a day (immediately after workout or before breakfast) during the training period. **Body composition**, using plethysmography, total cholesterol LDL, HDL cholesterol, urea, uric acid, creatinine, alanine transaminase, aspartate transami-

nase and HNP 1-3 salivary immune-peptides were assessed before and after intervention. Results Only B showed significant increase of fat-free mass ( $p=0.007$   $d=0.95$ ;  $+1.8\%$ ). Positive trends were observed for W ( $p=0.075$   $d=0.68$ ;  $+0.9\%$ ) and CHO ( $p=0.081$   $d=0.58$ ;  $+1.5\%$ ). No changes have been observed for the fat mass in all the three treatment groups. Although the three treatment groups showed no significant differences for all the health blood related markers, compared with the pre intervention values, only B showed a significant decrease in the basal ( $p<0.001$ ;  $d=0.7$ ;  $-35.8\%$ ) and post workout ( $p<0.001$ ;  $d=0.7$ ;  $-26.1\%$ ) levels of the HNP 1-3 immune-peptides. Discussion Results demonstrated that combining of 250 ml of orange juice mixed with 20 g of beef protein hydrolysate would maximise fat-free mass, and elicit positive immunity adaptation compared to mixing of orange juice with 20 g of whey protein isolate or 20 g of maltodextrin. Our results support previous positive effect of beef protein in promoting fat-free mass accretion (Negro et al., 2014) and muscle protein synthesis (Phillips, 2012) in adults. Consumption of beef protein supplementation with orange juice after workout or before breakfast would maximise fat free mass gains, and would also promote positive humoral immunity adaptation with no negative effect on the general markers of health. References Negro, M, Vandoni M, Ottobriani S, Codrons E, Correale L, Buonocore D, Marzatico F. (2014) Nutrients, 6, 3040-3049 Phillips, S.M. (2012). Meat Science 92, 174–178 Robinson, MJ, Burd NA, Breen L, Rerich T, Yang Y, Hector AJ, Phillips SM. (2013) Appl. Physiol. Nutr. Metab. 38, 120–125

## EFFECTS OF HYDROGEN RICH WATER ON INTERMITTENT EXERCISE

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**Introduction** Recent studies showed a positive effect of Hydrogen Rich Water (HRW) consumption on acid-basic homeostasis at rest. We investigated 2-weeks of HRW intake on repeated sprint performance and acid-base status during prolonged intermittent cycling exercise. **Methods:** in a single-blind protocol, nine trained male cyclists (age  $41.2 \pm 7.9$  years [mean  $\pm$  SD], maximal oxygen uptake [VO<sub>2</sub>max]  $52.6 \pm 4.4$  ml/kg/min) were provided daily with 2 liters of normal water (pH 7.6, oxidation/reduction potential [ORP] +230 mV, free Hydrogen content 150 ppb) (CTRL) or Hydrogen Rich (pH 9.5, ORP -450 mV, free Hydrogen 450 ppb) water (HRW) produced by a dedicate device. Tests were performed at baseline and after each period of two weeks of treatment. The sequence of treatments was randomized. The 30-min intermittent cycling trial consisted in ten 3-min blocks, each one composed by 90 sec at 40% VO<sub>2</sub>max, 60 sec at 60% VO<sub>2</sub>max, 16 sec all out sprint, and 14 sec active rest. Pulmonary O<sub>2</sub> uptake (VO<sub>2</sub>), heart rate and power output were measured during the whole test, while mean and peak power output (PPO), time to peak power and fatigue index (FI) were determined during all the 16 s sprints. Blood Lactate, pH and bicarbonate [HCO<sub>3</sub><sup>-</sup>] concentrations were determined at rest and after each sprint. **Results:** PPO decreased significantly (mean -10%,  $p<0.05$ ) in the control group from the 5th sprint when expressed as a percentage of the first sprint, and from the 8th sprint when expressed as absolute value, while it remained unchanged in HRW group. Mean power, FI and time to peak power showed no differences. In both conditions lactate levels increased and [HCO<sub>3</sub><sup>-</sup>] concentration and pH decreased progressively as a function of the number of sprints, showing a trend in favor of lower lactate and higher [HCO<sub>3</sub><sup>-</sup>] and pH in HRW vs CTRL. No side effects were recorded during HRW intake. **Discussion:** Two weeks of hydrogen rich water intake seems to improve performance in prolonged intermittent exercise, reducing fatigue and power decrement as happening with acute bicarbonate pre-exercise load. This research on HRW suggests that HRW could be used instead of bicarbonate for improving performance in anaerobic lactic exercise with the advantages of no side effects, no sodium overload and of encouraging correct hydration. References Aoki K, Nakao A, Adachi T, Matsui Y, Miyakawa S. Pilot study: Effects of drinking hydrogen-rich water on muscle fatigue caused by acute exercise in elite athletes. Med Gas Res. 2012;2:12. Ostojic SM. Serum alkalization and hydrogen-rich water in healthy men. Mayo Clin Proc. 2012;87(5):501-2 Ostojic SM, Stojanovic MD. Hydrogen-rich water affected blood alkalinity in physically active men. Res Sports Med. 2014;22(1):49-60.

## PROBIOTIC SUPPLEMENTATION AND GASTROINTESTINAL ENDOTOXEMIA BEFORE AND AFTER THE MARATHON DES SABLES.

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Whilst evidence of increased gastrointestinal endotoxemia (GE) has been previously demonstrated during single-day ultra-endurance events, less is known on the prevalence of GE following extreme ultra-events such as the Marathon Des Sables (MDS). The potential benefit of probiotic formulas on gut integrity during ultra-endurance events also requires further investigation. **PURPOSE:** To assess the impact of probiotic supplementation with or without glutamine on GE prevalence in runners competing in a multi-day ultra-run (MDS). **METHODS:** Thirty four healthy participants from the 2015 MDS UK cohort volunteered for a 12 week pre-race intervention and were randomly assigned to either: probiotic (PRO; 100mg.d<sup>-1</sup> lactobacillus acidophilus) (age  $40 \pm 3$  yrs., weight  $79.4 \pm 2.0$ kg, VO<sub>2</sub>max  $4.2 \pm 0.1$  L.min<sup>-1</sup>), probiotic with glutamine (PROglut; 40.5mg.d<sup>-1</sup> lactobacillus acidophilus and 900mg.d<sup>-1</sup> L-glutamine) (age  $39 \pm 2$  yrs., weight  $70.6 \pm 4.8$  kg, VO<sub>2</sub>max  $4.0 \pm 0.2$  L.min<sup>-1</sup>) and control (CON) (age  $42 \pm 3$  yrs., weight  $79.2 \pm 3.8$  kg, VO<sub>2</sub>max  $4.0 \pm 0.3$  L.min<sup>-1</sup>). Plasma lipopolysaccharides (LPS) (via Limulus Amebocyte Lysate chromogenic endotoxin quantification) were assessed at weeks 0, 12, post-race and 7 days post-race. Performance data was collated from official timing chips. Data presented as mean  $\pm$  SE. **RESULTS:** Mild to moderate GE was prevalent in all groups at baseline (PRO  $9.71 \pm 0.85$ pg.ml<sup>-1</sup>, PROglut  $9.89 \pm 1.43$  pg.ml<sup>-1</sup>, CON  $9.40 \pm 0.57$  pg.ml<sup>-1</sup>;  $P>0.05$ ). Whilst LPS, post intervention, was lower in PROglut there was no significance between groups ( $9.81 \pm 1.47$ pg.ml<sup>-1</sup> vs  $12.80 \pm 0.93$ pg.ml<sup>-1</sup> (PRO) vs  $11.72 \pm 1.08$  pg.ml<sup>-1</sup> (CON);  $P>0.05$ ). LPS were evidently reduced 6hrs post-race, but not different between groups (PRO:  $7.29 \pm 1.41$  pg.ml<sup>-1</sup>, PROglut:  $6.95 \pm 0.94$  pg.ml<sup>-1</sup>, CON:  $9.73 \pm 1.39$  pg.ml<sup>-1</sup>;  $P>0.05$ ). Plasma LPS returned to baseline levels 7 days post-race (PRO  $7.60 \pm 0.95$  pg.ml<sup>-1</sup>, PROglut  $10.41 \pm 1.04$  pg.ml<sup>-1</sup>, CON  $8.57 \pm 0.75$  pg.ml<sup>-1</sup>;  $P>0.05$ ). Race performance (hrs:mins) was not significant between groups, despite PRO and PROglut being ~9hrs faster than CON ( $41:28 \pm 2:31$  vs  $41:58 \pm 4:02$  vs  $50:43 \pm 4:38$ ;  $P>0.05$ ). **CONCLUSION:** Moderate GE was prevalent in all groups pre-race and fell significantly during the short-term recovery period. Despite promising results neither probiotic formula had a significant impact on GE or race performance.

## EXERCISE DOES NOT SEEM TO CHANGE QUALITATIVE FRUCTOSE DISPOSAL INTO GLUCOSE OR LACTATE

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**Introduction** Fructose is present in many sport drinks. It is known to be metabolized in a two-step process, involving conversion into lactate and glucose in the liver followed by their oxidation in extra-splanchnic tissues. Glucose synthesis from fructose is energetically more efficient when glyceraldehyde-3-Phosphate (P), rather than pyruvate-lactate, is used as a precursor. The relative activities of these two

pathways remain however unknown. The aim of this study was thus to explore metabolic fate of fructose carbons at rest and during exercise using highly enriched  $^{13}\text{C}$  fructose and isotopomer analysis of plasma glucose and lactate. Methods Three healthy sedentary volunteers [age (mean $\pm$ SD): 23 $\pm$ 1 y, weight: 67.1 $\pm$ 11.3 kg and BMI: 21.8 $\pm$ 2.1 kg/m $^2$ ] were studied after a 3-day weight-maintenance diet [55% carbohydrate (35% starch, 20% sugar), 30% lipids, and 15% proteins]. On the 4th day, fasted subjects ingested a test-meal covering 30% of daily energy requirements (with 35% as fat, 15% as protein, 20% as glucose and 30% as fructose (of which 5% was uniformly labelled with  $^{13}\text{C}$ )). Postprandial metabolism was studied for 6 hours by repeated blood sampling. Plasma glucose (M+1 to M+6) and lactate (M+1 to M+3) isotopomer distribution were determined by gas chromatography-mass spectrometry. Gluconeogenesis from glyceraldehyde-3-P was calculated using glucose M+3, and from pyruvate using glucose M+2. Pyruvate-phosphoenolpyruvate cycling was assessed from lactate M+1 and M+2. One subject repeated the experiment while adding a 60-min cycling exercise at 50%  $\text{VO}_2$  max immediately after test-meal ingestion (EX). Results In C, plasma glucose isotopomer ratios were 13 $\pm$ 4, 10 $\pm$ 5, 66 $\pm$ 4, 8 $\pm$ 1, 2 $\pm$ 0 and 1 $\pm$ 0 % of M+1 to M+6 respectively, and labelled plasma lactate ratios were 24 $\pm$ 6, 18 $\pm$ 0 and 57 $\pm$ 6 % of M+1 to M+3 respectively. EX did not alter relative abundances, with 10, 8, 70, 7, 2 and 3 % of labelled plasma glucose as M+1 to M+6 and 30, 15 and 54 % of labelled plasma lactate as M+1 to M+3, respectively. Discussion Glucose isotopomer distribution indicate that gluconeogenesis from fructose mainly proceeds from glyceraldehyde-3-P, both at rest and during exercise, and that gluconeogenesis from pyruvate remains low (less than 20%). The absence of glucose M+6 indicates that direct conversion of fructose into glucose does not occur. In addition, production of lactate isotopomers indicate a substantial activity of pyruvate-phosphoenolpyruvate cycling after fructose ingestion. Contact jerry.cros@unil.ch

## Conventional Print Poster

### PO-CPP-18 Physiology 2

#### AEROBIC EXERCISE TRAINING IMPROVES RESPONSE OF CENTRAL BLOOD PRESSURE TO ORAL GLUCOSE LOADING IN OVERWEIGHT/OBESE MEN

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Introduction: Central blood pressure carries important aspects for prediction of future cardiovascular events beyond peripheral blood pressure. Recent studies have shown that central blood pressure decreases after meal intake or glucose challenge, and the postprandial hemodynamic responses are blunted by obesity and insulin resistance. We investigated whether 12-week aerobic exercise training improves the response of central blood pressure to oral glucose loading in overweight/obese men. Methods: Thirteen overweight/obese men (age: 50  $\pm$  2 years, BMI: 27.1  $\pm$  0.7 kg/m $^2$ , expressed as mean  $\pm$  SEM) completed 12-week aerobic exercise training. Participants were instructed to perform walking or jogging for 40-60 minutes/session, 1-3 times/week under the supervision of exercise trainers, and were also encouraged to increase physical activity on their own at home to achieve a total of at least 150 minutes/week of moderate-to-vigorous intensity physical activity. Before and after the program, we evaluated anthropometric variables, homeostasis model assessment of insulin resistance (HOMA-IR), and central blood pressure. Central systolic blood pressure (i.e. radial second systolic peak pressure) was assessed using applanation tonometry at fasting and 2-hour after 75-g oral glucose loading. Results: The 12-week exercise training led to a significant weight loss (81.5  $\pm$  2.5 to 78.8  $\pm$  2.5 kg,  $P < 0.05$ ) and a significant decrease in HOMA-IR (2.4  $\pm$  0.4 to 1.8  $\pm$  0.4,  $P < 0.05$ ). Regular exercise did not change central systolic blood pressure at fasting state (109  $\pm$  5 to 106  $\pm$  4 mmHg, NS). Glucose loading decreased central systolic blood pressure only after 12-week exercise training (106  $\pm$  4 to 99  $\pm$  4 mmHg,  $P < 0.01$ ), but not before the training (109  $\pm$  5 to 107  $\pm$  5 mmHg, NS). Additionally, there was a significant difference in central systolic blood pressure at 2-hour after glucose loading between before and after the exercise program (107  $\pm$  5 to 99  $\pm$  4 mmHg,  $P < 0.05$ ). Discussion: We demonstrated for the first time that 12-week aerobic exercise training improves response of central systolic blood pressure to oral glucose loading in overweight/obese men. Previous studies have revealed that obesity and insulin resistance play key roles in diminishing of postprandial hemodynamic responses. In this study, exercise training led to a significant weight loss and a significant reduction in insulin resistance, indicating these changes contributed to the improvement of central blood pressure regulation after glucose loading. Finally, we suggest that aerobic exercise training has a greater effect on postprandial than fasting central hemodynamics. Contact: yoshikawat@live.jp

#### VENOUS RESPONSE OF SUPERFICIAL AND DEEP VEINS IN UPPER ARM DURING HEAD-UP TILT

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Introduction Vasoconstriction in arteries is induced by the increase in sympathetic nerve activity (SNA) via baroreflexes when the posture changes from supine to standing (Escourrou et al. 1993, Kitano et al. 2005). However, it is not understood well whether the increase in SNA during postural change causes the venoconstriction and secondary to decrease in venous compliance. In addition, there are deep and superficial veins in the limb, and the sensitivity of sympathetic nerve stimulation is different between both veins. Based on this, it is hypothesized that venous response during postural change differs between deep and superficial veins. Thus, to clarify our hypothesis, we investigated the change in cross-sectional area (CSA) and compliance of deep and superficial veins in upper arm during head-up tilt (HUT). Methods 10 healthy young subjects were exposed to 0°, 30° and 60° HUT each for 9 min. After the cuff wrapped on upper arm inflated to 60 mmHg for 8 min, CSA in a superficial basilic vein and a deep brachial vein was measured by ultrasound technique during gradual deflation in the cuff pressure (P) from 60 to 0 mmHg at 1 mmHg/s. The relation curve of CSA =  $\beta_2 \times (P)^2 + \beta_1 \times (P) + \beta_0$  was determined in each vein and thereafter the venous compliance equation was obtained as the compliance =  $\beta_1 + 2 \times \beta_2 \times (P)$ . Mean arterial pressure (MAP), heart rate (HR), stroke volume (SV), cardiac output (CO) and arterial vascular resistance in the forearm (AVR) were measured. Results Postural change induced the decrease in SV and the increase in HR and AVR, and these responses depended on angle of HUT. MAP and CO were unchanged. CSA of deep vein decreased during 30° and 60° HUT compared with 0° HUT, although compliance of deep vein did not change. CSA and compliance of superficial vein did not differ among conditions. Discussion The increased HR and AVR during HUT led to the maintenance of MAP and CO in spite of the decrease in venous return, indicating the increase in SNA via unloading of cardiopulmonary receptors during HUT in our study. At this time, the decreased CSA of not superficial but deep vein was confirmed. Our data revealed that the increase in SNA during HUT caused the venoconstriction but did not decrease

venous compliance, which specifically occurred in deep vein. These results suggest that venous response of deep vein rather than superficial vein might contribute to the control of blood pressure during orthostatic stress. References Escourrou P, Raffestin B, Papelier Y, Pussard E, Rowell LB. (1993). *Am J Physiol Heart Circ Physiol*, 264, H777-H782. Kitano A, Shoemaker JK, Ichinose M, Wada H, Nishiyasu T. (2005). *J Appl Physiol*, 98, 2081-2086. Contact oue@toyo.jp

### ACUTE CARDIAC AUTONOMIC RESPONSES TO AN INCREMENTAL ISOMETRIC EXERCISE TEST IN PRE-HYPERTENSIVE MALES.

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**Introduction:** Arterial hypertension and autonomic dysfunction are significant risk factors for cardiovascular disease. Isometric exercise training (IET) has been shown to reduce resting arterial blood pressure (BP) in normotensive and hypertensive populations; however, the mechanisms responsible remain unclear. Acute changes in autonomic modulation may be mechanistically linked to the reductions in resting BP observed following IET. Therefore, the aim of this study was to assess the cardiac autonomic responses to a single incremental isometric exercise test. **Methods:** Twenty-four pre-hypertensive male participants were recruited (mean age  $44.8 \pm 8.4$  years, systolic BP  $133 \pm 5.7$  mmHg, diastolic BP  $82 \pm 6.4$  mmHg). Each participant performed an incremental isometric wall squat test consisting of up to five, 2-minute stages of progressively increasing intensity, without rest. Haemodynamic and cardiac autonomic function was recorded at rest, during isometric contraction and immediately during recovery from beat-to-beat analysis of heart rate and BP using a plethymographic device, the Task Force Monitor®. Total power spectral density and associated low frequency (LF) and high frequency (HF) power spectral components in absolute (ms<sup>2</sup>) and normalised units (nu) and the LF/HF ratio were determined. **Results:** Systolic BP significantly increased from rest to during isometric contraction ( $133 \pm 5.7$  to  $174 \pm 18.5$ ,  $p < 0.001$ ) and significantly attenuated ( $133 \pm 5.7$  to  $107 \pm 23.7$ ,  $p < 0.001$ ) in recovery. Similar responses were seen in diastolic BP with a significant increase from rest to isometric contraction ( $82 \pm 6.4$  to  $115 \pm 16.3$ ,  $p < 0.001$ ) followed by a significant reduction ( $115 \pm 16.3$  to  $61 \pm 19$ ,  $p < 0.001$ ) in recovery. With respect to cardiac autonomic responses, there was a statistically significant increase in LFnu from rest to during isometric contraction ( $60.1 \pm 16.8\%$  to  $69.3 \pm 13.2\%$ ,  $p = 0.007$ ), followed by a significant attenuation below baseline in recovery ( $60.1 \pm 16.8\%$  to  $46.9 \pm 13.9$ ,  $p = 0.01$ ). The reverse was seen in HFnu with a significant decrease from rest to isometric contraction ( $39.9 \pm 16.8\%$  to  $30.7 \pm 13.2\%$ ,  $p = 0.007$ ) and significant increase above baseline in recovery ( $39.9 \pm 16.8\%$  to  $53.1 \pm 13.9\%$ ,  $p = 0.01$ ). Consequently, these autonomic responses were associated with a significant increase in the LF/HF ratio from rest to during isometric contraction ( $2.45 \pm 0.51$  to  $3.82 \pm 0.52$ ,  $p = 0.02$ ) followed by a significant reduction below baseline ( $2.45 \pm 0.51$  to  $1.12 \pm 0.14$ ,  $p = 0.046$ ) in recovery. **Discussion:** A single isometric exercise test significantly increased arterial BP, which was coupled with a significant residual increase in sympathetic over parasympathetic activity. In recovery, arterial BP significantly decreased below baseline, which was associated with a directionally opposite autonomic response beyond baseline, demonstrated by a significant residual increase in parasympathetic over sympathetic modulation. This acute cardiac autonomic and/or BP response may be important mechanisms attenuating resting BP following a programme of IET.

### ELEVATED VISCERAL ADIPOSITY AND ACUTE NEURAL STRESS; IMPLICATIONS FOR CEREBROVASCULAR FUNCTION

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**Introduction** Obesity has been demonstrated as a risk factor for the development of cerebrovascular disease (Goldstein et al., 2006), with the need to assess the effect of body fat distribution and more importantly visceral adiposity on cerebrovascular function becoming ever more apparent. The effect of a neural stress still remains unexplored within the literature. The aim of the study was to examine if an elevated visceral adiposity impairs cerebrovascular function and if this is further impaired by a neural stress. **Methods** Ten non-mediated aged matched obese 28 (mean)  $\pm 8$  (SD) years and 13 non-obese ( $22 \pm 5$  years) participants classified by body mass index ( $36.9 \pm 9.0$  vs  $24.2 \pm 2.9$  kg/m<sup>2</sup>, respectively) were recruited. Visceral adipose tissue (VAT) was assessed via computer tomography (GE Hawkeye Scanner), trunk fat percentage (TF) was assessed via dual energy x-ray absorptiometry (Lunnar Scanner) and waist circumference (WC) was measured at the midpoint between the last palpable rib and the top of the iliac crest. Middle cerebral artery velocity (MCAv, Transcranial doppler Ultrasound) and mean arterial pressure (MAP, finger photoplethysmography) were measured pre and post a neural stress (battery of psychometric tests). Cerebrovascular resistance (CVR) and conductance (CVC) were calculated as  $\text{MAP}/\text{MCAv}$  and  $\text{MCAv}/\text{MAP}$  respectively. Data were analysed using a 2-way repeated measures ANOVA and independent t-tests to establish group difference. Correlations were performed using a Pearson Moment Correlations, with significance established at  $P < 0.05$ . **Results** Obese had a higher VAT ( $81 \pm 28$  vs  $42 \pm 23$  cm<sup>2</sup>), TF ( $34 \pm 5$  vs  $26 \pm 7\%$ ) and WC ( $115.4 \pm 22.8$  vs  $80.9 \pm 8.7$  cm) compared to the non-obese ( $P < 0.05$ ). Obese had a higher CVR ( $1.54 \pm 0.40$  to  $1.55 \pm 0.39$  vs  $1.23 \pm 0.37$  to  $1.32 \pm 0.27$  mmHg/cm/s) and MAP ( $91 \pm 9$  to  $87 \pm 13$  vs  $77 \pm 22$  to  $83 \pm 11$  mmHg) ( $P < 0.05$ ) but no difference ( $P > 0.05$ ) were noted in MCAv ( $65 \pm 15$  to  $59 \pm 14$  vs  $64 \pm 11$  to  $65 \pm 11$  cm/s) and CVC ( $0.69 \pm 0.21$  to  $0.68 \pm 0.16$  vs  $0.99 \pm 0.69$  to  $0.79 \pm 0.16$  cm/s/mmHg) when compared to the non-obese. Correlations were observed between VAT and MCAv ( $r = -0.45$ ,  $P < 0.05$ ), CVR ( $r = 0.47$ ,  $P < 0.05$ ) and CVC ( $r = -0.45$ ,  $P < 0.05$ ) and TF and CVR ( $r = 0.42$ ,  $P < 0.05$ ). There was no effect of neural stress on cerebrovascular functions. **Discussion** The findings demonstrate an increase visceral adiposity was associated with impaired cerebrovascular function however there was no effect of an acute neural stress demonstrating the need to further investigations. **Reference** Goldstein LB, Adams R, Alberts MJ, Appel LJ, Brass LM, Bushnell CD, Culebras A, Debraba TJ, Gorelick PB, Guyton JR, Hart RG, Howard G, Kelly-Hayes M, Nixon JV, Sacco RL. (2006). *Circ*, 113, e873-923. Contact danielle.hodson@coventry.ac.uk

### VERY SHORT-TERM HRV ANALYSIS TO ASSESS AUTONOMIC CONTRIBUTIONS TO HEART RATE RECOVERY AFTER LOW INTENSITY EXERCISE

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**Introduction** Heart rate (HR) recovery dynamics are of prognostic value in diseased and athletic populations [1], because they can mirror states of altered autonomic control. While HR analysis alone holds only limited information regarding qualitative adjustments following exercise, very short-term HR variability analysis (vsHRV) [2] might be of additional value as it can reflect different autonomic contributions to HR control. The aim of this study was to assess autonomic contributions to the immediate HR-response following low-intensity exercise using vsHRV. **Methods** In this randomized cross-over study 22 healthy males ( $26.5 \pm 3.7$  yrs,  $76.6 \pm 7.5$  kg,  $182.0 \pm 6.6$  cm) performed one-legged isometric (ISO) and concentric (CON) HR-matched exercises with the right quadriceps femoris muscle at  $11.6 \pm 2.8\%$  and  $1.3 \pm$



1.1% of isometric maximal voluntary torque for 5 min. Cardiovascular (diastolic, systolic and mean arterial blood pressure, rate pressure product, HR, HRV) and respiratory responses (breathing rate, minute ventilation, oxygen uptake, carbon dioxide production) were measured before (PRE), during ISO and CON, during the first 5 min of recovery (REC 1 – 5) and during 5 min after recovery (POST). HR and vSHRV vagal modulation index HF-Power were analysed for the first 5 adjacent 60 sec periods following exercise cessation. Results HR moderately raised by from  $68 \pm 8$  bpm at PRE to  $82 \pm 8$  bpm during both types of exercise (+21%,  $p < 0.001$ ). While rating of perceived exertion, HRV indices of autonomic control, blood pressures, rate pressure product and respiratory responses were significantly different during the HR-matched exercises, contraction modality itself had no effect on REC and POST periods. After CON HR decreased to  $74.7 \pm 8.0$  bpm at REC 1 (-9%,  $p < 0.001$ ) and further to  $69.5 \pm 8.2$  bpm at REC 2 (-7% vs. REC 1,  $p < 0.001$ ). Similarly, HR declined after ISO to  $73.8 \pm 8.3$  bpm at REC 1 (-10%,  $p < 0.001$ ) and further to  $69.7 \pm 8.8$  bpm at REC 2 (-6% vs. REC 1,  $p < 0.001$ ). HR stayed at this level during REC 3 – 5. In contrast to HR, HF-Power fully recovered within the first 60 sec (REC 1). Discussion Our results indicate a fast parasympathetic and a slower sympathetic component, irrespective of the exercise modality, contributing to the HR recovery after low-intensity one-legged exercise. They further give evidence for vSHRV analysis after low intensity exercise being an appropriate tool to assess distinctive autonomic responses during immediate recovery. 1. Buchheit, M. (2014). *Front Physiol*, 5. 2. Smith, A. L., Owen, H., & Reynolds, K. J. (2013). *J Clin Monit Comput*, 27(5), 569-576. Contact: matthias.weipert@uni-rostock.de

## URINARY NO<sub>2</sub>-/NO<sub>3</sub>-OUTPUT WHILE PERFORMING A HIGH-INTENSITY INTERMITTENT TRAINING ON CYCLE ERGOMETER

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Introduction There are a lot of recent studies, analyzing the impact of dietary nitrate-supplementation on exercise performance. However the fate of NO<sub>3</sub> in the body is not fully understood. In this study we investigated the changes of urinary nitrate and nitrite excretion in subjects supplemented for 10 days with nitrate while performing a high-intensity intermittent training (HIIT) on a cycle ergometer. Methods Seventeen healthy male volunteers performed the HIIT (45x 30s at 100% - 10W and 30s of 10W, 45) while ingesting either sodium-nitrate [8.5mg/kg body weight/d] (N, n=9) or sodium-chloride [8.5 mg/kg body weight/d] (PLA n=8). Training was individually designed according to the subjects maximal power reached in an incremental exercise test performed prior to the training. Urine samples were taken both before and after the training. Concentration of nitrate, nitrite and creatinine in urine, as well as in plasma (pl) was measured simultaneously by gas chromatography-mass spectrometry (GC-MS) in 100-µL aliquots by a previously reported method (Tsikas, 2000). Results Mean collection time of urine (time between both samples) was N:  $125 \pm 21.9$  min, PLA:  $118.9 \pm 13.4$  min. Urine flow rate was N:  $1.95 \pm 1.3$  ml/min, PLA:  $2.61 \pm 2.4$  ml/min. Both parameters are not significantly different. Mean [NO<sub>3</sub>]pl differed from N  $217.16 \pm 67.8$  µM to PLA  $132.7 \pm 95.6$  µM ( $p=0.059$ ); [NO<sub>2</sub>]pl was  $1.53 \pm 0.199$  N and  $1.17 \pm 0.24$  in PLA ( $p=0.0054$ ). The urine [NO<sub>3</sub>] was in N  $3162.3 \pm 1830.1$  µmol/L and  $333.9 \pm 275.4$  in PLA ( $p=0.001$ ). Urine [NO<sub>2</sub>] in N was  $1.68 \pm 0.24$  and in PLA  $1.24 \pm 0.11$  ( $p<0.001$ ). Mean NO<sub>3</sub> output was N  $704.2 \pm 676.7$  µmol; PLA  $65.76 \pm 37.91$  µmol ( $p<0.03$ ). Mean NO<sub>2</sub> output was N  $0.388 \pm 0.25$  µmol; PLA  $0.381 \pm 0.37$  µmol (n.s.). Renal clearance for NO<sub>3</sub> was N  $25.61 \pm 23.8$  ml/min; PLA  $8.5 \pm 8.5$  ml/min ( $p=0.024$ ) and for NO<sub>2</sub> N  $2.75 \pm 1.98$  ml/min; PLA  $2.66 \pm 2.45$  ml/min (n.s.). The relative excretion for NO<sub>2</sub> was 2% under both conditions. For NO<sub>3</sub> it was  $23 \pm 14\%$  under NO<sub>3</sub>-supplementation and  $7 \pm 6\%$  under PLA. Discussion Despite different [NO<sub>2</sub>]pl the NO<sub>2</sub> output does not differ between both groups. In contrast with NO<sub>3</sub>-supplementation the excretion was load dependent. The creatinine clearance was similar under both conditions. Assuming a plasma volume of 3.5l in N, almost the entire NO<sub>3</sub> content of the plasma was eliminated by urinary excretion within 2 hours. Therefore, we postulate a large amount of resynthesizes, and/or a great contribution of NO<sub>3</sub> stores under substitution. M. Maassen was supported by Leibniz University: WIF II; Nr. 604604457 Contact moritz.luetzow@stud.mh-hannover.de

## EFFECTS OF ANABOLIC ANDROGENIC STEROIDS INTERRUPTION AFTER TRAINING AND DETRAINING IN CALCANEUS TENDON: HISTOLOGICAL CHARACTERISTICS

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INTRODUCTION The consumption of anabolic androgenic steroids (AAS) contributes to tendon inertness and rigidity, it alters the biomechanical properties of tendons and increases the potential risk of injury. (Marqueti et al. 2011; Marqueti et al. 2014). However, others potential detrimental effects caused by AAS in tendon remains unclear. The aim of present study was to evaluate the calcaneal tendon histological properties in combination with AAS administration and vertical jump after 6 weeks of ASS interruption and detraining. METHODS Forty Wistar novergicus albinus were randomized in two groups: Immediately After (IA) and Six Weeks After (6W); and in subgroups, equally: sedentary (S), trained (T), sedentary with AAS administration (SAAS), and trained with ASS administration (TAAS). Trained groups performed jumps in water: 4 series of 10 jumps each, a 30-second interval between the series, with 50-80% overload of the animal weight. After 7 weeks, IA group was euthanatized and 6W group stopped both training and AAS treatment. 6W rats were euthanatized after 6 weeks of detraining. RESULTS Immediately after intervention period, SAAS had showed more cells volume density (Vv%) of tendon proper than S in proximal region (PR). In peritendinous sheath, SAAS and TAAS had less adipose tissue than S. But in T blood vessels and cell Vv% in peritendinous sheath increased while SASS and TAAS decreased it. After 6 weeks, cells Vv% of tendon proper increased in T and TAAS, distal region (DR) but it had decreased in SAAS and TAAS in PR; adipose tissue had increased in T in PR and in SAAS and TAAS in DR; blood vessels Vv% had decreased in T in DR, but it had showed high levels in TAAS; and in SAAS, both, in both regions, and in DR of TAAS, the cell Vv% in peritendinous sheath had presented higher levels of content. DISCUSSION The main findings suggest that steroids can negatively affect tendon extracellular matrix (ECM) immediately after AAS administration as decreased blood vessels Vv% and cell Vv% in peritendinous sheath. AAS administration is correlated with higher levels cells Vv% of tendon proper. However, after 6 weeks, AAS, associated or not with training, showed a positive factor to maintain blood vessels Vv% in DR and cells Vv% of tendon proper content in both regions. Lastly, these signals can be associated to tendon recovery because stopping administrating AAS have improved tendon ECM and structure. REFERENCES Marqueti RC, Prestes J, Wang CC, Ramos OHP, Perez SEA, Nakagaki WR, Carvalho HF, Seliestre-de-Araujo HS (2011). *Scand J Med Sci Sports*, 21, 91-99. Marqueti RC, Paulino MG, Tomiosso TC, Nakagaki WR, Sbervelheri MM, Ferruci DL, Pimentel ER, Dolder, H (2014). *BMC Complement Altern Med*, 11 (51). CONTACT Rita de Cássia Marqueti (marqueti@gmail.com)

### EFFECTS OF SPRINTER'S ABILITY ON GAZE MOTION AND COGNITION DURING SPRINT OBSERVATION

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**Introduction** Action observation of excellent motion is important to acquire superior skills via the process of motor learning. Good sprint skill is evident in the analysis of elite sprinters such as gold medalists. Many sprinters, however, understand that acquisition of good skill is such a challenge that it can be accomplished only with intense practice. Good sprinters might have abilities to trace significant observation points during observation of performance by other elite sprinters and to enhance sensitivity of cognition for self-awareness. We aimed to compare sprinters and novices in terms of their gaze motion during observation of good sprint presented by a slow-motion video and their expressions of self-awareness to the sprint motion. **Methods** Subjects were ten student sprinters aged 18–22 years and eight novices aged 20–22 years. Sprinters were separated into good and poor groups by the result of athlete competition. An eye-gaze tracking system with an infrared light-emitting diode (IR LED) was used to define the coordinate for eye performance during visual sprint observation. The sampling rate (60Hz) was rapid enough to record the smooth-pursuit eye movements covering a 24-inch-wide screen. A sprint converted slow motion (1/10 speed) was presented on the monitor positioned at a distance of 120 cm in front of the subject. The coordinate of the eye movement (resolution, 1024 768 pixels) was superimposed by a synchronous trigger with the slow sprint motion video. We explicitly asked the subjects to concentrate on the images of the motion during the observation. The coordinate of the horizontal axis in the video images was set through a sprint cycle. The coordinate of the vertical axis was divided into three phases as follows: (1) around head, (2) torso and hip, and (3) legs and feet. The number of eye points located in each of the 3 segments were counted throughout the cycle. In addition, we asked the subjects to explain the characteristics of the sprint motion and gaze points of three models of elite sprinters after observation in order to assess the cognition for self-awareness. **Results** The good sprinters concentrated about 31% of the gaze points on (3) during a sprint cycle whereas the poor sprinters did about 10% on this segment, respectively. Novices spent about 73% of time on (1) and (2). Good sprinters particularly explained motions occurred in the segment (3) in the interview. The focus of the explanation of the poor sprinters was on either segment (2) or (3). Novices gave their impressions of sprint motions vaguely. **Discussion** The differences of gaze motion during sprint observation could reflect the sprinter's ability and the sensitivity of cognition for self-awareness to sprint motion. The pattern of gaze points for sprint motion would be significant in terms of improving sprint skill via motor learning. **References** Aglioti et al. (2008) *Nature Neuroscience*. 11(9) p1109-1116 Gredeback and Falck-Ytter (2015) *Psychological Science*. 10(5) 591–598 Contact atu-maru@nuhw.ac.jp

### EFFECT OF DIFFERENT DOSE OF LEUCINE INGESTION FOLLOW RESISTANCE EXERCISE ON SATELLITE CELL ACTIVATION OF SKELETAL MUSCLE IN RATS

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**Introduction** Skeletal muscle satellite cells (SCs) are essential for muscle growth, repair and regeneration in most of all conditions (Brack and Rando 2012, Lepper et al., 2011). And one of essential amino acid, leucine is known that it can promote proliferation and differentiation of SCs (Dai et al., 2015). However, potential influence of dose-dependent leucine supplementation after resistance exercise has not been well studied. Present study investigates potential influence of dose-dependent leucine supplementation follow resistance exercise on satellite cell metabolism in skeletal muscle in rats. **Methods** 10 week-old male SD rats were assigned to sedentary control (CON), 10%(0.135g/kg.wt) leucine supplementation group (L1), 50%(0.675g/kg.wt) leucine supplementation group (L5), exercise group (E), exercise with 10% leucine supplementation group (EL1) and exercise with 50% leucine supplementation group (EL5), total six groups. Ladder exercise was performed the groups involved in exercise intervention. And leucine supplementation was given daily at the same time to all of leucine supplementation groups, 45 min after finishing ladder exercise. SCs and embryonic myosin fiber were identified by immunohistochemistry. **Results** In SCs, E, L1E, and L5E groups were significantly higher than CON group in Pax7/fiber number ( $p=.005$ ,  $p=.024$ ,  $p=.016$ ). However, no difference in the number of Pax7/fiber among these groups. In embryonic myosin fiber, E, L1E and L5E groups were significantly increased in comparison with CON group ( $p=.004$ ,  $p=.004$ ,  $p=.000$ ). Moreover, L5E group is markedly higher than E and L1E group in embryonic myosin fiber ( $p=.001$ ,  $p=.001$ ). **Discussion** It means that resistance exercise is effective stimulus for proliferation and differentiation of SCs. No additional effect by leucine supplementation on SCs proliferation found. However, resistance exercise and high dose leucine supplementation promoted differentiation of SCs by forming embryonic myosin fibers. **References** Dai J, Yu M, Shen Z, Guo C, Zhauang S, Qiu X. (2015). *Nutrients*, 7, 3387-3400. Brack A, Rando T. (2012). *Cell Stem Cell*, 10, 504-514. Lepper C, Partridge T, Fan C. (2011). *Development*, 138, 3639-3646. Contact limch87@hanmail.net

### METABOLIC AND AEROBIC PROFILE OF WOMEN WITH AND WITHOUT NON-ALCOHOLIC FATTY LIVER DISEASE

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**Introduction** Non-alcoholic fatty liver disease (NAFLD) is a disease with high prevalence in adults, which has a high evolutionary potential for hepatic steatosis (HS), characterized by the accumulation of lipids in the hepatocytes, representing more than 5% of the liver weight. In the world, the prevalence of HS remains between 10 and 24% in adults of both sex and the physical inactivity, poor nutritional habits and metabolic syndrome are considered risk factors for the development of such histological disorder. **Objective:** The purpose of this study was to evaluate the relationship between the metabolic profile, aerobic fitness and the presence of HS in women. **Methods** We evaluated 454 women (mean age  $36.6 \pm 6.9$  years old), followed at the Continuing Review of Health service of the Israelita Albert Einstein Israelita Hospital- São Paulo - Brazil. The sample was separated into two groups; who had negative diagnosis of HS (weight  $61.6 \pm 9.3$  Kg; height  $164.6 \pm 6.2$ ; BMI  $23.0 \pm 3.3$ ) and positive diagnosis of HS (weight  $69.6 \pm 8.3$  Kg; height  $163.8 \pm 5.7$ cm; BMI  $26.1 \pm 3.2$  kg/m<sup>2</sup>) For analysis of aerobic fitness we used the incremental test by the Ellestad / Memorial protocol. For biochemical profile analysis was carried out blood sampling for measurement range glutamyl transpeptidase (Gamma GT), total cholesterol, HDL cholesterol, LDL cholesterol, triglycerides and C-reactive protein. The HS diagnosis was made by abdominal ultrasound. To determine the level of physical activity (PA) was used in the short version of International Physical Activity Questionnaire (IPAQ). Analysis of variance was performed using the Student t test, Mann Whitney U test (significance level:  $p < 0.05$ ). The statistical package was the Statistical Package for Social Sciences (SPSS 17.0). **Results** Results showed that 62.1% (N = 282) women are considered inactive and 4.8% (n = 22) of the total sample has HS. There was a signifi-

cant difference in the comparison of aerobic fitness among women with and without a diagnosis of HS ( $11.2 \pm 1$  and  $12.2 \pm 2.4$  METS, respectively). Biochemical results indicated significant difference for triglycerides ( $127.9 \pm 50.1$  and  $87.7 \pm 41.6$  mg/dL), HDL Cholesterol ( $53.8 \pm 13.2$  and  $62.5 \pm 13.6$  mg/dL) and Gamma GT ( $35.6 \pm 23.4$  and  $18.7 \pm 9.3$  U/L) in the comparison of positive HS and negative HS, respectively. However there was not significant difference in the same comparison to LDL cholesterol ( $116.5 \pm 31.4$  and  $104.9 \pm 28.0$  mg/dL) and CRP ( $3.7 \pm 2.9$  e  $2.6 \pm 4.3$  mg/dL). Discussion The group with HS presence showed lower aerobic capacity, higher rates of liver enzymes (reflecting the biggest oxidative stress) and higher plasma levels of CRP and these findings show cardiovascular risk increase with de HS presence. References GARBER, C.E.; et al. (2011). American College of Sports Medicine. 1334 - 1359. PROMRAT, K.; et al. (2010). Hepatology. 51, 1, 121- 129.

## Conventional Print Poster

### PO-CPP-22 Rehabilitation & Physiotherapy 1

#### EARLY TREATMENT WITH LOW POWER LASER DECREASE INFLAMMATORY RESPONSE INDUCED ACUTE TRAUMATIC INJURY MUSCLE

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Introduction Studies in recent years have shown that low-level laser therapy (LBP) modulates various biochemical processes, especially those related to increased mitochondrial respiration and tissue repair. The objective was to evaluate the influence of the therapy on acute LBP inflammatory response induced by a traumatic muscle injury model in Wistar rats. Methods Animals were randomly divided into following four groups: control group (CG), muscle injury group (IG), CG + LLLT, and IG + LLLT: laser treatment with doses of 3 and 5 J/cm<sup>2</sup>. Muscle traumatic injury was induced by a single-impact blunt trauma in the rat gastrocnemius. Irradiation for 3 or 5 J/cm<sup>2</sup> was initiated 2, 12, and 24 h after muscle trauma induction, and the treatment was continued for five consecutive days. Results The results demonstrate that GaAs with a dose of 3 J / cm<sup>2</sup> irradiation starting 2 hours after muscle injury model decreased all the oxidative stress parameters analyzed such as oxidation of lipids and protein content, antioxidants enzyme activities as GPX, SOD and CAT and the concentration of nitrite in the plasma. The GaAs therapy also induced a decrease in gene expression of IL-6, VEGF and BDNF whereas IL-10 level was increased after 5 days of injury. The behavioral results of motor deficit (open field) demonstrated that animals with muscular injury treated with GaAs (3 J / cm<sup>2</sup>) had an increase of the distance traveled and the number of surveys compared with muscle injury group Discussion The LLLT caused a reduction in the oxidant and inflammatory biomarkers, indicating that LLLT has a positive biological effect by modulating the redox state and accelerating the recovery of injured tissue. However, when irradiation was started 12 or 24 h after induction of trauma the LBL recovery effect was lost. This suggests that the sooner inflammation and oxidant status is resolved, the faster is the functional recovery of the injured muscle. We suggest that the group that received laser GaAs with a dose of 3 J / cm<sup>2</sup> irradiation starting 2 h after injury, showed an improvement in locomotion and exploration activity compared to previous results. Taken together, these findings strongly suggest that laser irradiation induced biostimulatory processes that accelerated or resolved the acute inflammatory response, as well as, the oxidant state elicited by the muscle trauma and this effect was dose and time dependente. REFERENCE Silveira PC, da Silva LA, Pinho CA, De Souza PS, Ronsani MM, Scheffer Dda L, Pinho RA. Med Sci 2013;28:431–436. Filippin LI, Cuevas MJ, Lima E, Marroni NP, Gonzalez- Gallego J, Xavier RM. The role of nitric oxide during healing of trauma to the skeletal muscle. Inflamm Res 2011;60:347–356. CONTACT fernandomilanezz@hotmail.com

#### A CROSS SECTIONAL ANALYSIS OF INFLUENCING FACTORS ON MISPERCEPTION IN SELF-REPORTED PHYSICAL ACTIVITY

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Introduction Misperception of one's own physical activity level is a recurrent problem in rehabilitation and health promotion [1-2]. The present study aims to determine (1) the closeness of agreement between self-reported and objective measure of physical activity; (2) influencing factors on over- and underestimation of physical activity and sedentary behavior; (3) differences in self-estimation between low back pain (LBP) patients and healthy controls. Methods 27 LBP patients and 53 healthy vocational school students wore a triaxial accelerometer (Actigraph GT3X+) during waking hours on seven consecutive days and answered a questionnaire (GPAQ) on physical activity over the same period of time. Bland-Altman analysis was performed for describing the closeness of agreement of the assessment methods. Influence of age, sex and body mass index on misperception of physical activity and sedentary behavior was examined with multiple linear regression. Mann-Whitney U tests were used for detection of group differences. Results Bland-Altman analysis showed poor agreement of self-reported and objective data with significant overestimation of moderate (42 min/day;  $p=0.003$ ) and vigorous activity (39 min/day;  $p<0.001$ ). Sedentary behavior was significantly underestimated (-122 min/day;  $p<0.001$ ). No significant influence of age, sex or body mass index on misperception of physical activity and sedentary behavior was detected. Group differences were found in the estimation of sedentary behavior ( $p<0.001$ ) and moderate physical activity ( $p=0.015$ ) with significantly bigger misperception in LBP patients. Discussion Findings based on self-reported physical activity have to be interpreted with caution since significant misperception and sedentary behavior is present in LBP patients and healthy controls. The present results contradict other studies that identified an influence of age, sex and body mass index on the overestimation of physical activity [1]. Further research on influencing factors is needed to identify possible strategies to overcome the problems associated with misperception in self-reports. Moreover, the causality between misperception and LBP needs to be examined. References 1. Godino, J.G., Watkinson, C., Corder, K., Sutton, S., Griffin, S.J., van Sluijs, E.M.F.. Awareness of physical activity in healthy middle-aged adults: a cross-sectional study of associations with socio-demographic, biological, behavioural, and psychological factors. BMC public health 2014; 14:421. 2. van Weering, M., Vollenbroek-Hutten, M., Hermens, H.J.. The relationship between objectively and subjectively measured activity levels in people with chronic low back pain. Clinical rehabilitation 2011; 25(3):256–63.

### ACUTE EFFECTS OF POLE WALKING IN WATER ON GAIT AND SPASTICITY IN A HEMIPLEGIC PATIENT

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1: The University of Tokyo (Kashiwa, Japan), 2: The University of Tokyo (Tokyo, Japan), 3: Fuji Onsen Hospital (Fuefuki, Japan) Purpose This study aimed to investigate the acute effects of pole walking in water on gait and spasticity during walking in a patient with hemiplegia. Methods The subject was a 64-year-old man with a right hemiplegia. He suffered from a left cerebral infarction 12 years previously, which resulted in Wernicke-Mann hemiplegia of the right limb. He performed walking in the pool with two poles for 20 minutes. The water temperature was 36°C. Four-meter walking test was conducted before and after pole walking in water. The subject used a cane during the walking test. A three-axis accelerometer was placed at the level of the second thoracic vertebra and the acceleration signal during walking was sampled at a rate of 100 Hz. The time interval between each step and the maximal acceleration value during foot contact were calculated from the acceleration signal in the vertical (VT) direction for six steps. Surface electromyograms (EMGs) of tibialis anterior, soleus, medial gastrocnemius (MG), rectus femoris (RF), biceps femoris long head, biceps brachii, triceps brachii, and trapezius upper fibers on the hemiplegic side was measured at a sampling rate of 1000 Hz during the walking tests and during pole walking in water. Results In the pre-exercise test, the time interval from the left heel contact to the right heel contact was  $2.11 \pm 0.29$  seconds and from the right heel contact to the left heel contact was  $3.30 \pm 0.67$  seconds. The maximum acceleration in the VT direction was  $1.109 \pm 0.031$  g during the left foot contact and  $1.098 \pm 0.022$  g during the right foot contact. These measurements changed to  $0.91 \pm 0.03$  seconds,  $1.25 \pm 0.06$  seconds,  $1.394 \pm 0.098$  g, and  $1.311 \pm 0.060$  g after exercise, respectively. Locomotor-like EMG activities appeared in MG and RF during and after pole walking in water, although these muscles showed spastic and tonic patterns of EMGs in the pre-exercise test. Discussion The decrease in the time interval and the increase in the VT acceleration indicate that the patient walked more smoothly and faster after pole walking in water. Exercise in water and walking with two poles could decrease postural threat for a patient with hemiplegia, which can decrease muscle spindle sensitivity and affect EMG activities during walking (Horslen et al., 2013). Although the present study is a case report and included only one subject, the results suggest that pole walking in water had an acute neurophysiological effect of decreasing spasticity on a hemiplegic patient, and changed the gait of the patient. Reference Horslen BC, Murnaghan CD, Inglis JT, Chua R, Carpenter MG. (2013). J Neurophysiol. 110(4), 899-906. Contact fukusaki@k.u-tokyo.ac.jp

### EPIDEMIOLOGICAL STUDY OF INJURIES IN A SPANISH HONOR LEAGUE RUGBY TEAM

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Introduction The amount and type of injuries in rugby practice depends on the division, if training or competition, player position (front or three quarters) and the time of the season. Rugby is a full-contact sport, so most of the injuries are moderate and mechanisms caused by extrinsic character. The purpose of this prospective investigation was to study the incidence, moment that injuries happen nature and severity of rugby injuries occurring in 32 players in an Honor League team of Madrid during the 2014-15 season. Methods Prospective and observational epidemiological study. For equipment was taken into account a division of honor from Rugby in Madrid. Were recorded prospectively injuries sustained in playing and training throughout the 2014-2015. We create a test for collecting anthropometric and personal data, characteristics of each player and their medical history. As a method for collecting information sheet data collection for epidemiological studies in professional rugby is constructed using the OSICS Result 32 players with an average age of 24.27. From a total of 62 injuries, the most frequent were ligamentous (32.26%), followed by muscle injuries (27.42%), 10 wounds (16.13%), 8 bone lesions (12.90%) and 7 tendon injuries (11.29%). Fronts are more lesions (74.19%) in comparison with the three quarters (25.81%) The most frequent lesions occurred in lower extremities with 26 injuries (41.95%), 12 injuries to the area of the head (19.35%), 11 injuries in upper extremities (17.74%), 8 lesions on the trunk (12.90%) and 5 in the area of the neck (8.06%). The area of the lower limb which suffered the highest number of injuries was knee (9 lesions) (34.62%), 6 in hamstring (23.08%), 5 in ankle (19.23%), 4 in calf muscle (15.38%) and 2 in quadriceps (7.69%). Discussion A total of 62 injuries were sustained, of which 24.19% were minor, 46.77% were moderate and 29.03% were major. The incidence of injury was 5.18 per 1000 player-game hours. This study reflects that rugby is a risk sport activity with a high incidence of injury. It's important for player to know this findings in fact of prepare themselves physically and have a good treatment for each injury. For every 1000 hours of play in games are produced 29.4 injuries, and only two injuries per 1000 hours of training. This occurs because in practice it reduces contact between players to prevent injuries that physical contact is the main risk factor in this sport.

### EFFECT OF A FREQUENT THERAPEUTIC CLIMBING TRAINING ON PHYSICAL ACTIVITY OF PEOPLE WITH MULTIPLE SCLEROSIS

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Introduction Previous studies demonstrated that physical activity has a positive effect on the health of people with Multiple Sclerosis (MS). Further, research has shown that people with MS are less physically active (Tzschoppe et. al. 2013, Motl et. al. 2010). Kern (2014) demonstrated that, a special therapeutic climbing program can motivate people with MS to be more physically active. Therefore, the aim of the study was to evaluate the motivation through therapeutic climbing (TC) on the physical activity level in everyday life of people with MS. Methods In this study, 81 people with MS were assessed using the BAECKE questionnaire ("short form questionnaire for the measurement of habitual physical activity", Wagner & Singer, 2003). The questionnaire distinguishes between three categories of physical activity: 'sports', 'working' and 'leisure time activities'. The TC training consisted of 2 hour sessions once a week, while the control group (CG) does not undergo any additional training. However, the work index was ignored in the present study, since 45% of the studied people with MS were not able to work. Results The therapeutic climbing group and control group (TC n=43, CG n=36, exclusion n=3) consist of 73% female and 27% male participants (mean age 48). The mean sport index of TC ( $2.86 \pm 0.67$ ) and the mean leisure time index ( $3.02 \pm 1.07$ ) was higher in comparison to the CG (sport index:  $1.91 \pm 0.83$ , leisure time index  $2.60 \pm 1.10$ ). There are significant differences in sport index ( $p=0.00$ ) and leisure time index ( $p=0.05$ ). With strong power a high and moderate effect size could be achieved (Sport index: d Cohen 1.26, leisure time index: d Cohen 0.39). Conclusion The results of this study pointed out that TC has a positive effect on physical activity of people with MS in their everyday life. In general the people of the climbing group are more active which could be demonstrated in the higher sporting and leisure time index and they do more different sports in comparison to the CG. The sports index has the highest validity.



ty in context with MS because it contains questions about the duration and intensity of sports. Further research may reveal, if the motivation for the climbing program exists because of a higher affinity to sports in general.

## EXERCISE PRESCRIPTION OF MEDITATIVE KARATE KATA CAN IMPROVE PHYSICAL AND MENTAL ABILITIES IN THE SENIOR-AGED INDIVIDUALS

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**Introduction** Impaired cognition and activities of daily living (ADL) have already become a major problem that cannot be ignored in the highly aged societies. It has been anecdotally told that ascetics of traditional oriental martial arts such as karate or tai chi, tend to have longevities with physical and mental toughness. This study was to investigate the physical and mental effects of karate kata prescription on the senior-aged. **Methods** Physically active volunteers of 21 Japanese elders with atherosclerotic risks such as hypertension or diabetes mellitus participated in this 12-week intervention. According to the individual's will, they were divided into a kata group (KG: 73.0  $\pm$  6.9 year-old, 2 males, 10 females) and a jogging group (JG: 66.8  $\pm$  5.4 year-old, 2 males, 7 females). We adopted Goju-style karate katas of Sanchin and Tensho that require ascetics to learn proper posture, coordination body movements with respiration and mental concentration. KG was instructed these meditative katas at least twice a week through 12 weeks. JG was prescribed a walking-to-jogging program as a control exercise at similar frequency. Each participant was also asked to join the sub programs, which was consisted of stretching, resistance machine training, cycle ergometer riding or treadmill walking. To estimate the effects on physical fitness, Chair-standing test (CS30) and Six-minute walking test (6MWT) were performed at baseline and after this intervention. Cerebral Exponent Macro (CEM), which was calculated from reading voice by using a chaotic algorithm, and heart rate responses against reading aloud tasks were adopted as stress indicators of neo-cortex or autonomic nerve system. New Stroop test II was used for evaluating cognitive functions. **Results and Discussions** With respect to the safety, all participants of KG accomplished their prescribed program, while 2 females of JG did not due to suffering from lumbago and lower leg disturbance respectively. Worsened atherosclerotic risks were not recognized in both KG and JG. Regarding the effects on physical condition, KG ( $p < 0.01$ ) showed a greater improvement of CS 30 results than JG ( $p < 0.05$ ), although only JG gained 6MWT distance ( $p < 0.05$ ). Increasing of forced expiratory volume was observed in only KG. As to the effects on mental aspect, reductions of heart rate responses against reading aloud tasks were observed in KG and JG (respectively,  $p < 0.05$ ). However, improved CEM with a statistical tendency was indicated only in KG ( $p < 0.1$ ). KG also tended to show an enhancement of the new Stroop tasks ( $p = 0.05$ ). Effects of exercise generally depend on age and baseline conditions of the subjects, and property of the program. Compared with JG, KG revealed favorable changes on physical and mental functions of the senior with lower orthopedic risks despite of older age ( $p < 0.05$ ). We conclude that exercise program based on meditative karate kata could safely improve muscle strength related to ADL, pulmonary function and mental ability among the senior-aged individuals.

## CORRELATION BETWEEN FOOT FUNCTION INDEX AND REARFOOT ANGLE WITH THE DOWN STAIRS FUNCTIONAL TASK: STANCE PHASE

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**INTRODUCTION** The influence of the feet position during functional tasks has shown great clinical interest. So far it has not been found studies that indicate the relationship between static clinical measures and dynamical feet functional task of down stairs, that is impaired especially when the foot injury are present. **OBJECTIVE** To verify the correlation between the Foot posture index (FPI) and rearfoot angle during the stance phase of the down stairs functional task. **METHODS** Twenty two individuals were evaluated, 22 feet, 5 men and 17 women (22.8 $\pm$ 3.6 years old, 60.2 $\pm$ 12.2kg, 165 $\pm$ 0.08cm; 21.8 $\pm$ 3.0kg/m<sup>2</sup>). To evaluate the static clinical measures were used FPI to analyze foot posture [1] and the goniometer to measure rearfoot angle [2,3]. Down stairs functional task evaluation has been performed by feet kinematic analysis using eight cameras for three dimensions capture (sagittal, frontal and transverse). Three trials were registered. Oxford Foot Model [4] and Vicon Nexus® software were used to analyze and process data. The data analysis was applied by Pearson correlation test, with alpha error of 5%. **RESULTS** When correlate clinical measures, FPI and rearfoot angle, with the variable rearfoot in relation to the ground during the stance phase, were found  $r=0.28$  (FPI-sagittal),  $r=0.29$  (FPI-transversal) e  $r=0.20$  (rearfoot angle-sagittal), as represented in table 1. When correlate clinical measures, FPI and rearfoot angle, with the variable rearfoot in relation to the tibia, during the stance phase, were found  $r=0.27$  (FPI-frontal),  $r=0.36$  (rearfoot angle-frontal) e  $r=0.33$  (rearfoot angle-transversal), as observed in table 2. **DISCUSSION** Clinical measures, FPI and rearfoot angle, showed mild correlation with the stance phase of the down stairs functional task. The professional that working in the health field should evaluate static and dynamic foot posture separately, to prescribe correct exercises in according to the static and dynamic evaluations. **REFERENCES** [1] Redmond AC et al. Development and validation of a novel rating system for scoring standing foot posture: the Foot Posture Index. Clin Biomech. 2006;21(1):89-98. [2] Astrom M, Arvidson T. Alignment and joint motion in the normal foot. J Orthop Sports Phys Ther. 1995; 22(5):216-22. [3] Tsai LC, Yu B, Mercer VS, Gross MT. Comparison of different structural foot types for measures of standing postural control. J Orthop Sports Phys Ther. 2006;36(12):942-53. [4] Carson MC et al. Kinematic analysis of multi-segment foot model for research and clinical applications: a repeatability analysis. J Biomech. 2001;34(10):1299-307. CONTACT liu.unifesp@gmail.com

## EFFECTS OF ULTRASOUND ASSOCIATED WITH GOLD NANOPARTICLES IN EXPERIMENTAL MODEL OF MUSCLE OVER-USE: ROLE OF OXIDATIVE STRESS

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**Introduction** During sports activities, especially those requiring high velocity of movement or displacements, the muscles are exposed to impacts, stresses and forces that can result in injuries, such as strains, ruptures and lacerations, which means that loss of contractile capacity reduces the functional capacity of athletes. Thus, to minimize these effects, the present study suggests, on the basis of an over-use model, that frequent use of ultrasound associated with gold nanoparticles (AuNPs) reduces the inflammation and oxidative stress parameters that are most likely involved in the decreased ability of muscle contraction. **Methods** Male Wistar rats were randomly divided into five groups: control (C, n: 12); exercise-overuse (EO, n: 6); exercise-overuse plus AuNPs (EO-N, n: 6); exercise-overuse plus ultrasound and saline (EO-U, n: 6); and exercise-overuse plus ultrasound and AuNPs (EO-UN, n: 6). The exercise program consisted of three different

models: low intensity (60 min at 13 m/min, no incline), moderate intensity (60 min at 17 m/min, no incline) and high intensity (inclination - 16% until exhaustion at 17 m/min—eccentric exercise). Exercise sessions were performed for 21 consecutive days, and one exercise model was applied daily in the following sequence: low intensity, moderate intensity and high intensity. Ultrasound was used with and without AuNPs in all animals an hour before the workout from day 4. Twenty-first days after the behavioral tests, blood collection and testing of oxidative stress and inflammatory parameters were performed. Results The overuse model promoted behavioral changes and increased creatine kinase, superoxide dismutase and glutathione peroxidase activity, as well as the levels of superoxide, nitrotyrosine, nitric oxide, thiobarbituric acid reactive substance, carbonyl, tumor necrosis factor  $\alpha$  and interleukin-6. These values were significantly decreased by AuNPs and by AuNPs plus ultrasound. Catalase activity remained unchanged and the glutathione level increased significantly after exposure to AuNPs plus ultrasound. Discussion This study found that the overuse model was effective in altering behavioral patterns, promoting muscle damage and increasing levels of muscle inflammation and oxidative stress. The results presented also suggest an important effect of ultrasound plus AuNPs, possibly by reducing the inflammatory response and increasing glutathione levels. Thus, the combined use of ultrasound and anti-inflammatory agents such as AuNPs represents an important alternative in the treatment of muscle injuries. Contact: psilveira@unesb.net

## INTRODUCTION OF EXERCISE THERAPY DURING DIALYSIS AND PHYSICAL/PSYCHOLOGICAL EFFECTS

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**Objective** The objective of this study was to perform a self-exercise program in maintenance dialysis patients attending our hospital and discuss the physical and psychological effects. **Subjects** Eligible subjects were 16 patients who received haemodialysis at our hospital between June 2012 and December 2015 and were able to continue exercise for 6 months or longer. **Methods** Wearing wrist/ankle straps with heavy weights or ceramic bands, the subjects did self-resistance exercise during dialysis. They did the exercise three times weekly for about 30 minutes, mainly on the legs. The effect of exercise was measured by muscle strength of pectoralis major muscle and quadriceps as well as physical function using 30-sec chair stand test, Timed "Up and Go" test, and 6-minute walk test, and the results were analyzed using average  $\pm$  standard deviation. In addition to these measurements, all patients were interviewed by nurses. **Results** Eligible subjects were 16 patients, including 11 males and 5 females. At the time of start of the study, their age ranged from 49 to 89 years ( $71.9 \pm 10.2$  years) and the period of maintenance dialysis ranged from 0.8 to 16.6 years ( $5.9 \pm 5.4$  years). Six months after start of exercise, the muscle strength of pectoralis major muscle and quadriceps increased significantly. Also, 30-sec chair stand test, Timed Up and Go test, and 6-minute walk test improved significantly. In the nurse interview, 13 answers, including multiple answers, could be gained. Thirteen responders said, "Can walk more easily"; thirteen responders said, "Can do exercise more easily than expected"; nine responders said, "Have less anxiety that muscle and body strength is decreasing"; ten responders said, "Others praise how much I have made efforts"; and seven responders said, "Glad to get good scores at physical strength test". **Discussion** It was demonstrated this exercise program could improve physical function such as muscle strength, ability to walk, and balance ability significantly. These answers from interview by nurses suggested that patients with incurable kidney diseases had positive thinking, positive awareness of oneself, and willing to survive that they had never had. As described above, adding a factor of "exercise" to dialysis could achieve physical and psychological effects, which may improve their activity of daily livings and quality of life.

## Conventional Print Poster

### PO-CPP-26 Training & Testing 2

#### EFFECTS OF AN EIGHT-WEEK PLYOMETRIC TRAINING PROGRAM ON SPRINT AND JUMP PERFORMANCE IN ADOLESCENT ELITE RUGBY PLAYERS

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1: Institute of Sport and Sport Science (University of Heidelberg, Germany), 2: German Rugby Union (Germany) **Introduction** Plyometric training can enhance explosive contractions thus improving explosive movements, such as throwing and sprinting (Markovic et al., 2007). As sprinting is a key factor for success in rugby, the objective of this study was to determine whether an 8-week plyometric training program would enhance selected aspects of jump and linear sprint performance in adolescent elite rugby players. **Methods** 16 German adolescent elite male rugby players (age,  $15.7 \pm 0.7$  y; height,  $172 \pm 6$  cm; body mass,  $73.5 \pm 3.0$  kg) were randomly assigned between a control (C, n=8) and an experimental group (E, n=8). Due to the off-season, C had no training at all and E solely performed plyometric training once a week (for 90 minutes over 8 weeks with stepwise increasing volumes - approx. 650 plyometric jumps per session). Before (baseline) and after 8 weeks (post), jump performance was checked via jump heights in the Counter-Movement-Jump (CMJ) and in the Squat-Jump (SJ) as well as via reactive strength index (flight-time  $\times$  ground contact time-1) in the Drop-Jump (DJ-RJ). Linear sprint performance was assessed via split-times required for 5m, 10m and 30m. **Results** A two-way ANOVA with repeated measures revealed that after 8 weeks E significantly ( $p < 0.01$ ) improved CMJ height (baseline:  $44.0 \pm 5.8$  cm; post:  $49.9 \pm 5.3$  cm), SJ height (baseline:  $38.7 \pm 5.2$  cm; post:  $46.4 \pm 6.0$  cm), DJ-RJ (baseline:  $2.60 \pm 0.41$ ; post:  $3.40 \pm 0.44$ ) as well as all sprint sections (e.g. 30m, baseline:  $4.38 \pm 0.24$  sec; post:  $4.12 \pm 0.24$  sec). In contrast, compared to baseline, all jumps and sprint sections were impaired in C after 8 weeks, however not significantly. Compared to C, after 8 weeks E had significant higher CMJ and SJ heights (each  $p < 0.05$ ), DJ-RJ ( $p < 0.01$ ) and an improved 0-5m sprint time ( $p < 0.05$ ). Prior to the 8-week training regimen, no significant differences between C and E were detected across all tested parameters. **Discussion** The main finding of this study was that an exclusive 8-week plyometric training program has the potential to markedly enhance jump and linear sprint performance in adolescent elite rugby players. We suggest that the gains in the linear sprint performance resulted from an enhanced jump performance due to an improved power development of the musculature involved in reactive jumping tasks. **References** Markovic, G., Jukic, I., Milanovic, D. & Metikos, D. (2007). Effects of sprint and plyometric training on muscle function and athletic performance. *Journal of Strength and Conditioning Research*, 21, 543-549.

## LONG-TERM TESTING OF ECCENTRIC STRENGTH IN ELITE FEMALE AUSTRIAN SKI RACERS AND ITS RELATIONSHIP TO RACING PERFORMANCE

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**Introduction** Eccentric leg strength is considered a crucial factor in alpine ski racing success (Hoppeler, 2015). The purpose of this study was to examine long-term isokinetic eccentric leg strength characteristics in elite Austrian female alpine ski racers, and to determine if eccentric strength was related to ski racing performance. **Methods** The strength testing data of 23 female members of the Austrian alpine ski team who were tested over 5 consecutive years in preseason fitness tests were examined. The athletes were tested on a Con-Trex leg press for unilateral eccentric leg extension strength (ECC). Range of motion was set at knee angles of 85° to 120°. The FIS points at the end of each of the 5 seasons for the best event of each athlete were used to determine ski racing performance. A repeated measures ANOVA with 2 factors was utilized to test if ECC and FIS points changed over the 5 seasons, and if ECC and FIS points interacted ( $p < 0.05$ ). Results The mean FIS points for the group was  $12.6 \pm 7.2$  in season 1, and improved to  $9.5 \pm 6.8$  in season 5. The mean ECC of the group was  $29.0 \pm 5.0$  N.kg<sup>-1</sup> in season 1, and  $30.2 \pm 5.0$  N.kg<sup>-1</sup> in season 5. ECC did not statistically change over the 5 seasons but performance based on FIS points did significantly change over the 5 seasons. There was no significant interaction between the 2 factors of ECC and FIS points. **Discussion** Over the 5 years the athletes improved in their FIS points but isokinetic eccentric leg strength did not change and was not found to effect racing performance. There is very little published research relating strength and power test results to athletic performance (Abernathy, et al, 1995). The complexities of ski racing make this even more difficult. Performances are not only determined by the physical abilities of the athlete. Ski characteristics, ski preparation, start number, and snow conditions are examples of important factors which influence performance but are not related to athlete physical preparation. Isokinetic testing is reliable (Abernathy, et al, 1995). Isokinetic tests can determine limb strength asymmetry, and compare concentric and eccentric strength. The results of unilateral isokinetic strength tests can determine if athletes have muscle structural balance (injury prevention), and if athletes are physically fit after a knee injury, which is unfortunately common in ski racing. However, strength tests have little value in predicting ski racing performance. References Abernathy, P., Wilson, G., & Logan, P. (1995). *Sports Medicine*, 19, 401-417. Hoppeler, H. (2015). *Eccentric Exercise: Physiology and application in sport and rehabilitation*, 1st Edition. Routledge, New York. Contact carson.patterson@uibk.ac.at

## EFFECT OF LOW INTENSITY CYCLING EXERCISE SUBSEQUENT TO UPPER-BODY RESISTANCE TRAINING ON MUSCLE HYPERTROPHY IN UNTRAINED MEN

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**Introduction** Many athletes perform low-intensity exercise such as cycling and running as methods of cool-down subsequent to resistance training and/or matches (Reilly and Ekblom, 2005). Concurrent upper-body strength training (arm-curls) and lower-body sprint interval training had lower increases of muscle cross-sectional area (CSA) and 1 repetition maximum (RM) compared to strength training and endurance training that was performed immediately after resistance training (Kikuchi et al., 2015). The purpose of this study was to examine whether or not low intensity cycling exercise and subsequent upper-body strength training influences training response of muscle strength and hypertrophy. **Methods** Fourteen subjects were randomly assigned to the experimental group: one group performed low intensity (55% of maximum oxygen consumption, 30 minutes) endurance cycle training immediately after arm resistance training (IA group,  $n=7$ ) and another group performed low intensity endurance cycle training and arm resistance training on separate day (SD group,  $n=7$ ). A supervised progressive arm resistance training (RT) program designed to induce muscular hypertrophy (10 reps at 75% 1RM of bilateral arm-curl exercise) was performed in 8 weeks, with training carried out 3 times per week. Results Significant increase in CSA from pre- to post- test was observed in the SD group ( $p=0.001$ ,  $ES=0.84$ , 95%CI -0.31 to 1.86), and in the IA group ( $p=0.004$ ,  $ES=0.45$ , 95%CI -0.64 to 1.48). Significant increase in 1RM from pre- to post- test was observed in the SD group ( $p=0.025$ ,  $ES=0.91$ , 95%CI -0.24 to 1.94), and in the IA groups ( $p=0.001$ ,  $ES=2.38$ , 95%CI 0.88 to 3.54). Higher percent change of CSA was observed in SD group ( $12.1 \pm 4.9\%$ ) compared to IA group ( $5.0 \pm 2.7\%$ ,  $p=0.029$ ). **Discussion** In conclusion, our data suggested that low intensity cycling exercise immediately after upper-body resistance training systemically influences training response of muscle hypertrophy, but not on separate day. References Reilly T, Ekblom B. (2005). *J Sports Sci*, 23, 619-627. Kikuchi N, Yoshida S, Nakazato K. (2015). *J Strength Cond Res*, 1064-8011. Contact [shigeto.tomiya@gmail.com]

## COMPARISON OF THE MAXIMUM TOE FLEXOR MUSCLE STRENGTH BETWEEN KENDO ATHLETES AND COMPETITIVE SWIMMERS

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**Introduction** Foot is the only region of the body to contact with the ground during standing with lower limb. And it also has the important roles, for instance, attenuating shocks of ground contact, supporting the body weight, controlling the posture, and so on. In the recent studies, toe flexor muscle strength (TFS) is often used as one of the indices of toe flexors. Moreover, TFS is suggested to be important for the improvement of sport performance (Goldmann et al. 2013). However, there is little information about athlete's TFS and differences due to sports events, as far as we know. Therefore, we investigated the difference in TFS between Kendo athletes and competitive swimmers, because the manners of gravity in these event are quite different. Swimming is one of the typical anti-gravitational events, in contrast, Kendo is applied large forces to the lower limbs during repeated hopping steps of forward and backward on the floors, besides bare-foot. So, the purpose of present study was to compare the TFS of Kendo athletes with competitive swimmers. Our hypothesis was that Kendo athletes showed higher TFS than competitive swimmers, because of the differences gravitational effect. **Methods** Subjects were male of Kendo athletes ( $n=30$ ) and competitive swimmers ( $n=13$ ). TFS in both feet was measured using a specifically designed dynamometer (T.K.K.3364, Takei Scientific Instruments) in standing. All subjects were gripped the grip-bar with their toes at maximal effort for 3 seconds. Measurements were performed twice in each foot. The TFS value was adopted the averaged of the maximum values for each foot, then relative of body weight was calculated (TFS/Wt). All data were presented in the form of mean $\pm$ SD. An unpaired t-test was used to examining the differences between two groups. The level of significance was set at  $p<0.05$ . Results TFS was  $245.1\pm52.8$  N in Kendo athletes, and  $281.1\pm59.8$  N in competitive swimmers. TFS/Wt was  $3.57\pm0.66$  N/kg in Kendo athletes, and  $3.92\pm0.90$  N/kg in competitive swimmers. TFS and TFS/Wt were no significant differences between two groups. **Discussion** Present study was investigated the difference in TFS between Kendo athletes and competitive swimmers. It is thought that Kendo is applied large force to the lower limbs. In practice,

there is a report that stamping foot was contact to ground from forefoot, and vertical ground reaction force was more than 10 times the body weight at the contact. On the other hand, swimming has no ground impact. From their differences, we hypothesized that TFS is higher in Kendo athletes than competitive swimmers. However, results of this study were no significant differences. It was contrary to the hypothesis. This result was implied that TFS fulfill important roles for sports performance, not only the case of contact with the ground. Reference 1 Goldmann J. P. et al., J Sports Sci 2013, 31(4): 424-433. Contact a-miyamoto@juntendo.ac.jp

### DETERMINATION OF LACTATE, HEART RATE AND VENTILATORY TURN POINTS IN INCREMENTAL LEG PRESS EXERCISE

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**Introduction** The lactate shuttle theory precisely describes an exercise intensity dependent three phase response of balanced or non-balanced muscle lactate production and local or systemic lactate oxidation (1). Glycolytic production, distribution in muscles and other tissues and finally reconvert lactate to glucose as an energy source to spare glycogen, underpins the link between glycolytic and oxidative metabolism (2). The aim of this study was to determine lactate, ventilatory and heart rate turn points to analyse metabolic and cardiorespiratory responses performing an incremental leg press exercise test. **Methods** 6 male students ( $25.8 \pm 5.2$  years,  $71.7 \pm 7.6$  weight) performed a 1-RM test to obtain maximal leg press performance. Several days later subjects performed an incremental exercise test (IET) on the leg press up to exhaustion. The weight per step was calculated as 30% of 1-RM / 15 to reach maximal workload in about 15 steps. Each step lasted 1min with a cadence of 30 reps/min. Turn points for lactate (LTP1, LTP2), ventilation (VT1, VT2) and heart rate (H RTP) were calculated by means of a linear regression break point analysis. HR as well as gas exchange data were measured continuously. Blood samples were taken before and after a warm up step, after each succeeded step, and after cool down phase to obtain blood lactate concentration (La). **Results** According to a three-phase response LTP1 ( $1.1 \pm 0.4$  mmol.l<sup>-1</sup>) and LTP2 ( $1.5 \pm 0.3$  mmol.l<sup>-1</sup>) could be determined at an intensity of  $18.8 \pm 3.9$  %1RM and  $28.4 \pm 3.0$  %1RM ( $50.3 \pm 10.1$  %Pmax and  $75.9 \pm 4.9$  %Pmax) respectively. Depending on Pmax, %PLTP1,2 were similar to standard IETs. Ventilatory threshold VT1 ( $27.5 \pm 7.2$  l.min<sup>-1</sup>) was  $18.6 \pm 3.8$  %1RM ( $49.9 \pm 11.3$  %Pmax) as well as VT2 ( $40.9 \pm 11.6$  l.min<sup>-1</sup>) was  $29.1 \pm 2.9$  %1RM ( $77.9 \pm 5.8$  %Pmax), were not significantly different from LTP1 and LTP2. Heart rate turn point (H RTP) was  $139 \pm 5.4$  min<sup>-1</sup> and the maximum heart rate was  $159 \pm 11.3$  min<sup>-1</sup>. Intensity at LTP2 and H RTP as well as LTP2 and VT2 were significant correlated ( $r=0.95$ ,  $p<0.01$ ;  $r=0.98$ ;  $p<0.01$ ) and not sign. different. **Discussion** It was possible to determine LTP1 and LTP2, VT1, VT2 and H RTP in the incremental leg press test. Lactate, heart rate and ventilation curves were comparable to standard IETs. These results indicate that knowledge and application of the lactate shuttle theory may also be applied for strength endurance exercise. **References** (1) Hofmann, P. & Tschakert, G. (2011). Cardiology research and practice, 2011: 209302. (2) Brooks, G. A. (2007). Sports Med. 2007;37(4-5): 341-3. **Address for correspondence:** christianalmer@gmail.com; peter.hofmann@uni-graz.at

### DEVELOPMENT AND VALIDATION OF THE ROPE-CLIMBING ERGOMETER FOR PHYSICAL FITNESS TESTS OF UPPER LIMBS

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**Introduction** The ergometer for testing physical fitness has been extensively used by many researchers and practitioners. The cycle ergometry has become the most prevalent in both laboratories and practical scenes. Meanwhile, no gold standard has been established for upper limbs, suggesting a room for further development of an ingenious ergometer that will expand the options of measurements under near-competitive conditions within a specific sport. The purpose of this study was to develop and verify the rope-climbing ergometer (rope-ergometer) which can assess physical capabilities in a pulling movement of upper-limbs. **Materials and Methods** The rope-ergometer developed in this study is designed for use in a sitting posture. On this device, a subject pulls a rope downward with both hands alternatively. This modality is similar to the commercially available rope-climbing training machine ("VLT Rope Trainer", Marpo Kinetics Inc.) which does not have an ergometry function. As resistance, mechanical load was generated to the rope by an electromagnetic braking equipment. The levels of load were controlled by a microcomputer system. In total 100 staged levels can be discretionarily set by operators. The tension of the rope for each instant of time was measured by a load cell device attached to the pulley above user's head, whereas the velocity was estimated with a rotary encoder. The tension and velocity of the rope were recorded with a sampling rate of 100 Hz. All control regulations were carried out by the microcomputer. Fourteen healthy male participants participated in the qualification experiment. The participants performed eight sets of maximal effort rope-climbing trials. The load levels were set at 0, 3, 6, 9, 12, 15, and 18 out of 100, respectively. The exercise duration was less than 10 seconds. The tension and the velocity were smoothed with a 9-sample simple moving average, and then the instant power was calculated. **Results and Discussion** The rope-pulling force increased with an increment in the load level (e.g., level 0:  $15.0 \pm 4.2$  kgf, level 18:  $39.1 \pm 2.6$  kgf), whereas the velocity decreased with an increment in the load level (e.g., level 0:  $1.87 \pm 0.23$  m/s, level 18:  $0.66 \pm 0.20$  m/s). The rope-pulling power reached a peak at the load level 9 ( $320$  W  $\pm$  123), and declined with a decrement and an increment in the load level, respectively (e.g., level 0:  $276 \pm 89$  W, level 18:  $254 \pm 87$  W). **Conclusion** The results of the qualification experiment suggest that the rope-ergometer developed in this study can be validated for testing maximal power in the upper limb exercise, taking the velocity-force relationship of a muscle into consideration.

### THE EFFECTS OF HIP THRUST TRAINING ON STRENGTH AND POWER PERFORMANCES OF LOWER EXTREMITY

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**Introduction** Hip joint, serves as the biggest and powerful joint in lower extremity, plays very important roles in many essential functional movements, like running and jumping. Hip thrust is the modern training way to enhance the strength of hip muscles, especially gluteus maximus (Contreras et al., 2011). However, less evidence was provided the benefits of the hip thrust training on strength of lower extremity and its functional performances. Therefore, the study aimed to analyze the effects of hip thrust training on strength and power performances of lower extremity. **Methods** Ten healthy collegiate students ( $173.1 \pm 4.6$  cm;  $69.8 \pm 11.6$  kg;  $19.9 \pm 0.8$  yrs) participated in 8 weeks of hip thrust training program (50-80% 3RM, 8-20 rep, 4 sets, 30-90 second rest between sets). Four students ( $170.7 \pm 5.2$  cm;  $67.3 \pm 12.9$  kg;  $21.4 \pm 1.6$  yrs) served as the control group. They repeated same tests and were asked to continue usual activities and not to start any exercise program. Both groups did not have any experience of hip thrust training. The tests, including vertical jump high, long jump, 30 m sprint, squat strength (1 repetition maximum, RM) (SS) and hip thrust strength (3RM) (HTS), were performed after identical warm-up exercises. **Results** After training, we found significant improvement in SS ( $p<0.05$ ) and HTS ( $p<0.05$ ), but not in vertical jump high, long jump and



30 m sprint. No changes were observed in the control group. Furthermore, the improvement in SS ( $37 \pm 15\%$ ) was positively correlated with that in HTS ( $44 \pm 27\%$ ) ( $r=0.65$ ,  $p=0.02$ ). Discussion The 8-weeks hip thrust training improved squat strength but not power performances of lower extremity. This is the first study to investigate the effects of hip thrust training on functional performances. The interesting finding was that the squat strength could be enhanced by the progressive hip thrust training program. We further analyzed the improvement of squat strength was associated with the increasing strength of hip extensors. Although hip extensors are highly activate during sprint and functionally important for powerful movements (Jamie et al., 2014), there were no changes in jumping and sprint performances after hip thrust training in our study. In conclusion, hip thrust training could be an assisted way to enhance squat strength, but not an optimum way to improve functional power movements.

## THE STUDY OF SCAPULAR STABILIZER MUSCLES STRENGTH AND FLEXIBILITY IN WEIGHTLIFTERS

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Introduction Weightlifting requires high power and musculoskeletal strength. Cvertraining and poor joint movement for a long time may cause high risk for scapular muscles imbalance and dysfunction. Thus, the aimed of this study want to examine the scapular stabilizer muscles strength and flexibility between weightlifters athletes and non-athletes Methods Eighty-one volunteers (38 males, 43 females) with age  $18.81 \pm 2.37$  years, weight  $67.74 \pm 19.75$  kg, height  $160.82 \pm 7.78$  cm and a body mass index of  $26.54 \pm 8.10$  kg / m<sup>2</sup> were participated in the study. They were divided into weightlifters group (23 males, 25 females) and control group (13 male, 20 female). At first, muscles flexibility were assessment by using physical method. After that, scapular stabilizer muscles strength included lower trapezius, internal and external rotator were measured via handheld dynamometer (Lafayette, USA) and surface electromyography (BTS FREEMG, Italy). The scapular stabilizer muscles strength and flexibility data between groups were compared by using the Independent t-test at  $p < 0.05$ . Results The study found that shoulder flexibility in weightlifters was significantly less than control group ( $p < 0.05$ ). Weightlifters group demonstrated significantly more scapular stabilizer and upperlimb muscles strength than control group ( $p < 0.05$ ) in dominant and non-dominant side. Discussion Our study showed Weightlifters muscles inflexible that may be due to the effect from strenuous strength training program. As shoulder muscles are very tight, It affects the strength of shoulder rotator muscles in weightlifters group. This information could be used for the baseline of muscular flexibility training and scapular muscles stabilization exercise program. Thus, the flexibility training programs should be instructed for the weightlifters. In addition, the scapular stabilizer training may be suggested for supplementary program. Especially the lower trapezius, internal and external rotator strength training should be added in weightlifting training to manage muscle dysfunction and gain maximum lifting performance. References Calhoon G, Fry AC. Injury rates and profiles of elite competitive weightlifters. *Journal of Athlete Training*. 1999;34:232-8. Raske A, Norlin R. Injury incidence and prevalence among elite weight and power lifters. *American Journal of Sports Medicine*. 2002;30:248-55. Maguire MC, Lorens K, Woods K, Hicks-Little C. Correlation between lower trapezius weakness and the incidence of shoulder pathology in overhead athletes *Journal of Athlete Medicine*. 2014;1:35-44. Contact Vanasant1@gmail.com, Tel. +662-314-6121

## MUSCLE ACTIVATION AND LACTATE RESPONSE TO ACUTE WHOLE BODY VIBRATION WITH BLOOD FLOW RESTRICTION IN HEALTHY UNTRAINED MEN

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Introduction The occlusion training, resistance exercise combined with blood flow restriction (BFR), has largely been reported to increase muscle mass and strength (Pope et al., 2013). However, whether an alternative passive occlusion training model, using whole body vibration (WBV) exercise combined with BFR (WBV+BFR) would elicit adaptive response is unclear. It has been suggested that increased in muscle activation and metabolic products are important factors in the adaptive response to occlusion training (Pope et al., 2013). Therefore, this study aimed the acute effect of WBV+BFR on muscle activation and blood lactate (LA) responses. Methods Eight healthy untrained male adults participated in this study and performed two exercise sessions, including WBV+BFR and WBV in a repeated measures crossover design that separated by one week intervals. The frequency and amplitude of WBV was set at 26Hz and 4mm respectively. The WBV protocol was designed by 10 sets for 1 min, with 1-2min rest between the vibration sets. In the WBV+BFR session, participants wore a BFR device around the proximal portion of thigh muscles and inflated the device to a pressure of 140 mmHg. During each exercise session, electromyography (EMG) signals of participants' thigh muscles of the dominant leg were collected, and rating of perceived exertion (RPE) was also assessed. Blood lactate was determined pre-exercise and post exercise. Results EMG from rectus femoris and vastus lateralis during WBV+BFR were significantly higher than that of WBV ( $55.96 \pm 5.31$  vs.  $42.41 \pm 6.68$ ;  $87.65 \pm 5.28$  vs.  $67.86 \pm 4.72$   $\mu$ V, respectively,  $p < 0.05$ ). RPE value was higher for WBV+BFR than WBV ( $5.69 \pm 0.49$  vs.  $3.84 \pm 0.45$ ,  $p < 0.05$ ). Both WBV+BFR and WBV exercise caused significant increase in LA ( $0.61 \pm 0.09$  to  $4.68 \pm 0.43$  vs.  $0.46 \pm 0.07$  to  $3.44 \pm 0.36$  mmol/l,  $p < 0.05$ ), and WBV+BFR significantly elicited the LA responses much higher than that of WBV post exercise ( $p < 0.05$ ). Discussion The study shows that adding BFR device while performing WBV would increase participants' RPE and primary muscles activation. In addition, LA response was manifested by this model. It is speculated that adding BFR device on WBV, the primary muscles tend to be aroused more motor units to accommodate the greater effort as blood flow is restricted. Result of this study was similar to those in the previously studies using external resistance in which the working muscle is further activated (Sartorio et al., 2011), and led to an increase in LA concentration (Yasuda et al., 2009). In conclusion, the passive WBV+BFR model can produce additive muscle contraction response in addition to WBV. It may be suitable for people who seldom do regular exercise. References Pope ZK, Willardson JM, Schoenfeld BJ. (2013). *J Strength Cond Res*, 27, 2914-2926. Sartorio A, Agosti F, De Col A, Marazzi N, Rastelli F, Chiavaroli S, Lafortuna CL, Cella SG, Rigamonti AE. (2011). *J Endocrinol Invest*, 34, 216-221. Yasuda T, Brechue WF, Fujita T, Shirakawa J, Sato Y, Abe T. (2009). *J Sports Sci* 2009, 27, 479-489. Contact flameyan@yahoo.com.tw

## Conventional Print Poster

## PO-CPP-30 Training &amp; Testing 3

**ADAPTATIONS IN THE CARDIAC SYSTEM OF AN OLYMPIC DOWNHILL SKIING CHAMPION: A 6-YEAR ECG CASE-STUDY.**

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Adaptations in the Cardiac System of an Olympic Downhill Skiing Champion: A 6-year ECG Case-Study. Introduction: The contribution of the cardiac system in optimizing the training process and performance results of highly skilled skiers remains unexplored. The purpose: to observe changes in particular ECG parameters which represent adaptations in the cardiac system of an Olympic champion in response to specific training and competition loads. Methods: The study involved a 2010 Olympic champion downhill skier. Bioelectrical heart activity was recorded by ECG using Omegawave 3 technology (USA). ECGs were recorded regularly for 6 years from 2004 up to the 2010 Olympic Games, where the athlete achieved the best results of his career. Initial data contained over 800 ECG assessments. ECGs were recorded at rest using standard limb leads I, II, III (including aVR, aVL, aVF), and unipolar chest leads V2, V3R, and V6. Recording time was at least 128 sec. and took place before training or competition (5:00 to 10:00 am). A comprehensive analysis of ECG intervals and amplitude characteristics was then conducted. Heart rate variability (HRV) analysis was also used to assess the state of the autonomic nervous system (ANS). Statistical analysis was performed using SPSS 23 (USA). Results: With increased sports preparedness, changes were observed in the basic function of both the cardiac system and ANS regulatory mechanisms. Over the course of the study, a general decrease in wave amplitude R, S, T in lead V2, and S and T wave amplitude in lead V6 was observed ( $p < 0.001$ ). The width of the QRS complex in V6 abduction significantly increased. In standard ECG leads the width of P and T waves was significantly increased, and the amplitude of the waves Q, R, S, T decreased ( $p < 0.001$ ). HRV parameters showed various wavelike trends depending on the period of preparation, all within normal range. A tendency towards decreased activity of vagal regulation and increased role of the sympathetic branch of the ANS was observed. However, during the year prior to the Olympic Games, both ECG and HRV parameters showed opposite trends. In ECG leads V2 and V6, wave amplitude R, S, T increased. In HRV indices, the activity of the parasympathetic branch of the ANS and autonomous cardiac rhythm control loop increased (RMSSD, Total Power, HF), and the sympathetic branch decreased (amplitude of the mode and Tension Index). Discussion: ECG and HRV parameters are physiological markers that reflect the biological cost of forming adaptational changes in response to daily training and competition stressors. Frequent monitoring of these changes can be useful for optimizing the training process. Contact: eichberger.peter@yahoo.com

**NEUROMUSCULAR ADAPTATIONS TO 2½-WEEK HIGH-INTENSITY INTERVAL TRAINING WITH COMPRESSION GARMENTS IN FEMALE ICE HOCKEY PLAYERS**

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INTRODUCTION High-intensity interval training (HIIT) is commonly used training method to improve performance. HIIT increases power and speed performance (Naimo et al. 2015), possibly because of improved motor control. Utilization of the compression garments (CG) during the exercise may enhance performance and recovery (Hamlin et al. 2012), and thus may enhance the training response. We studied neuromuscular adaptations to HIIT and possible benefits of the CG for training response. METHODS Fourteen female ice-hockey players were divided into compression garment (CG; height  $165 \pm 6$  cm, weight  $68 \pm 12$  kg, age  $22 \pm 4$  years,  $N = 6$ ) and non-compression garment (no-CG; height  $166 \pm 5$  cm, weight  $66 \pm 13$  kg, age  $22 \pm 3$  years,  $N = 8$ ) training groups. Both groups performed 2.5 weeks HIIT by running in 9.5 degree uphill. Rate of force development (RFD) was measured from plantar flexors. Levels of voluntary motor drive (V-wave/maximal M-wave) and spinal alpha-motoneuron excitability (H-reflex/20% M-wave) were quantified during maximal voluntary contraction from soleus muscle before and after the training. Light cells where used to measure acceleration and maximal speed during on-ice performance. RESULTS Both groups improved RFD (CG  $15.6 \pm 12.3\%$ ,  $p < 0.05$ ; no-CG  $14.9 \pm 18.9\%$ ,  $p < 0.05$ ) during the training. In addition, V-wave responses increased by  $20.3 \pm 14.7\%$  in CG group ( $p < 0.05$ ), while in no-CG group increment was only  $13.4 \pm 15.9\%$ . No significant changes were observed in H-reflex amplitude (CG  $0.0 \pm 48.6\%$ ; no-CG  $4.5 \pm 36.5\%$ ), nor in on-ice skating performance. DISCUSSION A significant HIIT-training-induced increase in V-wave amplitude implied increased or better-synchronized neural motor drive through the spinal alpha-motoneurons during maximal isometric contraction (Aagaard et al. 2002). However, utilization of CG didn't cause additional improvement in the force production, even though the level of voluntary motor drive was enhanced. It can be suggested that, possible benefits of CG should be confirmed with studies utilizing longer training periods and including more muscle groups such as quadriceps muscles. REFERENCES Aagaard P, Simonsen EB, Andersen JL, Magnusson P, Dyhre-Poulsen P (2002). J Appl Physiol, 92, 2309-2318 Naimo MA, de Souza EO, Wilson JM, Carpenter AL, Gilchrist P, Lowery RP, Averbuch B, White TM & Joy J (2015). Int J Sports Med 36, 61-66. Hamlin MJ, Mitchell CJ, Ward FD, Draper N, Shearman JP, Kimber, NE. (2012) J Strength Con Res, 26: 2975-2982, 2012.

**METABOLIC AND CARDIOVASCULAR RESPONSES DURING GROUP SUSPENSION TRAINING**

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Introduction Suspension Training (ST) is a recent form of bodyweight resistance training. ST produced higher muscle activations with respect to traditional exercises secondary to muscle activity used to maintain body stability and balance (McGill et al, 2014; Snarr et al, 2014) and a single training session could be used to improve core stability, strength, flexibility and endurance (Dudgeon et al, 2015). At present, no information is available on ST energy cost during group sessions. Therefore, the aim of this study was to evaluate metabolic and cardiovascular responses during group ST. Methods After signing their informed consent of participation, 18 college students (11 male, 7 female; Age:  $26.2 \pm 4.5$  years; Height:  $168.2 \pm 9.3$  cm; Weight:  $68.5 \pm 12.7$  kg; BMI:  $24.0 \pm 2.5$ ) novel ST practitioners volunteered for the study. After a familiarization period, Heart Rate (HR) and Oxygen Consumption ( $\text{VO}_2$ ) were continuously recorded by portable metabolic

system (Cosmed K4b2) during 18 different training sessions (Duration:  $42.5 \pm 7.3$  min). Energy expenditure was expressed as Metabolic Equivalents Task (MET). Analysis of Variance (ANOVA) was used to evaluate gender-related differences ( $p < 0.05$ ). Results Although no difference in HR emerged for gender (Males =  $68.3 \pm 6.9$  %HRmax, Females =  $70.7 \pm 5.1$  %HRmax), differences emerged for VO2 (Males =  $17.9 \pm 2.6$  ml/Kg/min, Females =  $15.2 \pm 2.6$  ml/Kg/min,  $p < 0.0474$ ; Males =  $1.32 \pm 0.16$  l/min, Females =  $0.88 \pm 0.13$  l/min,  $p < 0.0001$ ) and MET (Males =  $5.1 \pm 0.8$ , Females =  $4.3 \pm 0.7$ ,  $p = 0.0474$ ). Discussion According to ACSM guidelines (2014), findings suggest that ST could be classified as a moderate-to-vigorous intensity exercise. Furthermore, ST could be used to increase energy expenditure (about 250 Kcal for males and 200 Kcal for females) and to improve cardiovascular efficiency. However, further research is needed to evaluate the effects of ST protocols on metabolic and cardiovascular capacities. References ACSM 2014, Guidelines for Exercise testing and prescription. 9th Ed. Lippincott Williams & Wilkins. Dudgeon WD et al, (2015). International Journal of Sports Science, 5(2): 65-72. McGill SM et al, (2014). Journal of Strength and Conditioning Research, 28: 105-116. Snarr RL et al, (2014). Journal of Sport and Human Performance, 2: 1-8. Contact g.giancotti@unicas.it

## FEASIBILITY OF POSTURAL SWAY CALCULATION IN THE EQUINE ATHLETE USING WEARABLE SENSOR TECHNOLOGY

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**Introduction** Wearable sensor technologies have begun to revolutionise the fields of sport and health. While the use of these technologies are rapidly becoming the “norm” in areas such as sports performance analysis and physical activity monitoring, the field of equine sports has been slower to uptake. A huge opportunity exists to harness these technologies in the training of athletic horses. The aim of this study was to assess the feasibility of measuring postural sway using on-body inertial sensors. The long-term aim of this research would be to use this measure for longitudinal monitoring of fatigue/recovery of horses in the field. **Methods** A body-worn inertial sensor containing a tri-axial accelerometer was attached to one healthy horse at the highest point of the croup (posterior iliac spine) using a custom made attachment. The aim was to capture a “quiet standing” trial lasting at least 40s. Three quiet standing trials were recorded. Acceleration data were sampled at 51.2 Hz and band-pass filtered between 0.1-10 Hz. The initial 5 seconds of data were removed, and the subsequent 45 seconds of data were considered for further analysis. Cumulative horizontal acceleration was calculated using the medial-lateral (ML) and anteriorposterior (AP) acceleration vectors, by twice integrating the acceleration signal. Low frequency drift was reduced using a second-order polynomial fit and subtracting the mean amplitude of the signal before and after each integration procedure and then high pass filtered at 0.1 Hz. **Results** Only one trial out of three was suitable for analysis due to the horse’s idiosyncratic standing movements. The ranges of AP and ML displacement (i.e. 0-80mm) produced a stabilogram similar in shape, but differing in magnitude to previous work using force plates (Clayton and Nauwelaerts, 2012). This is expected, given the distance of the inertial sensors from the centre of pressure changes beneath the horse’s hoof. **Discussion** The sensor set-up and capture protocol successfully detected “quiet” postural sway in the equine animal. Our experiment confirmed the challenge of consistently capturing quiet standing data of sufficient length. It would therefore be preferable to perform long-term monitoring of postural sway while the horse is ‘sleeping’, due to the animals sophisticated ‘stay apparatus’, allowing it to remain standing in a resting state. Such data could be used to monitor the state of health of the equine athletes’ motor control system, similar to emerging approaches in human movement. **References** Clayton, HM, Nauwelaerts S. Equ Vet Med (2012) 44, 5, 550–553

## PERFORMANCE & METABOLISM IN MICE

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**Introduction** Maximal oxygen uptake (VO2 max) represents, both humans and animals, the integration of the cardiovascular, respiratory and muscular systems ability to take up and utilize oxygen during exercise, was applied to man in the nineteen-twenties by the Nobel Prize Archibald Hill. These measurements are intrinsically interesting in order to initiate comparative physiologic’s analyses and they are frequently of critical importance for investigations of evolution of physiological traits. The Performance & Metabolism in Mice (PMM) facility provides comprehensive, standardized or advanced, customized characterization of performance and metabolism in mouse models. **Materials and methods** 10 Swiss and 15 C57 female mice (3-4 months old) were tested for oxygen consumption (VO2) on a treadmill. Our equipments, independent and parallel treadmills (TSE, Franckfurt, Germany), allowing the VO2, VCO2, RER (VCO2/VO2) and the energy expenditure measurement by indirect calorimetry. During the exercise, automatic VO2 and VCO2 measurements are made without additional constraint on the animals (measured every 1s). VO2peak was determined as the highest value of VO2 achieved over 15s and expressed relatively to body and lean mass (measured by RMN) in ml.kg<sup>-1</sup>.h<sup>-1</sup>. All mice performed an incremental test (0.01 m.s<sup>-1</sup> increment each 15s). **Results** Regarding the lean mass, Swiss mice ( $28.73 \pm 1.78$ g) were bigger than C57 mice ( $18.43 \pm 0.93$ ) with a lean mass ratio lean mass/mass decreased ( $66.69 \pm 9.96\%$  vs  $79.37 \pm 2.83\%$ ). Swiss VO2peak relatively to lean mass ( $11.38 \pm 0.61$  ml.kg<sup>-1</sup>.h<sup>-1</sup>) were significantly different from C57 ( $9.57 \pm 0.52$  ml.kg<sup>-1</sup>.h<sup>-1</sup>;  $p < 0.01$ ). Concerning Vmax, we obtain a similar result between Swiss and C57 mice (respectively  $0.63 \pm 0.10$  m.s<sup>-1</sup> and  $0.71 \pm 0.08$  m.s<sup>-1</sup>;  $p < 0.01$ ). **Discussion** The metabolic exploration facility of PMM performs specific, on-demand experiments as well as comprehensive metabolic analyses to evaluate in vivo the energy balance in mouse. This exploration is performed under either basal condition or energy challenges using standardized techniques for the detection of phenotype in energy metabolism. It provides users with the techniques and scientific support used to design experimental protocols as well as for the development of new techniques to investigate metabolism. Besides the metabolic aspects, treadmills allow us to induce a stress that can, on one hand, reveal pathologies and/or rising adaptations, and on the other hand create muscle damage stimulating the regeneration processes.

## EFFECT OF EXERCISE INDUCED HYPOHYDRATION ON BODY COMPOSITION MEASUREMENTS IN ACTIVE AND ATHLETIC SUBJECTS

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**Laboratory for Biometry and Exercise Nutrition, Université libre de Bruxelles (ULB, Belgium)** **Introduction** Body composition is frequently assessed in active subjects and athletes to quantify its impact on performance or the effect of different kinds of physical/nutritional interventions. However subject hydration varies along the day and in between days due to physical activity which may induce errors in body composition estimation (1,2). Therefore the aim of present study is to quantify the effect of an exercise induced hypohydration on body

composition measurements using different methods. Methods Thirteen active (7 males) and 13 athletic (7 males) subjects took part in the experiments. Their body composition was assessed using anthropometric methods (skinfolds), multi-frequency bioelectrical impedance analyser (M-BIA) and dual-energy X-ray absorptiometry (DXA) before and after a run on treadmill that induces a body weight decrease of 2%. Correlations between individual weight losses and body composition changes were calculated. For DXA, segmental changes and correlation between initial percentage of fat mass and body composition changes was also calculated. Results Athletic subjects presented a significantly lower initial fat mass percentage (13%) compared to active subjects (24%) [ $P < 0.05$ ]. Average body composition changes between pre and post exercise are expressed in percentage of pre-exercise values. The lean mass measured by DXA and M-BIA decreased post-exercise by 2.5 and 1% respectively [ $P < 0.01$ ]. The fat mass was reduced post-exercise when measured using DXA (2.3%) and M-BIA (8.2%) [ $P < 0.01$ ]. Body fat percentage estimated using M-BIA was reduced by 5% [ $P < 0.01$ ] and did not change for DXA. Skinfolds sum and fat percentage calculated using Durnin and Wormersley equation combined to Siri equation (DWS) were slightly reduced (1.7%) post-exercise [ $P < 0.01$ ]. For DXA and M-BIA, fat mass changes were correlated with weight loss [ $P < 0.05$ ], whereas correlation was not significant for lean mass. Body fat percentage changes were significantly correlated with weight loss for DXA but not for M-BIA and DWS. For DXA, decreases of fat mass and lean mass were located respectively in the trunk and in trunk and legs. Initial percentage of body fat mass was correlated with changes of fat and lean mass. Discussion Changes of fat mass and lean mass due to exercise induced hypohydration were predominantly located in the trunk and were dependent on the method used. It also appears that initial body composition, which differs between athletic and less active subjects, may influence errors induced by hypohydration. References 1.Rodríguez-Sánchez et al 2014, Int J Sport Nutr Exerc Metab 25:60-68. 2.Saunders et al 1998, Med Sci Sports Exerc 30, 885-92. Contact mklass@ulb.ac.be

## Conventional Print Poster

### PO-CPP-34 Psychology 1

#### THE RELATIONSHIP BETWEEN COACH FEEDBACK AND SELF-PERCEIVED SPORT COMPETENCE IN COLLEGIATE MALE FOOTBALL PLAYERS

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Coach feedback significantly contributes to players' sport competence associated with intrinsic motivation. However, limited research has examined this relationship with observation in real sport-coaching settings. Therefore, the purpose of this study was to investigate the relationship between coach feedback and players' self-perceived sport competence in actual coaching contexts. One coach and 23 players of a male university soccer club participated in this study. The coach's feedback to the players was recorded for 10 weeks using VTR and, subsequently, categorized into seven domains: 1) positive, 2) negative, 3) instructive, 4) questioning, 5) organizing, 6) friendly, and 7) other. Both before and after receiving coach feedback, players were asked to complete a questionnaire, which consisted of 10 subscales: (1) pass and control decision-making, (2) speed, (3) dribble skill, (4) physical strength, (5) endurance, (6) defense skill, (7) leadership, (8) motivation, (9) long kick skill, (10) heading skill. A significant relationship between soccer players' self-perceived competence and coach feedback was found. The results reveal that frequency of positive feedbacks, such as praise and encouragement, are negatively associated with pass and control decision-making as well as dribble skill. The results further indicate that collegiate male soccer players tend to draw on self-comparison and other internal processes more than positive coach feedback to evaluate their competence. Alternatively, a positive association between negative feedback, such as scold, and pass and control decision-making competence was also found. In competitive sports setting, the coach and players would share their common goal as a victory. In this case, players who received negative coach feedback understand the coaches' intent behind that. As a result, negative coach feedback seems to improve players' self-perceived competence in pass and control decision-making areas.

#### POSITIVE SOCIAL-EMOTIONAL CONDITIONS, BASIC PSYCHOLOGICAL NEEDS AND WELL-BEING IN HIGH PERFORMANCE ATHLETES

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Introduction Based on Self-determination theory (Deci & Ryan, 2000) in this study a model was proposed testing associations between athletes' perceptions of the protective environmental resources on their training centre (belonging to the centre, caring relationships, high expectations and meaningful participation), psychological need satisfaction (competence, autonomy and relatedness), and well-being (subjective vitality, life-satisfaction and self-esteem). It was hypothesized that athletes' perceptions of socio-emotional conditions of the training centre will be positively related to psychological need satisfaction, which in turn will be positively related to well-being. Methods A total of 139 high level Spanish athletes from different sports (52 men and 87 women) ranging in age from 14 to 18 years ( $M = 15.7 + 1.12$ ), participated in this study. All participants practice sport five days a week ( $M = 5.35 + 0.66$ ), for over four hours per day ( $M = 3.78 + 1.04$ ). Participants completed a multi-section inventory including the Spanish adaptations of several questionnaires: a) Subscales of Caring Relationships, High Expectations and Centre Meaningful Participation from the Resilience Youth Development Module (Bernard & Slade, 2009); b) Subscale of Centre Connectedness from the California Healthy Kids Survey (WestEd, 2006); c) Subscale of Perceived Competence from the Intrinsic Motivation Questionnaire (McAuley et al., 1989; Balaguer et al., 2008); d) Scale of the Need for Autonomy (Reinboth & Duda, 2006; Balaguer et al., 2008); e) The acceptance subscale of the Need for Relatedness Scale (Richer & Vallerand, 1998; Balaguer et al., 2008); f) Subjective Vitality Scale (Ryan & Frederick, 1997; Balaguer et al., 2005); g) Subscale of Self-esteem of Self-Description Questionnaire-III (SDQ-III, Marsh et al., 1994; Balaguer et al., 2008); and h) Satisfaction with Life Scale (Diener et al., 1985; Aienza et al., 2000). Results Structural Equation Modeling analyses showed that athletes' perceptions of belonging to the centre ( $\text{Beta} = 0.39$ ), and opportunities for meaningful participation in their centre ( $\text{Beta} = 0.29$ ) positively predicted their psychological needs, which in turn contributed to improve subjective vitality ( $\text{Beta} = 0.31$ ), life satisfaction ( $\text{Beta} = 0.36$ ) and self-esteem ( $\text{Beta} = 0.27$ ). Discussion Overall, findings support the importance of providing positive social-emotional conditions in the training centres to promote positive functioning and favoring the athletes' well-being. References Deci, E. L., & Ryan, R. M. (2000). The "what" and "why" of goal pursuits: human needs and the self-determination of behavior. *Psychological Inquiry*, 11(4), 227-268. Contact Email: Isabel.Castillo@uv.es



## THE CHALLENGES AND COPING STRATEGIES EXPERIENCED BY TAIWANESE PROFESSIONAL BASEBALL PLAYERS IN THE UNITED STATES

CHI, L.K., CHEN, M.C., CHEN, S.Y.

*National Taiwan Normal University*

**Introduction** The purpose of this paper was to identify the challenges and coping strategies experienced by Taiwanese baseball players who played professional baseball league in the United States. **Methods** Semi-structured interviews were conducted to explore the adaptation experience with nine overseas players (ages 21-29 years, experiences 2-6 years), one sport agent, one coach, two team sport psychologists, one retired USA player, and three administration staffs, total 17 participants and 24 times interviews (7 players were interviewed twice at 1-year interval to follow their adaptation experience). The players competed at different levels: Rookie, Short A, 1A, Advantage A, 2A and MLB. Grounded theory principles were used for data collection and analysis. **Results** The results showed that the challenges encountered by Taiwanese baseball players in the United States included six inter-related main themes: insufficient English abilities, post-relocation loneliness, cultural differences, dynamic environment, performance pressure, and intensive competition. Among the challenges, insufficient English abilities were identified as the most impactful theme since it is related to relocation loneliness, dynamic environment, understanding new culture, and communication to teammates and coaches. Therefore enhancement of English ability was suggested most often among the participants. Cultural differences and dynamic environment were considered important at the first one or two years, and after that how to deal with performance pressure and intensive competition became prominent issues among all challenges. Coping strategies were suggested according to different challenges. **Four conclusion** was drew from coping strategies: 1) accumulation of experience was the foundation of adaptation process, 2) support from others was the most commonly used strategy, 3) the importance of taking initiatives, and 4) psychological skill trainings were suggested to help players better deal with performance pressure. **Discussion** The findings highlighted the complexity among these six themes of challenges and the potential areas sport psychologists could work on. Recommendations are provided to smooth the adaptation process for Taiwanese baseball players in the United States.

## THE RELATIONSHIP OF SELF DETERMINATION MOTIVATION TOWARDS PHYSICAL ACTIVITY, TIME SPEND SEDENTARY AND DEPRESSION SYMPTOMS IN RHEUMATOID ARTHRITIS PATIENTS

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**The Relationship of Self Determination Motivation Towards Physical Activity, Time Spend Sedentary and Depression Symptoms in Rheumatoid Arthritis Patients** **Introduction** Rheumatoid arthritis patients has been associated with a heightened risk of cardiovascular disease (Metsios et al., 2009) but also indicators of compromised mental health such as high anxiety and depression (Treharne, et al., 2005). Participation in moderate-to-vigorous physical activity (MVPA) has been found to accrue health benefits in this clinical population, and research evidence suggest that less time spent sedentary (ST) may also help RA patients enhance their well being. People with RA, however, tend to not engage in sufficient levels of physical activity (PA). Thus, it is important to better understand the motivational determinants of PA in this clinical population. Pulling from Self-Determination Theory, this study examined the associations between self determination (SD) toward exercise, objectively measured PA and ST, and depressive symptoms (DS) in RA patients. **Method** Valid data were obtained from 55 out of 115 patients with RA (age=55±13, 37 females) from the baseline assessment of a RCT. The accelerometer data were downloaded, reduced and analysed by the Activlife 6.0 software. Descriptive and path analyses were on variables derived from both questionnaire and objectively measured PA and ST. The Relative Autonomy Index (RAI) was employed as the indicator of the RA patients degree of SD regarding their exercise behaviour. **Results** The results revealed RA patients to spend more ST (499.11 ± 68.71, minutes per day) than the general population and do not meet the recommended level of MVPA (17.24 ± 15.80) during the 7 day assessment protocol. RAI positively correlated with moderate PA ( $r=.30$ ,  $p<.05$ ) and MVPA ( $r=.30$ ,  $p<.05$ ), and negatively correlated with DS ( $r=-.38$ ,  $p<.01$ ). Path analysis indicated that an amended model demonstrated acceptable fit to the data. **Discussion** RA patients spend more ST and engage in less MVPA than recommended which echoes previous research findings (Yu et al., 2015). Findings revealed more SD to be positively related to daily MVPA and negatively linked to DS among patients with RA. The unexpected associations between ST and DS may need to be examined further in the future. Limitations of this study in terms of sampling and the use of a cross-sectional design are addressed. Metsios, G. S., Stavropoulos-Kalininglou, A., Panoulas, V. F., Wilson, M., Nevill, A. M., Koutedakis, Y., et al. (2009). *European J Cardiovascular Prevention & Rehab*, 16(2), 188-194. Treharne, G. J., Kitas, G. D., Lyons, A. C., & Booth, D. A. (2005). *J Health Psychology*, 10(3), 457-474. Yu, C. A., Rouse, P. C., Veldhuijzen Van Zanten, J. J., Ntoumanis, N., Kitas, G. D., Duda, J. L., et al. (2015). *Arthritis Research and Therapy*, 17(1), 584-598. Contact: Chen-an Yu C.Yu@Kintston.ac.uk

## THE INTERNAL TASK HIDDEN IN THE MOVEMENT TROUBLE IN COLLEGE ATHLETES: ANALYSIS BY THE LANDSCAPE MONTAGE TECHNIQUE

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**Introduction** The purpose of this study is to examine the similarities between troubles in physical movement and the internal tasks in college athletes by using the Landscape Montage Technique (LMT). In psychological consultations with athletes, they express troubles related to their physical movements. For example, when they fail to do good performance, they often say, as a retrospective remark, that they felt their body stiffened; that they could not smoothly shift their weight from one foot to the other, etc. Therefore, it is important in the psychological consultations to grasp their troubles as not only their performance-problems but also internal problems even if they only mention the former. **Methods** This study considered the oral records of conversations in the personal psychological consultations with 2 college athletes. From the records of psychological consultations, this study identified troubles in physical movements; attitudes to sport and characteristics of the Landscape Montage Technique (LMT). The aim of the creation of LMT was to identify the internal tasks that they hold. **Results** Case A (male) had troubles in motor coordination. A said about attitudes toward everyday training that he played sports without any specific purposes. The LMT of A was a picture without the connection between items. Case B (female) felt uneasiness in her physical movement. B said about attitude toward everyday training that she was doing the training just in an uninterdependent-minded fashion. The LMT of B didn't have a sense of perspective, and was characterized by a vague road. **Discussion** The result of this study indicated that there were similarities between the troubles in physical movements and the internal tasks. The unnatural characteristics of LMT were considered as symbol of unstable identity of athletes. Such unstable identity made their physical movement unnatural.

**14:00 - 15:00****Mini-Orals****MO-PM22 Diet & Glucose****METABOLIC FLEXIBILITY AND ULTRA-ENDURANCE PERFORMANCE**

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**Introduction** Metabolic flexibility describes the ability of a cell or tissue to easily and quickly alter the flux through specific biochemical pathways according to energetic demand and substrate availability. The antithesis, 'metabolic inflexibility' is predominantly used in reference to diseased states associated with metabolic syndrome (Storlien, Oakes, & Kelley, 2004). Metabolic flexibility of skeletal muscle is ideal for an endurance athlete enabling both optimal fat and/or carbohydrate (CHO) oxidation when required. A long term CHO-restricted training diet increases  $\beta$ -oxidation whilst maintaining the potential for glucose metabolism. This study was designed to introduce metabolic flexibility in an exercise context and provide a best case scenario for the application of CHO-restriction to endurance exercise performance. **Methods** Eight highly trained male endurance athletes ( $\text{VO}_{2\text{max}}$   $67.0 \pm 10.4$  ml/kg/min) ate a moderate CHO ( $>5$  g CHO/kg/day) or low CHO ( $<2$  g CHO/kg/day) diet for 4 weeks in a randomised cross-over design. Performance was measured using a self-paced time trial to complete a fixed workload equivalent to 5 hrs at 55%  $\text{VO}_{2\text{peak}}$ . Separately, physiological and psychological measures were collected before, during and after a 2 hr fixed intensity ride at a workload calculated to elicit 60% $\text{VO}_{2\text{peak}}$ , including heart rate (HR), weight, body fat % (BF%),  $\text{VO}_2$ , respiratory exchange ratio (RER), venous blood sample, Rating of Perceived Exertion (RPE) and profile of mood state (POMS). A carbohydrate load was allowed on both diets from the day before the performance TT. **Results** Performance did not differ between diets (4:13:48  $\pm$  28:09 vs 4:16:00  $\pm$  20:43 for moderate CHO and low CHO respectively  $p = 0.888$ ). Physiological measures during the 2 hr fixed intensity ride were unchanged with the exception of RER which was significantly lower in low CHO ( $0.88 \pm 0.04$  Vs  $0.81 \pm 0.07$   $p = 0.047$ ). POMS showed a significant difference in total mood disturbance (TMD) at 2 weeks but returned to baseline by the end. **Discussion** Despite the hypothesised shift in macronutrient fuels (CHO - FAT) between diets the lack of performance difference can be credited to the fundamental level of metabolic flexibility of the athletes. The athletes were able to alter their metabolism to match the physiological challenge presented for optimum performance independent of diet. An increased fat oxidation in the low CHO athletes merely decreased their need for exogenous carbohydrate. Future research into "low-carbohydrate endurance performance" should focus on dietary adaptation periods greater than 2 weeks and whether an increased metabolic flexibility is beneficial for multi-day events of varying intensity (E.g. Tour de France). Storlien, L., Oakes, N. D., & Kelley, D. E. (2004). Metabolic flexibility. *Proceedings of the Nutrition Society*, 63(02), 363-368.

**EFFECT OF DIETARY ACID LOAD ON ACID-BASE STATUS AND EXERCISE PERFORMANCE**

HIETAVALA, E.M.1, STOUT, J.R.2, SUOMINEN, H.1, PITKÄNEN, H.3, PUURTINEN, R.1, SELÄNNE, H.4, MERO, A.A.1

*University of Jyväskylä*

1: University of Jyväskylä (Jyväskylä, Finland), 2: University of Central Florida (Orlando, USA), 3: Honka Holding (Honkajoki, Finland), 4: LIKES Research Center (Jyväskylä, Finland) **Introduction** Diet composition influences acid-base status of the body (Adeva & Souto, 2011). PRAL (potential renal acid load) represents the renal net acid excretion caused by a foodstuff and it can be calculated according to a nutrient content (Remer & Manz, 1994). We studied if capillary pH and extracellular buffering capacity change after a low-PRAL (LP) and a high-PRAL diet (HP) and whether dietary acid load has an effect on performance during submaximal and maximal aerobic exercise. **Methods** Healthy, recreationally active women ( $n=18$ , age  $27.6 \pm 3.4$  years, BMI  $21.6 \pm 2.2$  kg/m<sup>2</sup>) and men ( $n=15$ ,  $29.1 \pm 2.7$  years,  $24.5 \pm 2.6$  kg/m<sup>2</sup>) followed a 7-day LP (PRAL  $-68 \pm 23$  mEq/d) and a 7-day HP ( $54 \pm 17$  mEq/d) in a randomized order. At the end of the diet periods the subjects performed a cycle ergometer test ( $3 \times 10$  min at 35%, 55%, 75%, and until exhaustion at 100% of maximal oxygen consumption). Capillary blood samples were collected for pH, bicarbonate ( $\text{HCO}_3^-$ ) and lactate after all workloads. Oxygen consumption ( $\text{VO}_2$ ), ventilation (VE), heart rate (HR) and respiratory exchange ratio (RER) were monitored during cycling. **Results** Capillary pH ( $P \leq 0.039$ ) and  $\text{HCO}_3^-$  ( $P \leq 0.011$ ) decreased during HP in women and men. In women, pH was higher at rest ( $P < 0.001$ ) and at 75% of  $\text{VO}_{2\text{max}}$  ( $P = 0.005$ ) and  $\text{HCO}_3^-$  was higher at rest ( $P < 0.001$ ) and at all submaximal stages ( $P \leq 0.016$ ) after LP compared to HP. In men, pH was higher at rest ( $P = 0.038$ ) and at 100% of  $\text{VO}_{2\text{max}}$  ( $P = 0.034$ ) and  $\text{HCO}_3^-$  was higher at rest ( $P = 0.011$ ) and at 55% of  $\text{VO}_{2\text{max}}$  ( $P = 0.035$ ) after LP compared to HP. In women, the maximal workload was 23% longer ( $P = 0.001$ ) and maximal  $\text{VO}_2$ , VE, HR, RER and lactate were higher ( $P \leq 0.029$ ) after LP compared to HP. **Discussion** High dietary acid load resulted in decreased capillary pH and extracellular buffering capacity at rest in both men and women. Especially in women, pH and buffering capacity were higher during submaximal cycling after low dietary acid load, which led to improved maximal aerobic performance compared to high dietary acid load. It seems that there was a greater reliance on anaerobic metabolism after the low-PRAL diet. This might be advantageous during high-intensity exercise but detrimental during prolonged exercise. More studies are also needed to find out why dietary acid load affected performance only in women. **References** Adeva MM, Souto G. (2011). Diet-induced metabolic acidosis. *Clin Nutr*, 30(4), 416–421. Remer T, Manz F. (1994). Estimation of the renal net acid excretion by adults consuming diets containing variable amounts of protein. *Am J Clin Nutr*, 59, 1356–1361.

**ACCURACY OF CONTINUOUS GLUCOSE MONITORING DURING CONTINUOUS AND INTERVAL EXERCISE IN INDIVIDUALS WITH TYPE 1 DIABETES**

MOSER, O.1,2,3,4, MADER, J.K.2, TSCHAKERT, G.1, MUELLER, A.1, GROESCHL, W.1, PIEBER, T.R.2, KOEHLER, G.2, MESSER-SCHMIDT, J.3, HOFMANN, P.1

1: KFUG (Graz, AT), 2: MUG (Graz, AT), 3: UP (Potsdam, GER), 4: UAS (Gleichenberg, AT)

**Introduction** Aerobic high-intensity interval exercise (HII) and moderate continuous exercise (CON) can be safely performed with short-acting insulin reduction strategies in patients with type 1 diabetes (T1D) (Moser et al., 2015). Additional to therapy adaptations, continuous glucose monitoring (CGM) systems may serve as a tool to reduce the risk of exercise-induced hypoglycemia (Yardley et al., 2013). The aim

of the present study was to investigate the CGM accuracy for different mean intensity- and total duration-matched CON and HIE in T1D. Methods 7 male individuals with T1D performed CON and HIE at 5% below (I) and above (II) the first lactate turn point (LTP1) and 5% below the second lactate turn point (LTP2) (III) on a cycle ergometer (Hofmann et al., 2010). Glucose concentration was measured in the capillary blood (BG) and via a CGM (Guardian®) REAL-Time CGM, Medtronic, USA) system within the subcutaneous abdominal tissue. Comparison of BG vs. CGM was performed by using multiple t-tests, Bland-Altman method and Pearson correlation. Additionally, data were analyzed with Clarke Error Grid analyses. Values in zones A and B were deemed clinically acceptable. Results No significant differences were found in comparison of BG and CGM over time ( $p>0.05$ ). In CON the following bias and levels of agreement for I, II and III were found: 0.85 (-3.44, 5.15), -0.45 (-3.95, 3.05), -0.31 (-8.83, 8.20) similar to HIE: 1.17 (-2.06, 4.40), 0.11 (-5.79, 6.01), 1.48 (-2.60, 5.57). Correlations between BG and CGM were found during CON ( $p<0.01$ ) for I:  $r=0.93$ , II:  $r=0.92$ , III:  $r=0.96$  and HIE ( $p<0.01$ ) for I:  $r=0.74$ , II:  $r=0.99$ , III:  $r=0.91$ . During CON for intensity I, 96% of values were in zones A and B (52% and 44%), for II 100% (79% and 21%) and for III 78% (30% and 48%). During HIE, zones A and B were reached for intensity I by 100% (63% and 37%), for II by 93% (48% and 45%) and for III by 93% (55% and 38%). Discussion CGM values estimated BG with acceptable accuracy. Even so, in comparison of both exercise types, CGM was clinically accurate except during CON at III. Using CGM along with therapy adaption may be a practical tool to avoid exercise-induced hypoglycemia in patients with T1D. References Moser O, Tschakert G, Mueller A, Groeschl W, Pieber TR, Obermayer-Pietsch B, Koehler G, Hofmann P (2015). PLoS ONE, 10(8), e0136489. doi:10.1371/journal.pone.0136489. Yardley JE, Sigal RJ, Kenny GP, Riddell MC, Lovblom LE, Perkins BA (2013). Diabetes Technol Ther, 15(1), doi: 10.1089/dia.2012.0182. Hofmann P, Tschakert G (2010). Cardiol Res Prac, Article ID 209302, 10 pages. doi: 10.4061/2011/209302. Contact {peter.hofmann@uni-graz.at}

### INHIBITION OF GLYCOLYSIS AS A TOOL TO ENHANCE PERFORMANCE? - EFFECTS OF LEG-INDUCED HIGH BLOOD LACTATE ON SUBSEQUENT DYNAMIC AND STATIC ANAEROBIC UPPER BODY EXERCISE

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Objectives Studies have shown that high intensity exercise has an effect on subsequent lower body exercise by inhibiting glycolysis and enforcing a higher oxidative metabolism (1,2). The aim of this study was to examine the effect of a high blood lactate concentration induced by high intensity leg exercise on subsequent dynamic pull ups and static hanging. Methods Nine trained sport students (age:  $25.1 \pm 1.9$  yr; BMI:  $21.7 \pm 1.4$  kgm<sup>-2</sup>) participated in the dynamic (d) and static (s) trial, with (26.6  $\pm$  2 sec all out shuttle run) and without pre load (PRE) on four different days. Pull ups and static hanging (90° elbow flexion) were performed in randomized order on a horizontal bar with legs placed on a box. Each testing was preceded by a 15 min standardized warm up. Time between warm up and testing was 14 min. During testing heart rate (HR) and gas exchange data (VO<sub>2</sub>, VCO<sub>2</sub>, VE) were monitored and lactate levels (La) were measured at specific time points. Results Anaerobic exercise without PRE increased La from  $1.24 \pm 0.4$  to  $6.4 \pm 1.39$  (d) and  $1.12 \pm 0.4$  to  $5.11 \pm 1.13$  mmol/l (s). In PRE La increased from  $9.28 \pm 1.98$  to  $10.89 \pm 2.13$  (d) and  $9.04 \pm 1.69$  to  $9.83 \pm 1.39$  mmol/l (s). Net La accumulation was sign. reduced in PRE conditions by 75.5% (d) and 80% (s). Performance increased sign. by 1 rep (4%) in d and remained unchanged in s ( $106.7 \pm 36.5$  /  $106.2 \pm 31.14$  sec). A sign. increase in net VO<sub>2</sub> (d: 50%; s: 30%), VE (d: 34%; s: 36%) and VCO<sub>2</sub> (d: 26%) but was reduced by 30% in s. Net respiratory exchange ratio (RER) was significantly lower during work and recovery after PRE in dynamic and static testing. Conclusions A high blood La induced by anaerobic leg exercise, inhibits glycolysis and forces higher oxidative metabolism in subsequent anaerobic dynamic and static upper body exercise. A higher amount of oxidative metabolism during strength endurance exercise leads to a higher performance as can be seen in the dynamic version. This concept may be applied in sports such as sport climbing but has to be evaluated in more detail. References 1) Bogdanis, G. C., Nevill, M. E. & Lakomy, H. K. (1994). Effects of previous dynamic arm exercise on power output during repeated maximal sprint cycling. Journal of sports sciences, 12 (4), 363–370. 2) Müller, A., Tschakert, G., Moser, O., Gröschl, W. & Hofmann, P. (2015). High intensity exercise warm up, inhibition of glycolysis and its practical consequences. In Müller, E., Kröll, J., Lindiger, S., Pfusterschmied, J. & Stöggl, T. (Hrsg.): Science in Skying 6. Meyer & Meyer Sport, 2015, S. 224-230. Contact philipp.birnbaumer@edu.uni-graz.at; peter.hofmann@uni-graz.at

### GLUCOSE-FRUCTOSE BEVERAGES DO NOT ALTER THE EFFECTS OF TRAINING ON LACTATE METABOLISM

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Introduction It is generally accepted that lactate is produced by skeletal muscle during exercise, and is either used in adjacent muscle fibers (lactate shuttle) or recycled to glucose in the liver. We have shown that ingestion of fructose-containing drinks stimulates lactate production and release from the liver during exercise, and that fructose-derived lactate is subsequently used as an energy substrate by muscle. The regulation of this liver to muscle fructose-lactate shuttle remains unknown. In this study, we assessed whether consumption of fructose-containing beverages alters the effects of training on fructose and lactate metabolism. Methods Two groups of eight sedentary male subjects were endurance-trained for three weeks while ingesting 489 mL/h of either a 9.8%-glucose 6.2%-fructose beverage (GLUFRU) or water (C) during exercise training sessions. An incremental test to exhaustion and a metabolic test were performed before and after the interventions to assess training adaptations and substrate use during endurance-type exercise. Indirect calorimetry, [1-<sup>13</sup>C]lactate and [6,6-<sup>2</sup>H<sub>2</sub>]glucose were used to calculate plasma lactate appearance, clearance and oxidation and glucose kinetics. Results Anthropometrics and performance parameters were similar in both groups at baseline. Plasma glucose concentrations ( $+1 \pm 3$  vs.  $+3 \pm 3$  % vs. baseline values), glucose rate of appearance ( $+3 \pm 7$  vs.  $+2 \pm 3$  %) and metabolic clearance ( $+6 \pm 8$  vs.  $+1 \pm 5$  %) remained stable after both GLUFRU and C training (all  $p=n.s.$ ). Overall, lactate concentrations were decreased after intervention in both GLUFRU and C, but not differently between groups ( $-10 \pm 5$  vs.  $-20 \pm 4$  %;  $p<0.01$  vs. baseline,  $p=n.s.$  between GLUFRU and C), as a result of an increased lactate metabolic clearance ( $+26.5 \pm 11.4$  vs.  $+17.5 \pm 10.2$  mL·min<sup>-1</sup>;  $p=0.01$  vs. baseline,  $p=0.56$  between GLUFRU and C). Lactate appearance ( $+10 \pm 6$  vs.  $-4 \pm 9$  %) and oxidation ( $+9 \pm 6$  vs.  $-6 \pm 9$  %) remained unchanged across time and conditions (all  $p=n.s.$ ). Maximal oxygen consumption ( $+287 \pm 53$  vs.  $+249 \pm 104$  mL·min<sup>-1</sup>) and power eliciting lactate threshold ( $+25 \pm 5$  vs.  $+25 \pm 8$  W) were similarly increased in GLUFRU and C (both  $p<0.01$  vs. baseline,  $p=n.s.$  between GLUFRU and C). Discussion These data corroborate our earlier observation that fructose is converted into lactate by the liver and subsequently oxidized during exercise. Endurance training did not alter liver lactate release, but increased lactate metabolic clearance. The effects of endurance training were not differently altered by the consumption of fructose during training sessions, however. Contact Robin.Rosset@unil.ch

### EXERCISE TRAINING ATTENUATES AGE-INDUCED CHANGES IN MITOCHONDRIAL FUNCTION AND INSULIN RESISTANCE IN RAT SKELETAL MUSCLES

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**Introduction** Aging is characterized by a progressive loss of muscle mass and muscle strength called 'sarcopenia'. Age-related muscle atrophy is due to loss of muscle fibers associated with mitochondrial dysfunction. Accumulating evidence shows that impairment in skeletal muscle mitochondria with aging is thought to play a primary role in insulin resistance (Petersen et al., 2015; Toledo and Goodpaster, 2013). The development of insulin resistance, particularly in skeletal muscle, is closely associated with type II diabetes. The purpose of this study was to identify the role of exercise in age-induced sarcopenia, mitochondrial dysfunction, and insulin resistance in rat skeletal muscles. **Methods** Four and 20 month old Fischer-344 rats were randomly assigned to young sedentary (YS), young exercise (YE), old sedentary (OS), or old exercise (OE) groups (N=10 rats/group). Exercise training groups ran on a treadmill at 15 m/min (young) or 10 m/min (old), 45 min/day, 5 day/week for 8 weeks. The skeletal muscles such as soleus (SOL, Type I) and white gastrocnemius (WG, Type IIb) were permeabilized by sarponin for determination of mitochondrial respiratory capacity, Ca<sup>2+</sup> retention capacity, and mitochondrial H<sub>2</sub>O<sub>2</sub> emission. Oral glucose tolerance test (OGTT, 2 g glucose/kg) was performed to measure blood glucose levels. **Results** Exercise training attenuated age-induced decrease in only gastrocnemius (Type II) mass. Insulin resistance by oral glucose tolerance test was elevated in OS rats. However, exercise training preserved whole body insulin sensitivity in OE rats (P<0.05). The mitochondrial respiratory capacity and Ca<sup>2+</sup> retention capacity were decreased by aging and protected by exercise training in both SOL and WG (P<0.05). In addition, exercise attenuated age-induced mitochondrial H<sub>2</sub>O<sub>2</sub> emitting potential in both SOL and WG (P<0.05). **Discussion** These data demonstrate that regular exercise training prevents the impairment of mitochondrial function in skeletal muscles as well as sarcopenia induced by aging, supporting the concept that the exercise regulation of mitochondrial dysfunction with aging is a primary factor protecting against aging-induced sarcopenia and insulin resistance in skeletal muscle. **References** Petersen KF, Morino K, Alves TC, Kibbey RG, Dufour S, Sono S, Yoo PS, Cline GW, Shulman GI. (2015). *Proc Natl Acad Sci U S A*, 112(36):11330-4. Toledo FG, Goodpaster BH. (2013). *Mol Cell Endocrinol*, 379(1-2):30-4. (kwakhb@inha.ac.kr)

### PRE-EXERCISE INGESTION OF CARBOHYDRATE DOES NOT INDUCE HYPOGLYCEMIA DURING CYCLING EXERCISE IN JAPANESE MEN

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**Introduction** A number of studies have demonstrated that carbohydrate (CHO) ingestion 30 min before exercise induces hyperglycemia and hyperinsulinemia, which is followed by a rapid decrease in blood glucose and hypoglycemia early in exercise. However, these studies were mainly performed with Caucasian subjects, and it has never been investigated in Japanese subjects. Because Japanese individuals have lower insulin secretory capacity compared with Caucasian, CHO ingestion before cycling exercise may not induce hypoglycemia in them. Furthermore, it remains unknown whether a fasting status before ingestion of CHO influences on the occurrence of hypoglycemia during exercise. Therefore, the purpose of this study was to investigate whether CHO ingestion before cycling exercise induces hypoglycemia in Japanese men regardless of a fasting status. **Methods** Eight males (age 20.6±1.1 yr) completed four trials. After a 12-h overnight fast (12h) or 3-h fast (3h), subjects ingested either 150 g of glucose in 500 mL of water (Glu), or 500 mL of placebo (Pla), 30 min before exercise. The exercise trial consisted of 60 min of submaximal cycling exercise at 75% VO<sub>2</sub>max, immediately followed by a performance trial at 90% VO<sub>2</sub>max until exhaustion. Blood samples were obtained at 30 min before exercise (before drinking Glu/Pla), at the start of exercise, 15, 30, and 60 min during exercise and after a performance trial for determination of plasma glucose, serum insulin levels. We considered blood glucose levels below 60mg/dL as hypoglycemia. **Results** At the start of exercise, the plasma glucose and serum insulin were significantly higher in the 12h+Glu and 3h+Glu trials compared with 12h+Pla and 3h+Pla trials (glucose, 122±17, 124±27 vs. 79±11, 79±8 mg/dL, p<0.05; insulin, 38.4±12, 39.0±11 vs. 5.1±5, 4.4±9 μU/mL, p<0.05). Although the plasma glucose and serum insulin rapidly decreased at 15min of exercise compared with the start of exercise in the 12h+Glu and 3h+Glu trials, the plasma glucose remained above 60 mg/dL (82±12 and 69±15 mg/dL). In the performance trial, there were no differences in the exercise times to exhaustion between the four trials. **Discussion** The present study suggests that CHO ingestion before cycling exercise does not induce hypoglycemia in Japanese men regardless of fasting status. The previous study reported that Japanese men had lower insulin secretory capacity than US white men (Vasudha A, 2015). Thus, hypoglycemia might not occur during cycling exercise in Japanese men due to the differences in insulin secretory capacity by ethnicity. **References** Vasudha Ahuja et al. (2015). *Diabetologia* 58:265-271.

### EFFICACY OF INGESTION OF A NOVEL INSULINOTROPIC PROTEIN HYDROLYSATE COMBINED WITH CARBOHYDRATE ON RECOVERY OF SKELETAL MUSCLE GLYCOGEN AND SUBSEQUENT ENDURANCE EXERCISE CAPACITY

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**Introduction** Supplementing sub-optimal carbohydrate (CHO) refuelling strategies with either intact, or hydrolysed protein sources may compensate for inadequate CHO intake, and in certain conditions, augment glycogen resynthesis following short-term recovery (≤6hours). Addition of an insulinotropic protein source may also positively influence protein turnover following prolonged endurance exercise and facilitate recovery. **Methods** The effect of CHO, or CHO supplemented with either casein (CHO-C) or an insulinotropic casein hydrolysate (CHO-H) on recovery of skeletal muscle glycogen and markers of protein synthesis following prolonged endurance exercise were determined in trained male cyclists (n=11, mean±SEM age 28.8±2.3y; body mass (BM) 75.0±2.3 kg; VO<sub>2</sub>peak 61.3±1.6mL.kg<sup>-1</sup>.min<sup>-1</sup>). Participants cycled for 2h at 70% VO<sub>2</sub>peak followed by a 4h recovery period. Following endurance exercise, participants consumed an isoenergetic drink at +0h and +2h of recovery containing (i) CHO (1.2g.kg<sup>-1</sup> BM), (ii) CHO-C or (iii) CHO-H (1.04 and 0.16g.kg<sup>-1</sup>BM respectively). Trials were conducted in random order in a double-blind manner. Following recovery, participants then completed a timed cycle to exhaustion at 70% VO<sub>2</sub>peak. Muscle biopsies from the vastus lateralis were taken prior to commencing each trial, and at +0h and +4h of recovery for determination of skeletal muscle glycogen, and intracellular markers of insulin signalling and protein synthesis. Serum and plasma samples were collected every 30 min. **Results** Despite an elevated peak in insulin following CHO-H ingestion, there was no significant difference in skeletal muscle glycogen resynthesis at +4hr between any trial (p=0.256). Paradoxically, an elevated insulin response in CHO-H coincided with higher plasma glucose throughout the same time period. There was no significant difference for timed cycle to exhaustion between trials (71.0±7.9, 63.9±6.3 and 63.2±5.1mins for CHO, CHO-C and CHO-H respectively) (p=0.652). **Discussion**



Glycogen resynthesis during recovery from intense exercise after ingestion of sub-optimal CHO ingestion combined with an insulinotropic protein hydrolysate, is not improved by the augmented insulin response. Furthermore, elevated insulin secretion may paradoxically increase plasma glucose concentrations during recovery. Work is currently on-going to elucidate any potential differential regulation of intramuscular insulin signalling and protein synthesis in responses to the various recovery drinks. karl.cogan@ucdconnect.ie This study was supported by funding from Food for Health Ireland

### THE EFFECTS OF 3 WEEKS OF UPHILL AND DOWNHILL WALKING ON LIPIDS AND GLUCOSE METABOLISM IN PRE-DIABETIC MEN

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**Introduction** It is still a matter of debate whether lipids and glucose metabolism are differently affected by regular concentric (e.g. uphill walking) and eccentric (e.g. downhill walking) endurance exercise (Drexel et al., 2008, Marcus et al., 2009). The aim of this study was to investigate in a real world setting the effects of 3 weeks of uphill and downhill walking on lipids and glucose metabolism in pre-diabetic men. **Methods** 16 pre-diabetic men (age: 56.9±5.1 years; BMI: 28.1±2.3 kg/m<sup>2</sup>) performed 9 supervised and monitored uphill (N=8) or downhill (N=8) walking sessions within 3 weeks. Markers of the glucose metabolism and blood lipids were measured before and after the training period. **Results** After uphill walking (pretest vs. posttest) glucose tolerance (area under the curve: 322.7±69.5 vs. 279.5±47.8 mg/dl; P=0.05; ES:large), triglycerides (165.8±90.8 vs. 117.0±45.3 mg/dl; P=0.036; ES:large), HDL-C (45.4±6.2 vs. 53.2±10.8 mg/dl; P=0.05; ES:large) and total cholesterol/HDL-C ratio (4.6±0.8 vs. 4.0±0.8; P=0.012; ES:large) improved significantly. No significant metabolic adaptations were measured after downhill walking. When adjusted for energy expenditure uphill and downhill walking had equal effects on all metabolic parameters. The magnitude of the baseline impairments of the glucose tolerance correlated significantly with the extent of change in the uphill walking group (R=-0.728; P=0.041) and in the downhill walking group (R=-0.730; P=0.040). **Discussion** Our findings do not confirm prior results that downhill walking is equally effective in improving glucose tolerance when compared to uphill walking (Drexel et al., 2008). In contrast to downhill walking 3 weeks of uphill walking effectively improved glucose tolerance and most of the measured lipid markers in pre-diabetic men. However, when considering the related energy expenditure both types of walking seem to have equal effects. Moreover persons with more pronounced impairments of the glucose metabolism benefited from both training regimens. **Literature** Drexel H, Saely CH, Langer P, Loruenser G, Marte T, Risch L, Hoeffle G, Aczel S (2008). Metabolic and anti-inflammatory benefits of eccentric endurance exercise - a pilot study. *Eur. J Clin Invest*, 38, 218-226. Marcus RL, LaStayo PC, Dibble LE, Hill L, McClain DA (2009). Increased Strength and Physical Performance with Eccentric Training in Women with Impaired Glucose Tolerance: A Pilot Study. *Journal of Women's Health*, 18, 253-260. Contact Marc.philippe@student.uibk.ac.at

### THE EFFECT OF CHIOS MASTIC GUM EXTRACT AS A FACTOR RELATED TO LIPID METABOLISM, GLUCOSE METABOLISM AND BODY COMPOSITION

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**Introduction** "Chios mastic gum (Chios mastiha)" is the air-dried, resinous exudation of the mastic tree. Its scientific name is known as *Pistacia lentiscus* var. *Chia*, and originates from the Island of Chios in Greece. It is a famous pharmaceutical plant being the first natural chewing gum since the Hippiocratic period in ancient Greece. There are many studies that have found therapeutic effects of *Pistacia lentiscus* var on various ailments and Diseases (Petersen et al., 2011). This study aims at exploring ways in introducing Chios mastic gum to Japan with focus on its therapeutic effect on lipid metabolism, glucose metabolism and body composition. **Methods** We studied the results of our experiment on 12 healthy Japanese male of over 40 years old. Group-C (n=6) received placebo powder 5g/day. Group-M (n=6) received Chios mastic powder 5g/day. The period of the experiment lasted six months for both groups. We carried out the following blood test and physical measurement three times: 1. before starting the experiment, 2. 3 months after having started the experiment and 3. 6 months after having started the experiment. **Blood test:** Items concerning lipid metabolism consists of total cholesterol, LDL-cholesterol, HDL-cholesterol, triglycerides and L-CAT. Items concerning hepatic function consists of SGOT, SGPT and gamma-GTP. **Group of Glucose Metabolism** consists of insulin and glucose. We measured body composition including BMI, waist circumference, percentage of body fat and muscle mass. **Results** Comparing the differences between the two Groups, we have found that : The 2nd and 3rd blood test compared to the 1st, there was not significant difference about total cholesterol, HDL-cholesterol, triglycerides, L-CAT, SGOT, SGPT, gamma-GTP and glucose. However, Group-M exhibited significant reduction of LDL-cholesterol and insulin in the 3rd blood-test comparing it with the 1st : LDL (p<0.05) , insulin(p<0.08). Both groups indicated no significant difference on Body Composition in 2nd and 3rd measurement comparing them with the 1st. **Conclusion** This study suggests that Chios mastic gum extract has a potential to decrease LDL-cholesterol and insulin. And this study will also propose culinary ways of Chios mastic gum so that it will be introduced into Japanese society as an appropriate food for Japanese people. **References** Petersen R.K, Christensen K.B, Assimopoulou A.N, Fretté X, Papageorgiou V.P, Kristiansen K, Kouskoumvekaki I. (2011). *Journal of Computer-Aided Molecular*, 25(2), 107-116. Contact Fukazawa, T. demeter@toki.waseda.jp Do not insert authors here

## Mini-Orals

### MO-PM31 Nutrition & Performance

#### DOES CHRONIC USE OF CAFFEINE REDUCE ITS ACUTE ERGOGENIC EFFECTS DURING HIGH INTENSITY INTERVAL TRAINING?

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**DOES CHRONIC USE OF CAFFEINE REDUCE ITS ACUTE ERGOGENIC EFFECTS DURING HIGH INTENSITY INTERVAL TRAINING?** Based on extensive research showing positive effects on performance (Spriet, 2014), many athletes use caffeine before and during competitions (Coso et

al, 2011). However, the use of caffeine during training is not well understood. Therefore, the first aim of this study was to test the hypothesis that caffeine acutely increases power output, heart rate (HR), and blood lactate during high intensity interval training (HIIT). The second aim was to test the hypothesis that chronic use of caffeine reduce its hypothesised acute ergogenic effects during HIIT (tolerance). Methods Twenty recreational male endurance athletes (age  $33 \pm 9$  years;  $VO_{2max}$   $55.3 \pm 8.9$  ml/kg/min) took part in the study. Each participant completed 7 test visits in the laboratory. During the first was an incremental test, and familiarized. A second familiarization occurred during visit 2. During visit 3 and 4, the acute ergogenic effects of caffeine (3 mg.kg<sup>-1</sup> body weight) ingested 1 hour before HIIT were assessed using a placebo-controlled. HIIT consisted of 4 bouts (RPE 16, 17, 18, and 19) of 4 min each. Participants were randomly allocated to two groups. One group took caffeine 3 times a week 1 hour before 3 of their regular training sessions. The other group took placebo (Dextrose). After 4 weeks of such chronic supplementation, all participants performed a follow-up assessment of  $VO_{2max}$  (visit 5) and the acute effects of caffeine (visits 6 and 7). Relevant main effects and interactions on  $VO_{2max}$  and power output/HR/blood lactate during HIIT were analysed by mixed analyses of variance (ANOVA). Results No significant changes in  $VO_{2max}$  were observed in either groups after 4 weeks of training. As hypothesised, caffeine acutely increased power output, HR and blood lactate during HIIT at both the baseline and follow-up assessments. There were no significant interactions and main effects of time suggesting the development of tolerance to these acute ergogenic effects of caffeine during HIIT after 4 weeks of chronic supplementation. Discussion Caffeine ingestion one hour prior to HIIT acutely increases power output, HR and blood lactate for the same RPE. Frequent use of caffeine before training (3 times a week for 4 weeks) does not reduce these acute ergogenic effects of caffeine during HIIT. This observation argues against the development of tolerance and suggests that pre-training caffeine ingestion is a useful strategy to increase training intensity. Whether this increase in training intensity leads to greater gains in performance needs to be investigated in future studies with more controlled training programs and longer follow up periods. Reference Coso, J.D., Munoz-Guerra, J (2011). *Appl Physiol Nutr Metab*, 36: 555–561. Spriet, L.L. (2014). *Sports medicine*, 1,44(2):175-84. Hawbeer\_980@hotmail.com

## EFFECTS OF CAFFEINE ON CENTRAL AND PERIPHERAL FATIGUE DURING ANAEROBIC EXERCISE PERFORMANCE – A SYSTEMATIC REVIEW

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Introduction: It has been shown that caffeine ingestion delays fatigue and it seems to be ergogenic during high-intensity exercise. Caffeine may attenuate the loss of force-generating capacity induced by anaerobic exercise, but its mechanisms of action at the various levels of the motor pathway are not fully understood yet. The aim of this review was to systematically evaluate the existing literature about the effects of caffeine on central and peripheral fatigue during anaerobic exercise performance. Methods: Studies were identified by searching from the earliest record until February 2016 (week 1) using the MEDLINE (Ovid), PubMed and Web of Science. The search terms used were “caffeine” and “central fatigue” or “peripheral fatigue” or “muscle fatigue”. Randomized controlled trials published in peer-reviewed journals were considered for inclusion. Intake of caffeine and a measure of central and/or peripheral fatigue during anaerobic exercise were required in each study. Results and discussion: Nine studies with a total of 103 participants were included. Electromyographic (EMG) activity from 7 studies showed no effect of caffeine on muscle activation variables during submaximal isometric contractions and in anaerobic cycling exercise. Two of these studies also used intramuscular EMG and found no differences on firing rates between conditions. Only one study (Plaskett & Cafarelli, 2001) found a significantly higher EMG activity in the caffeine condition at the end of the protocol, possibly due to an improved motor unit synchronization. Effects of caffeine on the enhancement of calcium mobilization is still controversial. Fredholm et al (1999) showed that the doses required to achieve this effect would be toxic to humans. Nevertheless, one study showed an attenuated decrease of the twitch amplitude (Meyers & Cafarelli, 2005) and another one an offset of the decline in low-frequency tetanic force (Tarnopolsky and Cupido, 2000) and, therefore, this hypothesis should not be dismissed. Caffeine's effects on central excitability are clear, potentiating motor evoked potentials before task failure. This effect has been convincingly attributed to the mechanisms of adenosine receptor antagonism. However, it seems that this central effect is not associated with enhanced maximal voluntary activation (Kalmar and Cafarelli, 2004; Kalmar and Cafarelli, 2006), demonstrating that voluntary activation is not limited by central excitability. References: Plaskett, C. J., & Cafarelli, E. (2001). *JAP*; Fredholm, B., Bättig, K., & Holmén, J. (1999). *Pharmrev*; Meyers, B., & Cafarelli, E. (2005). *JAP*; Tarnopolsky, M., & Cupido, C. (2000). *JAP*; Kalmar, J., & Cafarelli, E. (2004). *JNeuroscienceM*; Kalmar, J. M., & Cafarelli, E. (2006). *JAP* rnomesquita@hotmail.com

## THE EFFECTS OF CAFFEINE ON PHYSIOLOGICAL AND METABOLIC RESPONSES AND ON EXERCISE PERFORMANCE DURING A SIMULATED TREADMILL SOCCER-GAME PROTOCOL

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Introduction In several previous studies, the effects of caffeine ingestion on exercise performance, blood metabolites and physiological responses were equivocal, possibly due to different experimental protocols and caffeine dosage employed. However, no studies have examined the influence of caffeine on physiological and metabolic responses and on performance in exercise simulating a soccer game in a well-controlled laboratory environment. Therefore, the aim of the present study was to examine the effects of caffeine ingestion on metabolic and physiological responses and on exercise performance during a protocol simulating a soccer game on treadmill in well-trained soccer players. Methods Twenty well-trained male soccer-players (age,  $22 \pm 4$ ; weight,  $74.2 \pm 7.7$  kg; height,  $1.80 \pm 0.05$  m, body fat,  $11.5 \pm 3.7$  %,  $VO_{2max}$ ,  $60.8 \pm 4.3$  ml/min/kg) underwent two experimental trials after ingestion of either 6 mg/kg caffeine or placebo, in a controlled laboratory environment, using a simulated soccer game protocol on treadmill. Plasma glucose, lactate, free fatty acids (FFA), glycerol and epinephrine concentrations, heart rate (HR), countermovement jumps (CMJ), reaction time, rating of perceived exertion (RPE), arterial blood pressure (BP) and soccer-specific time to fatigue were evaluated. Results Plasma glucose, lactate, FFA, glycerol and epinephrine concentrations, HR, CMJ, BP and time to fatigue were significantly higher, while RPE was significantly lower with caffeine compared with placebo ( $p < 0.05$ ). Reaction time did not differ between the trials ( $p > 0.05$ ). Discussion Caffeine was found to enhance CMJ and soccer-specific time to fatigue; increase the concentration of blood metabolites, HR and BP; and reduce RPE during a simulated soccer-specific treadmill protocol. These results may suggest that there is a direct stimulant action of caffeine on metabolic and physiological responses and/or on central and peripheral (e.g., neuromuscular junction) nervous system contributing to improving high-intensity endurance performance and muscle explosiveness, respectively.

## INFLUENCE OF CAFFEIN ON MUSCLE FORCE: PERCEPTION OF SIDE EFFECTS

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**Introduction** The placebo effect plays an important role whenever the effect of an intervention is investigated. When measuring the muscle force, the result depends crucially on the perception of the subject (Beedie et al. 2006). To avoid such effects, normally a double blind study is chosen so that neither the subject nor the investigator knows whether the placebo or the verum was applied. If the verum has side effects, the administration of active placebos, i.e., placebos with similar side effects is suggested (Thomson 1982; Pollo et al. 2011). When investigating the effects of drinking coffee on the muscle force, the subjects could get some information about being in the placebo or the verum group by the well-known side effects such as increased heart rate or increased urge to urinate. We investigated the expectancy of the subjects before and after the force measurement. **Method** The isometric force of 17 male subjects ( $26.7 \pm 4.8$  yrs,  $1.8 \pm 0.1$  m,  $76.1 \pm 6.6$  kg) was measured in a double-blind, crossover, randomized study under the influence of caffeine containing coffee (CAF) and decaffeinated coffee (DECAF). Before and after the measurements, the subjects were asked if they think they were in the placebo or the verum group. Results 5 out of 17 subjects (29.4 %) guessed both the CAF and the DECAF group correctly before the force measurements and 8 of 17 (47.1 %) after the measurements. In 22 of 34 trials (64.7 %) the placebo group was chosen. Compared to a percentage of 50 % this was a significant difference. The subjects who decided correctly did not show a significant increase in muscle force. **Discussion** The percentage of correct answers did not differ significantly from the 50% level when there is no information about the group membership. However, assuming that the knowledge of some side effects should increase this level to at least 55% would lead to a significant difference between the reported perception and this level. That suggests that in studies investigating the influence of drinking coffee the knowledge of side effects does not play a role. A conditioning effect that evokes side effects just by drinking inert placebo liquid would lead to wrong perceptions of having got CAF instead of DECAF. The observed tendency to DECAF could be due to the lack of perceived side effects and the general feeling of being deceived in the study. **References** Beedie, C. J., Stuart, E. M., Coleman, D. A. & Foad, A. J. 2006 Placebo effect of caffeine in cycling performance. *Med. Sci. Sports Exerc.* 38, 2159–2164. Pollo, A., Carlino, E. & Benedetti, F. (2011), Placebo mechanisms across different conditions: from the clinical setting to physical performance. *Phil. Trans. R. Soc. B* 366, 1790–1798. Thomson, R. (1982), Side effects and placebo amplification. *Br. J. Psychiatry*, 140:64–68.

## DOES CAFFEINE CONTAINING COFFEE CHANGE THE SHAPE OF THE FORCE-VELOCITY RELATION IN THE MUSCLE?

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**DOES CAFFEINE CONTAINING COFFEE CHANGE THE SHAPE OF THE FORCE-VELOCITY RELATION IN THE MUSCLE?** Institute of Sports Science, University of Graz, Austria **Introduction** The beneficial effects of caffeine on endurance for long-time muscle activation have already been stated (Warren et al., 2010). For short-time activation, however, the knowledge is comparatively rare. Therefore, the purpose of our study was to investigate the shape of the force-velocity relation (FV) of the muscle in short-time movements after administering caffeine containing coffee. **Methods** In a double-blind, crossover, randomized, counterbalanced study design, 17 male subjects ( $26.71 \pm 4.79$  yr,  $1.80 \pm 0.07$  m,  $76.09 \pm 6.57$  kg) performed several leg extension movements on an inclined leg press with maximum voluntary contraction. The trials were conducted with preceding administration of caffeine containing coffee (CAF) ( $4.83 \pm 0.17$  mg/kg body weight) and decaffeinated coffee (DECAF). 60 minutes prior to exercise each subject got CAF or DECAF. Subsequently, they performed dynamic leg extension movements with different loads and isometric movements with fixed skid ( $120^\circ$  angle) of the leg press. In accordance with the washout phase, 1 week, the subjects ingested the opposite substance and passed the test protocol a second time. By using nonlinear parameter identification, Hill's constants (a, b, c) - for getting FV of the muscle - were determined from a model of the movements (Siebert et al., 2007). A paired t-test was used to calculate the p-value. Results In the CAF compared to the DECAF conditions a significant change ( $p = 0.04$ ) in the curvature of the FV curves and in Hill's constant b ( $p = 0.04$ ) could be observed. The maximum isometric force in the muscle ( $p = 0.06$ ), the maximum power output ( $p = 0.42$ ), the maximum velocity ( $p = 0.44$ ) and the maximum isometric force measured outside of the muscle ( $p = 0.07$ ) didn't show a significant increase or decrease. However, all subjects which were  $\leq 25$  yr ( $23.0 \pm 2.12$  yr) ( $n = 9$ ), had a significant increase of the maximum isometric force in the muscle ( $p = 0.02$ ). The daily mean caffeine intake of these subjects was reported to be 0.7 cups/day, half as much as the older ones ( $n = 8$ ) ( $30.88 \pm 2.93$  yr) drank (1.4 cups/day). **Discussion** The measurements show that administering caffeine containing coffee leads to an increase of the curvature of the force-velocity relation in the muscle. This curvature is related to the efficiency, comparing the consumed chemical energy to the mechanical energy output. There is a disparity in the response of the muscle after caffeine intake of more and less habituated coffee drinker. The effect of expectancy when drinking coffee is published in another abstract. **References** Siebert T, Sust M, Thaller S, Tilp M, Wagner H (2007). *Hum Mov Sci*, 26, 320–341. Warren G, Park N, Maresca R, McKibans K, Millard-Stafford M (2010). *Med Sci Sports Exerc*, 42(7), 1375–1387. Contact philip.hoeher@edu.uni-graz.at

## THE VALUE OF AN ACUTE DOSE OF ROOIBOS IN HEALTHY MALES: AN EXERCISE-INDUCED OXIDATIVE STRESS SCENARIO

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**Introduction** The unique South African herbal tea, rooibos was previously shown to modulate the redox status in humans (Marnewick et al., 2011). The current study aimed to profile a number of oxidative stress biomarkers, as well as exercise performance indicators after two exercise regimes to assess the efficacy of an acute dose of rooibos in altering these biomarkers. **Methods** Forty healthy adult male volunteers were randomised in a single blinded, cross-over placebo controlled study. They consumed a standardised breakfast snack and three capsules of a rooibos extract or placebo before undergoing a muscular isokinetic strength and cardiovascular endurance fatiguing trial. Muscle fatigue was induced using elbow extension/flexion test on the Biodex (15 repeats, 5 sets) while the cardiovascular endurance stress was induced via the multistage treadmill exercise test (Bruce protocol). Blood samples were taken at 5 time points during these regimes. Participants recorded 3 non-consecutive day food records before each intervention. None were taking any dietary supplements. Results Isokinetic strength significantly increased as represented by the total work ( $P=0.019$ ), average power ( $P=0.021$ ) and average peak torque ( $P=0.01$ ) during the 2nd extension when comparing rooibos with placebo. No significant differences were shown for the other repetitions. The multistage maximal exercise test showed no significant differences in exercise time to exhaustion or maximum heart rate at termination between the rooibos and placebo. When considering the blood oxidative stress biomarkers, rooibos significantly

decreased the levels of conjugated dienes at all 5 time points when comparing with the placebo. Rooibos also significantly enhanced ( $P<0.05$ ) the antioxidant capacity (ORAC) (4-5%) at these 5 time points. Discussion Results show an acute dose of rooibos to be protective against exercise-induced oxidative stress, by minimising the oxidative damage to that of baseline levels possibly due to an enhanced defence system. Although rooibos provided some cellular protection, it is unclear if it is related to the improved exercise markers, as previous studies reported modifications in blood oxidative stress did not consistently correspond with exercise-induced indicators of endurance and strength (Pereira-Panza et al., 2015; Goldfarb et al., 2011). Critical analysis is needed. References Goldfarb AH, Garten RS, Cho C, Chee PD, Chambers LA. (2011). *Med Sci Sport Exerc*, 43, 501-508. Marnewick JL, Rautenbach F, Venter I, Neethling H, Blackhurst DM, Wolmarans P, Macharia M. (2011). *J Ethnopharmacol*, 133, 46-52. Pereira-Panza VS, Diefenthaler F, Da Silva EL. (2015). *Nutrition*, 31, 1072-1082. Contact marnewick@cput.ac.za

## QUANTIFICATION OF NUTRITIONAL INTAKE DURING A CONGESTED FIXTURE PERIOD IN PLAYERS FROM THE ENGLISH PREMIER LEAGUE

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1: Liverpool Football Club (Liverpool, UK), 2: LJMU (Liverpool, UK) Introduction Muscle glycogen is the primary energy source during soccer match play (Krustrup et al. 2006). In times of fixture congestion (i.e. consecutive matches every 2-3 days), it has therefore been suggested that soccer players consume high daily carbohydrate (CHO) intake ( $>6$  g/kg) in an attempt to promote muscle glycogen re-synthesis and match day physical performance (Anderson et al. 2015). The aim of this study was to therefore quantify daily energy intake and macronutrient composition in English Premier League (EPL) soccer players undergoing a period of fixture congestion. Methods Six professional EPL (from one team) soccer players (mean  $\pm$  SD; age:  $27 \pm 3$  years, body mass:  $80.5 \pm 8.7$  kg, height:  $180 \pm 7$  cm, body fat:  $11.9 \pm 1.2\%$ , lean body mass, LBM:  $65.0 \pm 6.7$  kg) completed daily food diaries alongside the remote food photographic method (RFPM) over a 7-day period consisting of 2 competitive games (Day 2 and 5) and 5 training sessions (Day 1, 3, 4, 6 and 7). Data were analysed for total daily energy, CHO, protein and fat intake using dietary analysis software (Nutritics Ltd, Ireland). Results Energy intake was greater on ( $P<0.05$ ) match days (MD) ( $3789 \pm 577$  kcal and  $61.1 \pm 12.5$  kcal/kg LBM) compared with training days (TD) ( $2948 \pm 686$  kcal and  $45.2 \pm 12.2$  kcal/kg LBM, respectively). Similarly, CHO intake was also greater ( $P<0.05$ ) on MD ( $6.4 \pm 2.2$  g/kg) compared with TD ( $4.2 \pm 1.6$  g/kg). In contrast, neither protein ( $2.7 \pm 0.4$  g/kg v  $2.5 \pm 0.7$  g/kg) nor fat intake ( $1.5 \pm 0.6$  g/kg v  $1.2 \pm 0.2$  g/kg) was different between MD and TD, respectively. CHO intake during matches ( $35.8 \pm 21.5$  g/min) was also different ( $P<0.05$ ) from that consumed during training sessions ( $5.5 \pm 10.3$  g/min). Discussion In accordance with current sports nutrition guidelines (Burke et al. 2011), we conclude elite soccer players consume apparently adequate energy and CHO intake for the typical loads observed on MD versus TD. However, on the basis of a congested fixture period (i.e. 2 days between games), we suggest players should consume higher daily energy and CHO intakes (similar to those reported on MD) on TD between matches so as to promote glycogen re-synthesis in recovery from match play and prepare for the subsequent game. References Anderson L et al. (2015). *J Sports Sci* 4: 1-10. Burke LM et al. (2011). *J Sports Sci* 29: 17-27. Gunnarsson T.P et al. (2013). *Scand J Med Sci Spor* 23: 508-515. Krustrup P et al. (2006). *Phys Fit Perf* 38: 1165-1174. Contact L.J.Anderson@2009.ljmu.ac.uk

## Mini-Orals

### MO-PM27 Ageing 2

## OBJECTIVELY MEASURED STRIDE LENGTH UNDER FREE-LIVING CONDITION ASSOCIATES WITH WHOLE BODY MUSCLE MASS IN OLDER ADULTS

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[BACKGROUND & OBJECTIVE] Although the walking related parameters, such as walking speed, the time spent in walking, the walking distance, positively associates with the health outcomes, a little is known about the significance of the stride length under free-living condition. Recently we have developed a novel approach for obtaining objective assessments of stride length during physical activity by an accelerometer under controlled condition. The purpose of the present investigation was to examine the relationship between the stride length under free-living condition and the whole body muscle mass in older adults. [METHODS] Forty adults, aged from 63 to 85, participated in the present investigation ( $71 \pm 5$  years of age,  $160 \pm 7$  cm of height,  $57 \pm 8$  kg of body weight, 19 women and 21 Men). All participants wore a pedometer with an accelerometer (Lifecorder-4sec, Kenz, Japan) for 7 days continuously under free-living condition. In 1-min interval, the walking distance and the number of steps was obtained; thereafter the minute-by-minute stride length was also calculated. In the present investigation, the stride length during moderate intensity physical activity (MVPA) was evaluated. The body composition including the lean body mass (LBM) and the muscle mass (MM) was estimated by the bio-impedance analyses. [RESULTS] In women, the time spent in MVPA at  $<70$  cm of the stride length was negatively associated with the LBM and MM ( $p<0.05$ ). Furthermore, the time spent in MVPA at  $>90$  cm of the stride length was positively associated with the LBM and MM ( $p<0.05$ ). In contrast, no significant relationship was obtained between the patterns of the stride length and the body composition in male participants. [DISCUSSION] The results of the present investigation demonstrated that the significant associations between the patterns of the stride length during free-living condition and the body composition in older women. Interestingly, the time spent in the MVPA at narrow stride length and wide stride length differently associated with LBM and MM. The wider stride length may be recommended to reduce the risk of the sarcopenia in older women. The relationship between the stride length under free-living condition with whole body muscle mass remain unclear in older men.



## DOES THE SENSORY PROFILE CORRELATE WITH DAILY ACTIVITY IN ADULTS AND OLD ADULTS

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**Introduction** The organization of sensory inputs is necessary to adapt to situations in daily life. Dunn's model of sensory processing explains behavioral responses to sensations and the relationship between neurological thresholds and behavioral responses. Regular physical activity such as walking is a common health promotion strategy, yet participation is insufficient. Many factors contribute to participation in physical activity. The relationship between sensory processing and physical activity capacity in adults has not been examined. **Methods** Ninety one participants (men 37) aged 45-80 years divided according to their ages: adult 45-59 years (n=48), and old age 60-80 years (n=43) participated. None of the participants lived alone and all were free of chronic diseases. Each participant filled in a sensory profile questionnaire (The Adolescent/Adult Sensory Profile (AASP)) and results were categorized as: Low Registration, Sensation Seeking, Sensory Sensitivity, and Sensation Avoiding. Participants wore a StepWatch 3 Activity Monitor (SAM; Cyma Corporation, Mountlake Terrace, WA) to collect data on ambulatory activity for 4 days. MANOVA with Bonferroni post hoc test examined the differences in activity level between age groups. Linear regression was performed to examine whether sensory processing abilities and age can predict physical activity. **Results** The adult group had a higher step count than the old age group ( $p < 0.01$ ), with less inactivity phases and more time spent doing activities with low and medium intensity. Participants who registered sensory input less efficiently, were more inactive than those who registered sensory input in an adequate manner (based on the AASP norms) ( $p < 0.01$ ). Inactivity time during the day was predicted by age (8%) ( $p = 0.006$ ), meaning that the old age group had greater inactivity. Low registration sensory profile added 4% to the prediction ( $p = 0.05$ ) indicating that people registering less sensory input had a greater tendency for inactivity. On the other hand, high activity levels were predicted by lower sensitivity (6%) ( $p = 0.016$ ). **Discussion** The present study provided evidence that in addition to age, the sensory profile plays a role in the intensity and amount of daily physical activity determined by step count and frequency. The sensory profile was found to be predictive of activity level and the relationship between sensory processing and behavioral management was revealed. This fact needs to be considered when physical activity programs are prescribed.

## MULTI-COMPONENT EXERCISE TRAINING IN ELDERLY DAY CARE CENTERS: A PILOT STUDY

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**Introduction** Evidence has shown that supervised exercise interventions offer benefit regarding both physical and cognitive health, particularly for frail community dwelling older people (Andy et al., 2015). On the other hand, multi-component exercise intervention composed by strength, endurance and balance training seems to be the best strategy to improve rate of falls in physically frail older adults (Cadore et al. 2013). However, the optimal program for each specific elder population remains unclear. In the present study, we analyzed the effect of a multi-component exercise program on elder people who attend a Day Care Center. **Methods** Participants were community dwelling elderly from Matia Day Care Center, which were randomized in two groups: Control and Experimental (a multi-component exercise session per week during 3 months). Inclusion criteria included: aged  $\geq 70$  years, scored  $\geq 50$  on the Barthel Index, scored  $\geq 20$  on MEC Test (an adapted version of MMSE in Spanish) who were all capable to walk independently for 10 m. Physical activity by accelerometry, and anthropometric and physical parameters were analysed before and after the programme. **Results** The average age  $\pm$  SD of participants was  $83.14 \pm 5.50$ . At baseline, 80% of participants did less than 30 minutes of moderate physical activity per week (median (IR) 1 min/day (4.76)). After the intervention, the experimental group improved significantly in 8 Foot Up and Go Test ( $p < 0.05$ ), and increased in arm flexion and sit to stand tests (%16.3 and %12.3 more repetitions), 6 minutes walking test (%5.8 more distance) and fast walking speed at 2,44 and 4 meters (%4.6 and %3.0 less time), while control group showed a decline in those test performance. **Discussion** There is some indication that long-lasting multi-component exercise program performed in Elderly Day Care Centers could be beneficial in order to slow or even improve physical fitness of participants. Results also showed that studied Day Care Center people do not fulfill the recommendations of WHO to do at least 150 minutes of moderate physical activity per week. Future investigations are needed to identify optimal programs. Particular attention need to be paid by managers and staff in Elderly Day Care Centers. **References** Andy C. Y., Wong T. W., Lee P. H. (2015). Sports medicine-open, 1(1), 1-13. Cadore E. L., Rodríguez-Mañas L., Sinclair A., Izquierdo M. (2013). Rejuvenation research, 16, 105-114.

## A PILOT TRIAL OF MULTI-COMPONENT EXERCISE TRAINING IN OLDER RESIDENTS IN LONG-TERM RESIDENTIAL CARE FACILITIES

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**Introduction** The literature has shown that participation in regular physical activity protects against diverse components of frailty syndrome by increasing balance and mobility and reducing falls, as well as institutionalization, hospitalization and mortality (de Labra et al., 2015). A multi-component exercise intervention programme seems to be the best strategy for improving gait, balance, strength, as well as reducing rate of falls in older individuals (Cadore et al., 2013). However, more studies are needed to determine which exercises are best suited, most effective, and safest for institutionalized population (Aguirre and Villareal, 2015). Thus, our aim was to describe the possible effect of a multi-component exercise programme in older residents in Long-Term Residential Care Facilities. **Methods** A multi-component exercise programme including strength, balance and aerobic exercises was carried out (3 sessions/week during 3 months) with institutionalized elderly from Matia Residential Care Facilities. Inclusion criteria were: age  $\geq 70$ , score  $\geq 50$  on the Barthel Scale, ability to walk independently for 10m and score  $\geq 20$  in the MEC Test (the adapted version of MMSE to Spanish). Anthropometric (bioelectric impedance) and physical parameters (accelerometry, normal and fast Gait Speed and Senior Fitness Test) were analysed. **Results** 92% of the participants (aged  $86.55 \pm 7.83$ ) did less than 15 minutes of moderate physical activity per week (median (IR) 1.08 (0.75)). Improvements on different physical parameters such as Arm Flexion ( $P < 0.05$ ) and Chair Stand (22.2% and 20.0% more rep.), 8 Foot Up and Go, normal and fast Gait Speed (7.4%, 11.8% and 7.1% less time) and 6 Minutes Walking Test (2.4% more meters) were observed. Fat percentage and the level of physical activity measured with accelerometry did not change from the week before to the week after the programme. **Discussion** Participants in Long-Term Residential Care Facilities are not active enough comparing the results with the recommendation of WHO to do at least 150 minutes of moderate physical activity per week. The results of the pilot study seem to demonstrate that a multi-component exercise program is effective to improve aerobic capacity, strength and dynamic balance of institutionalized individuals. Further studies are needed to assess the specific exercise programmes and strategies to increase physical activity in institutionalized older people. **References**

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### COMPARISON OF AEROBIC VERSUS RESISTANCE VERSUS COMBINED EXERCISE IN OLDER ADULTS AT RISK FOR AGE-RELATED FUNCTIONAL DECLINE

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1Institute for Sport & Health, 2Institute of Food & Health, School of Public Health, Physiotherapy and Sports Science, University College Dublin; 3Medfit Proactive Healthcare, Blackrock, Co. Dublin. Introduction Regular exercise can help delay the onset of development of lifestyle-related chronic diseases such as type 2 diabetes, obesity, and sarcopenia as well as maintaining physical and cognitive function. However, mode-specific exercise effects are not well-studied in older adults. The present study is investigating exercise training in older adults (>65 y) through a comparison of aerobic (AER) versus resistance (RES) versus combined (CEX) exercise training. Methods Participants (n=42; m/f 22/20), were divided into four groups: control (CON), AER, RES, and CEX. Each training group trained three times per week for 12 weeks. CEX comprised of 12 min of resistance training (6 exercises x 1 min each x 2 sets) and 12 min of aerobic training per session (3 x 4 min at 80% of predicted HRmax). AER comprised of 24 min of aerobic training (6 x 4 min at 80% of predicted HRmax). RES comprised of 24 min of resistance training (6 exercises x 1 min each x 4 sets). CON were advised to continue with their current physical activity levels and both the training groups and control group were asked to maintain their current dietary habits. Pre- and post-intervention assessments included body composition (DXA), handgrip strength, Short Physical Performance Battery (SPPB), Montreal Cognitive Assessment Test, Chester step test, stair climbing test, and upper and lower limb strength tests (1 RM chest press and leg press). Results The results thus far represent preliminary findings as the study is on-going and n-sizes will be approximately doubled. Significant improvements have been observed in 1 RM leg press in all three training groups whereas at current n-sizes we observe differential effects of training on improvements in grip strength (RES, CEX only), sit-to-stand (AER, CEX only), timed up and go test (AER, CEX only), 1 RM chest press (RES, CEX only), and reduction in body fats (RES, AER only) CEX only was effective in improving gait speed leg power. Neither whole body or leg lean body mass (LBM) has changed in any training group, but arm LBM has tended to increase in CEX only. Discussion For many of the other parameters, preliminary results suggest there is positive evidence for CEX, and differential responses for AER and RES, with suggested support for CEX and AER over RES in relation to many of parameters tested. On study completion with larger sample size and complimentary analysis of plasma markers of metabolic health, we anticipate extraction of mode-response relationships for key training variables, thus informing practitioners to design effective training programmes for older adults. Acknowledgement Mr. Timmons is funded by an Irish Research Council Employment-based Postgraduate Fellowship. Contact james.timmons@ucdconnect.ie

### EFFECT OF YOGA EXERCISE ON AGE-RELATED DECLINE IN AUTONOMIC NERVOUS SYSTEM ACTIVITY IN WOMEN

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Introduction The autonomic nervous system (ANS) maintains homeostasis through the balance of the sympathetic and parasympathetic nervous system. Currently, the analysis of heart rate variability (HRV) offers an indirect, non-invasive assessment of ANS activity. Age-related, early-onset, progressive decline in ANS parameters of HRV has been reported. Moreover, autonomic nervous activity disorder plays an important role in climacteric symptoms in menopausal women. Therefore, the purpose of this study was to investigate the effect of yoga exercise on the age-related decline in autonomic nervous system activity in women. Methods A total of 113 healthy women (age 45.4 +/- 12.4 years) who took a yoga course regularly participated in this study. They attended a 90-120 minute yoga exercise session conducted by a well-qualified instructor. ANS activity was assessed before and after the yoga exercise session by HRV power spectral analysis, which enabled us to identify separate frequency components: total power (TP), low-frequency (LF; sympathetic nervous system activity) power and high-frequency (HF; parasympathetic nervous system activity) power. Statistical analysis was performed using the following tests: Pearson's correlation coefficient and Student's t-test. Results With regard to the relationship between ANS activity at rest and age in subjects who did yoga regularly, We found a negative correlation between the ANS parameters and aging in subjects with less than 5 years of yoga experience (n=66) [LnTP (R2=0.14), LnLF (R2=0.11) and LnHF (R2=0.27)]. Whereas, no significant correlation was found in subjects with more than 5 years of yoga experience (n=47). The changes in ANS parameters before and after one yoga lesson were investigated in subjects aged 40 and older who have been decline ANS activity (n=77). LnTP (p<0.01) and LnLF (p<0.01) were significantly increased after the yoga session. LnHF tended to be increase after the yoga session (p<0.1) in subjects aged 60 and older. Discussion In subjects with more than 5 years of yoga experience, there was no significant correlation between the ANS parameters at rest and aging. Furthermore, ANS activity significantly increased after yoga exercise. Therefore, we concluded that yoga exercise in daily life enhances ANS activity and improves the autonomic balance. Because autonomic nervous activity disorder plays an important role in climacteric symptoms in menopausal women, yoga exercise may be effective in relieving these symptoms. Contact kimoto@asahikawa-nct.ac.jp

### AGE AND THE EFFECT OF EXERCISE, NUTRITION AND COGNITIVE TRAINING ON OXIDATIVE STRESS

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Introduction: The purpose of this study was to investigate the effect of six months resistance training – using elastic bands – alone or combined with a nutritional supplement, and cognitive training on markers of oxidative stress and antioxidant defense in Austrian institutionalized elderly. In respect to the very old age of our study population we further compared subjects above and below their statistical life-expectancy (LE) regarding their responses to the intervention. Methods: Participants (n=105) were randomly assigned into the three intervention groups –elastic band resistance training (RT), RT combined with protein and vitamin supplementation (RTS) or cognitive training (CT) – and performed two guided training sessions per week for a duration of six months. Markers for oxidative stress (MDA, 8oxodG,

8oxoGuo), antioxidant defense (uric acid, FRAP, SOD, CAT, GSH-Px) and DNA strand breaks (comet assay) were analyzed and also transformed into an "antioxidant factor" to compare the total effect of the intervention. Physical fitness was assessed by the six-minutes-walking, the chair-rise and the handgrip strength tests. Results: At baseline we observed significant negative correlations between 8oxoGuo and handgrip strength ( $r = -0.350$ ,  $p = 0.001$ ) as well as between high sensitive troponin-T and the 6-minutes-walking test ( $r = -0.210$ ,  $p = 0.035$ ). Both, RT and RTS groups, showed significant improvements in walking and chair-rise performance after six months. However, only subjects of the RT group ( $\Delta 4.9 \pm 7.2$  points) demonstrated an about twice as high non-significant increase in "antioxidant factor" compared to RTS ( $\Delta 2.4 \pm 7.6$  points) and CT ( $\Delta 2.2 \pm 6.5$  points) groups over the 6 months. Interestingly, this difference became significant (RT vs. RTS/CT,  $p < 0.05$ ) analyzing subjects over their statistical LE, whereas no difference was observed between the intervention groups under LE. Conclusion: Especially in very old subjects, a better fitness level seems to reduce oxidative DNA damage and decrease levels of cardiac risk markers. Interestingly, subjects over their statistical LE were more susceptible to six months of elastic band resistance training regarding the general oxidative state, compared to elderly under their statistical LE. However, the antioxidants of the provided supplement might have contributed to a suppression of the optimal adaptation to exercise of the redox-system in the RTS group.

## EXERCISE REDUCES CARDIOVASCULAR RISK FACTORS IN PATIENTS WITH ALZHEIMER'S DISEASE.

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Introduction: Alzheimer disease (AD) is the leading cause of dementia beginning with impaired memory. Several factors has been associated with increased risk of AD, but among those, cardiovascular disease are the most consistently reported. Hypertension, diabetes, obesity and dyslipidemia have all been found to increase the risk of dementia. Although AD patients present a high cardiovascular risk (CVR), AD conventional therapy consists in cognitive treatments. Even though literature underline some exercise-induced positive effects in patients with AD, the effects of exercise training (ET) on CVR in AD are still mated of debate. Therefore, the aims of this study were to determine alterations of CVR markers in AD patients and to compare the effects of ET with respect to conventional cognitive treatment (CCT) in patients with AD. Methods: In seventeen patients with AD ( $77 \pm 7$  yrs) and 11 age-matched healthy controls (OLD), CVR markers (glycaemia, HDL, LDL, triglycerides, systolic and diastolic blood pressure, and BMI) were measured. Following, AD patients were randomly assigned to ET group ( $n=8$ ) or CCT group ( $n=9$ ) that performed 72 treatment sessions, 3 times a week. ET included 90 min of aerobic and strength training. CCT included cognitive multi-modal stimuli (visual, verbal, auditive). Baseline measurements (T0) were repeated after 6-month of treatment (T1). Results: In comparison to the OLD group AD patients exhibited significant aggravation of some CVR markers (systolic and diastolic blood pressure  $+15.6\%$  and  $+13.8\%$  respectively, glycaemia  $+10.5\%$ , triglycerides  $+18.0\%$ ). HDL, LDL and BMI did not differ significantly. After ET some of the CVR markers were significantly ameliorated (systolic and diastolic blood pressure  $-5.2\%$  and  $-6.4\%$  respectively, glycaemia  $-12.6\%$ , triglycerides  $-23.9\%$ ). HDL, LDL and BMI did not change significantly between pre- and post ET. The CCT group did not show any change in the CVR markers between pre- and post treatment. Conclusion: Data from the current study confirm that AD patients present higher CVR factors compared to age-matched counterparts. Furthermore, only ET program improved most of the CVR markers. The results are particularly remarkable considering that hypertension, disorder of glucose or insulin and other CVR markers could play pivotal role not only in onset of AD but even in its progression. Indeed, diabetes, hypertension, obesity, dyslipidemia and metabolic syndrome are positively associated with blood brain barrier dysfunction, hyperinsulinemia, adipokines and cytokines production, and increased oxidative stress. These conditions, possibly leading to an increased brain amyloid  $\beta$  deposition worsening the AD progression, could be faced by a 6-month ET program.

## Mini-Orals

### MO-PM23 Fitness Perception & Performance

#### FITNESS SELF-PERCEPTION IN RUGBY PLAYERS IN COLOMBIA: PART I

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Introduction: Rugby research has been focused on the assessment of the anthropometric and physiological players' profiles, as well as injuries related to its practice leaving aside other issues such as self-perception, which has a significant influence on subjects' self-esteem and performance. The aim of this study was to evaluate the Fitness self-perception in Rugby players in Colombia. Methods: A cross-sectional study was conducted in Rugby players from 7 cities in Colombia, aged 18 and older and with at least a year of sport practice ( $n=116$ ; 70.7% male, 29.3% female; 57.8% Backs and 42.2% Forwards). Fitness self-perception was assessed using the International Fitness Scale (IFS) questionnaire (Español and Ramírez, 2014). Results: The medians of age and sport practice were 23 and 3 years, respectively. Most players (63.4%) reported their General Physical Fitness and its components as 'Good'. There were no significant differences by position on the field or sex in General Physical Fitness self-perception. Cardiorespiratory Fitness was better self-perceived by men who referred it as 'Good' while women as 'Average', without significant differences by position on the field. Muscular Strength was also rated as 'Good' by players, particularly women, with no significant differences between groups. In Speed/Agility players perceived themselves as 'Good'; most Backs (65.7%) value it as 'Good' while most Forwards (46.9%) as 'Average' showing the same pattern for Flexibility, perceiving it as 'Good' without significant differences by gender. According to their position on the field, Forwards have a lower perception of their Flexibility, which considered 'Average' while Backs referred to it as 'Good'. Discussion: Our results are consistent with previous players profile descriptions. The differences found between players are related to the specificity of the position on the field, especially in Speed/Agility; Backs stand out as being faster than Forwards (Da Cruz-Ferreira and Fontes, 2011). In a highly demanding physical sport like Rugby, is important to test self-perception due to individual self-perception influences performance (Weston et al., 2011). Our study has as limitation that we did not compare fitness profile and fitness self-perception; but it could address an important issue to improve in these athletes. References Da Cruz Ferreira, A., & Fontes, C. (2013). *Revista Brasileira de Medicina Do Esporte*, 19(1), 52–55. Español, M., & Ramirez, R. (2014). *Revista Española de Salud Pública*, 88(2), 271–278. Weston, N., Greenless, I., & Thelwell, R. (2011) Inter-

national Journal of Sport and Exercise Psychology, 9(2), 173-188 Contact: rosmarmartinez@usantotomas.edu.co  
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## RELATIONSHIP BETWEEN PERCEIVED PHYSICAL LITERACY AND PHYSICAL ACTIVITY LEVELS AMONG HONG KONG ADOLESCENTS

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This study aims to investigate the relationship between perceived physical literacy (PL) and physical activity (PA) levels among Hong Kong adolescents. Over 5400 students from 15 secondary schools (ages 12-18) in Hong Kong were recruited into this cross-sectional study. Self-report scores from perceived PL and PA levels were recorded by using Perceived Physical Literacy Instrument (PPLI) and International Physical Activity Questionnaire for Adolescent (IPAQ-A). A random sub-sample (N=450) from 15 participating schools wore accelerometers (Actigraph GT3X+) to measure PA for at least 8 hours per day in 7 consecutive days as objective measures for students' PA level. The research team first validated the relationship between IPAQ-A and accelerometer, and then confirmed the relationship between the perceived PL and PA levels. Pearson's Product-Moment Correlation used to calculate the relationship between the self-reported MET minutes per day from IPAQ-A and PA minutes per day in each intensity level from the accelerometer. Correlations between PL and PA of participants were examined. The overall correlation was compared with age, gender, academic achievement and socio-economic status. The findings were useful in intervening in the perception of PL and participation in PA for adolescents in Hong Kong. The results can help promoting an active and healthy lifestyles to adolescents, and finally, preventing chronic diseases in the future.

## DEVELOPMENT IN PERFORMANCE ON THE ANDERSEN SHUTTLE RUN TEST IN BOYS AND GIRLS 6 TO 11 YR OLD

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**Introduction** The Andersen intermittent shuttle run test is a popular fitness test for children and adolescents (Andersen et al. 2008). As for other shuttle run tests, test performance increases with age, but that is not well documented for this test. Thus, we have compared the test performance development of children 6 to 11 yr doing the Andersen test. **Methods** 2010 children aged 6 to 11 took part in the study which went on for six months at seven different schools. The test was explained and the children were especially instructed to stand still in the rest periods, and to run at an even pace in the work periods, doing as best as one could. Test personnel counted the number of shuttles each child ran. The running site had cones for every 5th m used for calculating the total distance covered. The test was run once. The linear regression between age and distance was calculated and differences in slope between age 6 to 8 and 9 to 11 was analysed with independent t-test assuming homoscedastic variance. Results presented are the slope (standard error of regression) unless otherwise noted. A significance level of  $p < 0.05$  was used. **Results** The mean distance covered increased by age, from 777 m to 1020 m at age 6 and 11 yr for the boys and girls combined. The slope was 78.7 (4.8) m-yr<sup>-1</sup> from age 6 to 8. From age 9, it was 39.0 (4.4) m-yr<sup>-1</sup>,  $p < 0.001$ . For the oldest group, the slope also differed between boys and girls, 35.3 (6.6) m-yr<sup>-1</sup> vs 49.8 (6.9) m-yr<sup>-1</sup>,  $p < 0.001$ . Both height and body mass increased linearly from 6 to 11 yr. Between 6 and 8 yr the height increased with 0.059 (0.002) m-year<sup>-1</sup> and body mass 3.3 (0.2) kg-year<sup>-1</sup>. The oldest group had a height increment of 0.060 m (0.002) m-year<sup>-1</sup> and 4.2 (0.3) kg-year<sup>-1</sup> for body mass. These differences were not statistical significant. **Discussion** We found a statistical significant difference in the slope of distance covered in the Andersen test between those aged 6 to 8 and 9 to 11 yr. This difference is not related to bodily changes, as both height and body mass rates were not statistical different between the two groups. Motivation and learning are two factors that are important for physical performance. If the 6 yr old found the test difficult to perform, a learning effect can explain the steeper increase the first three years, and from age 9, a ceiling effect appears. The difference in slope between sexes in the oldest group may be related to onset of puberty for the girls. If so, a new increase in slope would be expected for the boys from age ~13 yr. **References** Andersen L.B, Andersen T-E., Andersen E., Anderssen S.A. (2008), J Sports Med Phys Fitness, 48,434-437. Contact Asgeir Mamen, asgeir.mamen@kristiania.no

## STUDY OF PHYSICAL ACTIVITY AND FITNESS IN PRIMARY CARE PROFESSIONALS

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**INTRODUCTION** Physical inactivity is recognized as one of the biggest risk factors in the development of heart disease. From the Primary Care are promoted health prevention activities but it is unknown whether the staff practice them. The aim of this study is to know weekly hours with moderate-intense physical activity and the degree of sedentary lifestyle of the professionals in a Primary Care Center, as well as to describe physical state and analyze its association with the degree of physical activity, sedentary lifestyle and self-rated health. **METHODS** Cross-sectional study by administering at the initial visit different questionnaires [7-day physical activity, RAPA, VREM and self-rated health questionnaire (EQ-5D)] to the professionals of a primary care centre in Barcelona province. Each participant was provided with a pedometer. Heart rate variability was measured with the Polar Heart Rate Monitor RS800 performing 10-minute measurements in the early morning in both supine and sitting position. Time and frequency spectrum were analyzed using Kubios software **RESULTS** 46 primary care professionals were recruited. 71,7% Females. Age 44,5 (SD 10,2). BMI 25,7 (SD 5,7). 21,8% administrative, 30,4% nursing and 47,8% medical. 21,74% were active, 13,04% moderately active, 65,32% inactive or indolent. 19,47% did usually strength exercises and 34,78% elasticity exercises. 86,94 % reported good/very good self-rated health and 6,51% poor/very poor. 32,61 % never walk and 15,22 % walk every day. 19,57 % walk 30 minutes/day. 43,48% do not do any kind of sport and 10,87%. 52,17% index LF/HF<1,5. LF/HF 2,37 (SD 2,64) 9.9 days/month were dedicated to walk (41 minutes/session). Participants performed 7,740 steps/day on average. 7.4 days/month engaged on sports (38 minutes/day). **DISCUSSION** Participants generally have good self-rated health but a lack of physical activity is evidenced. Participants showed a predominance of the parasympathetic system in the HRV analysis. Most important limitations are the cross-sectional nature of the study and the size of the sample. **REFERENCES** Ruiz Comellas A, Pera G, Baena Díez JM, Mundet Tudurí X, Alzamora Sas T, Elosua R, et al. (2012) Rev Esp Salud Pública, 86(5), 495-508. Tudor-Locke C, Burkett L, Reis JP, Ainsworth BE, Macera CA, Wilson DK. (2005) Prev Med, 40:293-8. CONTACT anamaria.bofill@udg.edu



## DO JUNIOR FEMALE ATHLETES ADAPT BETTER THAN MALE COUNTERPARTS AFTER TRAVELING TO A FOREIGN COUNTRY?

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**BACKGROUND** Although many elite athletes go abroad for international competitions and training nowadays, junior athletes may find it difficult to adapt to new environment because of their paucity of experience. Little has been studied, however, about the consequences of travelling to a foreign country on junior athletes and their response to it. **PURPOSE** To evaluate their ability to cope with new environment and search for any differences of the ability between the genders. **METHODS** Forty-one top-level Japanese junior track and field athletes (22 boys and 19 girls, aged  $16.0 \pm 0.7$  years) who traveled from Tokyo to Colombia via New York in order to participate in an international competition were involved in this study. They filled a questionnaire regarding, performance, sleep problems, appetite, fatigue and jet-lag, 8 times from day 1 through day 8, before they went to bed. The answers were scored by visual analogue scale from -5 (very negative compared to usual status, which is scored as 0) to 5 (very positive compared to usual status). All data were analyzed using Wilcoxon's rank test. **RESULTS** While there was not a significant difference relating to sleep problems, the boys felt less flexible ( $-1.1 \pm 1.5$  and  $0.2 \pm 1.3$  respectively,  $p < 0.05$ ) and more fatigued ( $-1.6 \pm 1.5$  and  $-0.6 \pm 1$  respectively,  $p < 0.05$ ) than the girls on the first day. In addition, the boys were not able to taste food as good as the girls, during the whole 8 days ( $-0.1 \pm 1.9$  and  $1.3 \pm 2$  respectively,  $p < 0.05$ ) and this was more prominent during the first 4 days than the latter. **DISCUSSION** Since amount of sleep in the aircraft and other factors during the flight did not show any gender differences in our study, we speculated that adaptability to the change of environment differs between boys and girls. Since Anshel et al reported that the way of coping with acute stress relating to performances differs between the genders, further investigation is required to seek for difference in managing themselves with new environment. Although difference in taste preferences between the genders was recognized, it might only reflect the fact there is a possibility that the girls merely preferred the local food than the boys and not be derived from difference in adaptability. Thus, we need information after traveling to other countries as well and further research is required. **REFERENCE** Anshel et al. Racial and gender differences on sources of acute stress and coping style among competitive athletes. *J of social psychology*. (2009), 149(2), 159-177. **CONTACT** yuka.voila@gmail.com

## CIRCUMSTANCES OF FALL DIFFER BETWEEN FEMALE AND MALE MOUNTAIN HIKERS

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**Introduction** Mountain hiking is the most attractive mountain-sport activity in the Alps during the summer season with some million hikers in Austria each year (Burtscher et al., 2007). Mountain hiking is defined as walking in a mountainous environment predominantly on marked trails and paths. Mountain hiking is generally characterized as a long-lasting activity including a large muscle mass with a predominantly moderate intensity which is considered beneficial for health (Powell et al., 2011). The other side of the undoubtedly positive health effects of mountain-hiking activities is the risk of accidents, emergencies and even fatalities. Preliminary analyses of mountain-hiking accidents revealed that a) about 50 % are caused by falls and b) differences between female and male hikers can be considered (Faulhaber et al., 2012). Therefore the goal of the present project was to provide information on the circumstances of mountain-hiking accidents caused by falls based on data of a more-year period focusing on differences between female and male victims. **Methods** Non-fatal and fatal accidents during mountain hiking in Austria, which were documented by the Austrian Alpine Police (Ministry of the Interior) during a 9-year period (summer seasons 2006 to 2014) were included into the retrospective analysis. Documentation was performed using standardized forms and data input was conducted by instructed staff of the Austrian Alpine Police. Anonymized data was provided to the University of Innsbruck for analyses. Characteristics of female and male victims were compared by unpaired t-tests or Chi-square tests as appropriate. **Results** Data of 6022 victims with known sex were included into analyses (48 % female, 52 % male). Female victims were slightly older compared to male victims ( $53 \pm 17$  vs.  $51 \pm 19$  years,  $p < 0.01$ ). Fatal accidents were more frequent among males (8.9 %) compared to females (3.2 %). In both sexes accidents happened predominantly during the ascent (81 % in females, 76 % in males,  $p < 0.01$  between sexes). Only 0.6 % of the female hikers seem to have consumed alcohol on the day of the accident compared to 3.5 % of the male hikers ( $p < 0.01$ ). **Discussion** Although the results have to be interpreted carefully since only more severe accidents with the need of external help (e.g. rescue) were included, the results indicate that there are clear sex specific differences. Further studies should focus on risk factors for falls in mountain hikers focusing on sex-specific aspects. **References** Burtscher M, Pachinger O, Schocke MFH, Ulmer H. (2007) *Int J Sports Med*, 28, 621-624. Faulhaber M, Ruedl G, Burtscher M. (2012) *FTR*, 4, 171-175. Powell KE, Paluch AE, Blair EN. (2001) *Annu Rev Public Health*, 32, 349-365. **Contact** martin.faulhaber@uibk.ac.at

## COMPARING THE SUBACROMIAL SPACE AT 90° SHOULDER ABDUCTION WITH AND WITHOUT EXTERNAL HUMERUS ROTATION AND DURING UPRIGHT ROW POSTURES IN YOUNG HEALTHY SUBJECTS: AN ULTRASOUND EVALUATION

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**Introduction** The lateral rises performed with or without humerus rotation (shoulder abduction up to 90° and above), and the upright row (UR) performed with dumbbells or barbells implying an internal humerus rotation (shoulder abduction  $> 90^\circ$ ) (Durall et al., 2001) are common exercises employed by people in gyms. However, the UR can be related to the onset of subacromial impingement syndrome (SIS) (Kolber et al., 2014). Conversely, it seems that the lateral rises with an external humerus rotation are not associated with SIS onset. Since one of the factors involved in the onset of SIS is the reduction of subacromial space (SS), we evaluated SS at different shoulder postures that reproduced the final positions of the abovementioned exercises. **Methods** Twenty-five healthy males (age,  $24 \pm 5$  yrs; stature  $175 \pm 8$  cm; body mass  $74 \pm 12$  kg) underwent SS ultrasound evaluation of the right arm with sagittal anterior approach. A line was marked on the skin at the mean point of the anterior acromial aspect found by ultrasound. Scans were taken while executing with (WL) and without (NL) 4-kg load: 90° shoulder abduction (SA) with no humerus rotation (90°n); 90° SA maximum external rotation (90°er); SA during upright row (UR). A fluid goniometer was attached with a Velcro® strap on the back of the arm to check the SA degrees. Reliability was assessed. **Repeated measures ANOVA** 3x2 and paired samples t-test were employed ( $\alpha = 0.05$ ). **Results** Significant differences between loads ( $p = 0.003$ ,  $\eta^2 = 0.37$ ), angles ( $p < 0.001$ ,  $\eta^2 = 0.72$ ), and significant interaction ( $p = 0.004$ ,  $\eta^2 = 0.45$ ) were found. SS values were higher at 90°er compared to 90°n and UR ( $p < 0.001$  for both) in WL. Differences were found between 90°n and both 90°er ( $p = 0.002$ ) and UR ( $p = 0.009$ ) in NL. Differences between NL and WL were found at 90°er ( $p < 0.001$ ). Intra-observer reproducibility was optimal for all measurements (range 0.97–0.99). **Conclusion** In our participants, postures of SA at 90°er showed larger SS than at 90°n and UR both WL and NL. This

could imply that excluding the external humerus rotation during SA may be potentially dangerous in susceptible subjects, favouring the onset of SIS. References Durall CJ, Manske RC, Davies GJ. (2001). Avoiding shoulder injury from resistance training. *Strength Cond J*, 23(5), 10–18. Kolber MJ, Cheatham SW, Salamh PA, Hanney WJ (2014) Characteristics of shoulder impingement in the recreational weight-training population. *J Strength Cond Res* 28:1081–1089 Contact stefano.longo@unimi.it

### TESTING A MODEL OF SUCCESSFUL AGEING IN A COHORT OF MASTERS SWIMMERS

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**INTRODUCTION** Successful ageing (SA) can be defined as high physical, psychological, cognitive, and social functioning in later life (Bowling, 2007). Masters athletes train for, and compete in, sport specifically designed for older adults (Reaburn & Dascombe, 2008). Due to their high levels of physical function, masters athletes are often proposed as exemplars of SA (Cooper et al., 2007; Hawkins et al., 2003). However, the SA status of masters athletes is yet to be tested using a SA model which incorporates measures of psychological, cognitive, and social functioning. The aim of this study was to propose a model of SA and determine if data from a cohort of masters swimmers fit the proposed model. **METHODS** A survey comprising standardised measures was administered to a sample of 169 masters swimmers (males  $N = 66$ ; females  $N = 103$ ) competing at the 2013 Australian Masters Swimming Championships. Structural Equation Modelling was used to determine if our conceptual SA model mapped onto data collected from the masters swimmers. One hypothesised model and four alternative conceivable SA models were tested to determine which model best fit the data. The variables we included were self-rated SA and physical, psychological, cognitive, social functioning. **RESULTS** The best fitting model was the hypothesised one with the latent factors of physical ( $b = 0.31$ ,  $SE = 0.11$ ), psychological ( $b = 0.25$ ,  $SE = 0.11$ ), cognitive ( $b = 1.08$ ,  $SE = 0.79$ ), and social ( $b = 1.20$ ,  $SE = 0.63$ ) functioning all loading onto the higher order SA factor. The self-rated SA manifest variables also significantly loaded onto the SA latent factor (all  $ps < .05$ ). **DISCUSSION** Our study found that high self-rated SA represents underlying physical, psychological, cognitive, and social functioning. Our findings provide evidence that SA is a multifaceted construct which incorporates more than just physical health. Future directions for research include testing this model in a cohort of non-masters athletes to determine if the same SA model holds. **REFERENCES** Bowling, A. (2007). Aspirations for older age in the 21st century: What is successful aging? *The International Journal of Aging and Human Development*, 64(3), 263-297. Cooper, L., Powell, A., & Rasch, J. (2007). Master's swimming: An example of successful aging in competitive sport. *Current Sports Medicine Reports*, 6(6), 392-396. Hawkins, S., Wiswell, R., & Marcell, T. (2003). Exercise and the master athlete—a model of successful aging? *The Journals of Gerontology Series A: Biological Sciences and Medical Sciences*, 58(11), 1009-1011. Reaburn, P., & Dascombe, B. (2008). Endurance performance in masters athletes. *European Review of Aging and Physical Activity*, 5(1), 31-42. **CONTACT** David Geard Email: d.geard@cqu.edu.au Phone: +06 409 340 350

## Mini-Orals

### MO-BN01 Running Biomechanics

#### RELATIONSHIPS IN 800 METER RUNNING PERFORMANCE AND AEROBIC AND ANAEROBIC RUNNING CAPACITIES IN HOMOGENEOUS MIDDLE-DISTANCE RUNNERS

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**Introduction** Most long-distance running performances can be explained by three physiological variables: maximal oxygen uptake ( $\dot{V}O_{2max}$ ), running economy (RE), and lactate threshold (LT); however, a model explaining 800 m running performance has not been established. Aerobic and anaerobic metabolisms contribute 60% and 40%, respectively, to the overall energy expended during an 800 m running event (Hill, 1999), having greater metabolic capacities for both is essential for the best performance. Maximal accumulated oxygen deficit (MAOD) and peak accumulated blood lactate concentration ( $\Delta bLa$ ), known as the anaerobic metabolic capacity, are related to 800 m running performance (Bosquet et al., 2007). The purpose of this study was to clarify the relationships with 800-m running performance and aerobic and anaerobic running capacity in homogeneous performance runners, and to investigate a model to explain 800 m running performance. **Methods** Ten male university student middle-distance runners (age  $19.6 \pm 1.0$  yr; height  $170.5 \pm 4.8$  cm; body mass  $58.8 \pm 3.3$  kg; 800 m personal best time  $1'52.4 \pm 1.9$ ) took part in this study. They carried out four running tests within 7 days: 800 m, maximal, submaximal (65, 70, 75, 80, 85 and 90 % $\dot{V}O_{2max}$ ) and supramaximal tests ( $121.7 \pm 4.4$  % $\dot{V}O_{2max}$ ). RE was estimated as energy cost (kcal/kg/km) during 65% $\dot{V}O_{2max}$  running, LT was expressed as intensity of  $\dot{V}O_{2max}$ . Results A significant positive relationship was observed between 800 m running performance ( $25.0 \pm 0.8$  km h<sup>-1</sup>) and  $\dot{V}O_{2max}$  ( $p < 0.05$ ) but not MAOD ( $p = 0.76$ ), RE ( $p = 0.60$ ), LT ( $p = 0.09$ ) and  $\Delta bLa$  ( $p = 0.12$ ). 57.2% of the 800 m running performance was explained by  $\dot{V}O_{2max}$  (VIF=1.33), LT (VIF=1.15), RE (VIF=1.22), MAOD (VIF=2.05) and  $\Delta bLa$  (VIF=1.64) ( $p = 0.13$ ). **Discussion** This study showed that  $\dot{V}O_{2max}$  was the most important variable in an 800 m running performance. On the other hand,  $\Delta bLa$  explains the variables for 800 m running performance better than MAOD. It was suggested that MAOD was not an important variable to estimate the 800 m running performance in homogeneous performance runners. Aerobic metabolism contributes to 60% of the overall energy expended during an 800 m run (Hill, 1999), however 800 m running performance was explained 57.2% by even aerobic and anaerobic physiological variables in homogeneous performance runners. **References** Hill DW. (1999) Energy system contributions in middle-distance running events. *J Sports Sci*, 17, 477-483. Bosquet L, Delhors PR, Duchene A, Dupont G, Leger L. (2007) Anaerobic running capacity determined from a 3-parameter systems model: Relationship with other anaerobic indices and with running performance in the 800 m-run. *Int J Sports Med*, 28, 495-500. **Contact** fumiya.tanji.238@gmail.com

## ALTERED NEUROMUSCULAR CONTROL DURING BAREFOOT RUNNING: A METHODOLOGICAL AND EXPERIMENTAL APPROACH

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**Introduction** Barefoot running has been previously associated to injury risk and performance (Liebermann et al., 2010). Furthermore it is well known that about 50% of rearfoot runners change in midfoot or forefoot strike patterns if they run barefoot (Santuz et al., 2015). These acute non familiar changes from shod to barefoot condition may challenge the neuromuscular system affecting the dynamic control of running stability. The maximal Lyapunov exponent (LyE) which quantifies how the system's states respond to very small perturbations, has been often used to assess neuromuscular control during gait (Dingwell and Cusumano, 2000; Hoogkamer et al., 2015). We completed a twofold experimental approach aiming (a) to examine the reliability of LyE during running using a cluster of trunk markers and (b) to investigate the dynamic stability of runners on shod and barefoot conditions. **Methods** Twenty healthy participants who run at their preferred speed ( $2.87 \pm 0.42$  m/s) on a pressure-plate equipped treadmill were engaged in the study. To examine the reliability of the LyE the participants conducted two-minute running trials; two trials per day for three consecutive days, which were considered as one block. The whole task was then repeated after a minimum of one week apart, namely a second block. To address the effects of barefoot condition on running stability we examined two additional barefoot trials on the first day of the second block. The LyE has been calculated on the vertical axis for eleven markers on the back, individually and in clusters. **Results** The ICCs within the same day, between the days and between the blocks ranged from 0.7 to 0.9. We did not find a day or block effect in the comparison of the resulting LyE. Markers on the spine provided the most reliable results. Further we found a significantly higher LyE values ( $p < 0.05$ ) in the barefoot compared to shod running. **Discussion** Our findings provide evidence for an acceptable and specific to used markers reliability in LyE during running. Furthermore the increased LyE in the barefoot running indicates deficits in the neuromuscular control of stability compared to the shod condition that may affect injury risks and running performance. **References** Lieberman, D. E., Venkadesan M., Werbel W. A., Daoud A. I., D'Andrea S., Davis I. S., Mang'eni R. O., Pitsiladis Y. (2010). *Nature* 463:531–535. Santuz A, Ekizos A, Arampatzis A. (2015). *Ann Biomed Eng.* DOI: 10.1007/s10439-015-1484-3. Dingwell J, Cusumano J. (2000). *Chaos*, 10(4), 848-863. Hoogkamer W, Bruijn S, Sanaert S, Swinnen S, Van Calenbergh F, Duysens J. (2015). *Gait Posture*, 41(2), 592-596. Contact: antonis.ekizos@hu-berlin.de

## BENEFITS OF HABITUAL BAREFOOT LOCOMOTION – A SYSTEMATIC REVIEW

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**Introduction** Little is known about the differences of long-term habitual barefoot (HB) and shod (HS) locomotion. The aim of this study was to systematically review the literature for comparisons of HB and HS populations, and to synthesize the effects of HB locomotion on performance, biomechanics, pathologies and the foot. **Methods** Following the PRISMA guidelines, a literature search was performed comprising Web of Science, MEDLINE, EMBASE and Cochrane databases. Study inclusion criteria were peer-reviewed published investigations of HB and HS participants. Two researchers independently reviewed selected studies, evaluated quality and level of evidence. A consensus meeting with all authors was performed, if consent was not achieved. **Results** Of initially found 2535 studies, a total of 15 studies were included. Six studies investigated foot morphology and biomechanics. Three studies considered foot arch and respectively one study discussed injuries and foot diseases. No study investigated motor performance outcomes. Pooled results of HB populations show limited evidence for reduced ankle dorsiflexion at footstrike (pooled effect size  $-3.47$  (95% CI  $-5.18$  to  $-1.76$ )) and hallux angle ( $-1.16$  (95% CI  $-1.64$  to  $-0.68$ )), as well as shorter ( $-0.20$  (95% CI  $-0.33$  to  $-0.07$ )) and wider ( $0.55$  (95% CI  $0.06$  to  $1.05$ )) feet compared to HS populations. Very limited evidence was found for reduced hip flexion, higher peak eversion angles, higher maximal internal rotation angles and dorsal excursion of the metatarsophalangeal joint in HB participants. Furthermore, HB locomotion had a reduced rate of rearfoot strikes, stride length and time, shorter contact time in running with a longer contact time in walking. Conflicting evidence was found for knee angle ( $-0.25$  (95% CI  $-1.34$  to  $0.85$ )). No differences in relative injury rates were found with limited evidence for a different body part distribution of musculoskeletal injuries, more foot diseases and less foot deformities and defects in HB runners. **Discussion** The analysis suggests that habitual footwear use influences biomechanics and foot morphology as well as injury and foot deformity rates. No evidence was found on motor performance. Despite a large amount of studies investigating short-term effects of barefoot locomotion (Jenkins and Cauthon 2011, Hall et al. 2013), only limited or very limited evidence is known for long-term effects. Our study shall help to guide future research and encourage to perform well-designed prospective studies examining the effects of habitual barefoot locomotion. **References** Hall JPL, Barton C, Jones PR and Morrissey D (2013). *Sports medicine* 43(12): 1335-1353. Jenkins DW and Cauthon DJ (2011). *JAPMA* 101(3): 231-246. Contact: karsten.hollander@uni-hamburg.de

## INFLUENCE OF MINIMALIST FOOTWEAR ON IMPACT ACCELERATIONS DURING RUNNING

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**Introduction** The scientific interest on the effects of the minimalist shoes on the runners' performance and injury risk has increase unstoppably in the last years. However, the majority of the studies have not controlled if foot strike is altered when measuring impacts accelerations during running. As a result, it is unclear if the alterations of impacts accelerations are a consequence of the minimalist shoes or the type of foot strike. Therefore, the aim of this study was to analyse impact accelerations during running with minimalist and conventional shoes while controlling the athletes' foot strike. **Methods** Seventeen male runners habituated to run with minimal shoes performed two running tests of 30 minutes at 80% of their individual maximal aerobic speed on a running track. Participants performed one session with own conventional shoes (CS) and the other session with minimal shoes (MS) (drop = 0, midsole < 4mm) in a random order. Impact accelerations were measured for 10 seconds every 5 minutes (5', 10', 15', 20', 25', 30') on the tibia and head. Head and tibial peak acceleration, acceleration magnitude, acceleration rate and shock attenuation were calculated from the acceleration signal. A pressure mat was placed on the running track in order to measure foot strike during running. **Results** Foot strike remained unaltered between both shoe conditions. Running with minimal shoes increased the tibial acceleration magnitude (CS vs MS:  $11.54$  (0.94) vs  $13.18$  (0.75) G;  $p = 0.013$ ), tibial peak acceleration (CS vs MS:  $6.80$  (0.56) vs  $7.96$  (0.40) G;  $p = 0.025$ ), tibial rate (CS vs MS:  $530.84$  (79.11) vs  $789.87$  (57.09) G/s;  $p = 0.012$ ), head rate (CS vs MS:  $75.78$  (7.61) vs  $123.43$  (13.88) G/s;  $p < 0.001$ ) and shock attenuation (CS vs MS:  $60.42$  (3.78) vs  $67.40$  (1.69)%;  $p$

= 0.046) compared to running with the conventional shoe. Discussion When foot strike remains unaltered, running with minimal shoes significantly increases impact acceleration parameters compared to running with conventional shoes (Willy & Davis, 2014). Taking into account that elevated peak accelerations and acceleration rates have been associated with the occurrence of stress fractures (Milner et al., 2006), this type of footwear should be used with caution as it may be putting runners at greater risk of overuse injuries. References Milner C, et al. (2006). *Med Sci Sports Exerc.*, 38(2), 323-328 Willy W, & Davis I (2014). *Med Sci Sports Exerc.*, 46(2), 318-323. Contact pedro.perez-soriano@uv.es

### THE EFFECT OF WEARING MASAI BAREFOOT TECHNOLOGY SHOES ON RECOVERY AFTER MARATHON RUNNING

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Introduction A fast recovery from post-full marathon fatigue enables to stay good condition for training as well as for daily life. We previously reported that unstable rocker shoes (Masai Barefoot Technology: MBT) can promote fast recovery in the subjective fatigue from marathon running (Nakagawa et al. 2014). However, it was questionnaire study, and not based on objective indexes. The purpose of the present study was to investigate whether MBT shoes can promote recovery from marathon based on muscle damage markers. Methods The 25 university students participated in the study. They were divided into two groups and wore MBT shoes (MBT group, n=11) or ordinary shoes (control group, n=14) from immediately after marathon (42.195 km) for 1 weeks later. Before (Pre), immediately (Post), 1 day (D1), 3 days (D3) and 8 days (D8) after marathon, muscle hardness (ultrasound elastography), isometric muscle force, muscle soreness and subjective fatigue were measured. Number of steps per day in recovery period was also measured. For each index, the difference between post or D1 and D3 or D8 was calculated as the magnitude of recovery. Results There was no statistical group difference in marathon time and number of steps per day in recovery period. The magnitude of recovery of muscle hardness of gastrocnemius, knee extension force and subjective fatigue were significantly higher in the MBT group compared to the control group. Discussion The result of subjective fatigue had similar tendency to that in our previous study. In addition, we found that muscle hardness and force in some muscles recovered faster in the MBT group. It has been reported that electromyographic activities in lower limb muscles including gastrocnemius and RF were higher during standing or walking with wearing the MBT (Nigg et al. 2012). This activity could become an active rest for lower-limb muscles with heavy damages. In conclusion, wearing MBT shoes can be effective for the recovery of muscle hardness and muscle force from marathon-induced damages. References Nakagawa K, Obu T, Kanosue K. (2014). *Open Access J Sport Med*, 5, 267-271 Nigg B, Federolf PA, Tschanner VV, Nigg S. (2012) *Footwear Science*, 4(2), 73-82 Contact nakagawa.kento.22@gmail.com

### OVERGROUND AND TREADMILL RUNNING DATA COLLECTION METHODS: COMPARISON OF KINETIC VARIABLES ACROSS SHOD CONDITIONS

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Introduction Over past decades volumes have been written comparing overground (OG) and treadmill (TM) running mechanics (e.g. Riley et al., 2008) with only a few studies investigating differences in kinetics between the two modes. These studies have generally focussed on running performance (Kluitenberg et al., 2012), however, there is a lack of studies investigating the degree of agreement between OG and TM in terms of impact variables pertinent to shock absorption and orthosis prescription. This study investigated the agreement between OG and instrumented TM data collection methods for measuring kinetic variables during running across a range of shod conditions including barefoot. Methods Vertical ground reaction force data (1000 Hz) were collected from both lower limbs during seven running trials (self-selected speed  $\pm$  5%) conducted on an OG runway with Kistler force platforms embedded within the ground and an instrumented TM (Gaitway, Traunstein). Measurements were taken under three shod conditions: barefoot, shod, and shod with a prefabricated foot orthotic. The data were analysed using two-way repeated measures ANOVAs and a range of agreement statistics including Intraclass Correlation Coefficients (ICC-3,1). Results Whilst a few ICCs showed strong agreement ( $>0.80$ ), significant interactions revealed that for both feet impact peak force was lower for instrumented TM trials during shod ( $\sim 13\%$ ) and orthotic ( $\sim 14\%$ ) conditions ( $p < 0.05$ ), however no significant differences were reported in barefoot trials. Time to impact peak was significantly shorter during OG trials ( $\sim 10$ -45ms) compared to TM trials ( $p < 0.05$ ) for all three conditions. Active peak forces were significantly reduced during TM trials compared to OG trials for all shod conditions ( $p < 0.05$ ), apart from the barefoot trial for the right foot. Finally, contact times were significantly shorter during the OG trials ( $\sim 25\%$ ) for all shod-conditions ( $p < 0.05$ ). Discussion This study identified a number of significant differences in multiple kinetic variables between OG and TM data collection methods when analysing running under a number of shod conditions. The data show a trend of more moderate impacts while running on a TM compared to OG especially for shod conditions. This study has many practical implications for practitioners prescribing foot orthoses and researchers working in this field. It is important that practitioners are aware of the potential differences which may be produced when utilising the two different methods, as these differences could lead to incorrect conclusions being drawn, potentially resulting in inappropriate orthosis prescription. References Riley et al. (2008). *Med Sci Sports Exerc*, 40(6), 1093-1100. Kluitenberg et al. (2012). *BMC Musculoskel Disord*, 13(1), 1-8. Contact e.l.gregg@leedsbeckett.ac.uk

### INTRA-INDIVIDUAL VARIABILITY IN NOVEL FOOTWEAR ASSOCIATED WITH INJURY IN DISTANCE RUNNERS

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Introduction Evidence surrounding the use of minimalist shoes to reduce incidence of running-related injuries remains inconclusive (Ryan et al.). However, interest in minimalist footwear is high (Rothschild). With no consistent risk factors currently identified for injury, what may be more important is understanding the variables that enable one runner to adapt successfully to a new running shoe while another gets seriously injured. The aim of our study was to examine initial adaptive response to novel footwear, via intra-individual variability, in a shoe with a zero heel-to-toe drop. Methods Thirty experienced, rearfoot-striking runners (15 M; 15 F) who had never worn zero-drop running shoes were enrolled. Subjects ran at 70% VO<sub>2</sub>max speed for 10 minutes each in a habitual shoe (HAB), a minimal shoe (MIN; New Balance Minimus), and a maximal shoe (MAX; Altra Paradigm), which were selected for their zero-drop, similar fit, and different midsole thicknesses (11 and 25 mm). Subjects were instrumented with a lower-body inertial measurement system and ran on an instrumented treadmill to collect continuous joint kinematics and vertical ground reaction forces. Runners were randomly assigned MIN or MAX to wear for all runs for four weeks. The amount and structure of variability were calculated by coefficient of variation (CV), standard deviation (SD), and detrended fluctuation analysis (DFA; expressed as  $\alpha$ ) (Hausdorff et al.), respectively. All variability measures were



normalized to HAB condition and compared via independent t-tests. Results Shoe type was significantly associated with injury with all injuries (7 out of 27) occurring in the group wearing MIN shoes ( $p=0.005$ ). Consequently, subsequent analyses were restricted to this group. Normalized to the HAB shoe, CV was not significant for any spatiotemporal measures. SD demonstrated a trend for stride time ( $p=0.09$ ) with injured runners having increased amount of variability in MIN shoe than uninjured runners. DFA values for MIN condition demonstrated a trend ( $p=0.09$ ) towards lower values in injured ( $\alpha=0.97$ ) compared to uninjured runners ( $\alpha=1.17$ ) in the MIN shoe. Discussion The reduction in structure of variability in injured runners suggests they had reduced flexibility in their gait strategy while running in MIN compared to their HAB shoe, despite displaying a greater amount of variability. A more constrained movement pattern (i.e., a more consistent stride interval) could result in continual loading on the same soft tissue structures leading to overuse and injury. More prospective research is needed to determine the extent to which variability can be used to predict injury, particularly following the transition to novel footwear. References Ryan, M., et al. (2013) Br J Sports Med 48(16): 1257-62. Rothschild, C. E. (2012). J Strength Cond Res, 26(8): 2021-2026. Hausdorff J.M., et al. (1996) J of Applied Phys 80(5): 1448-1457. Contact cagresta@umich.edu; Acknowledgements: Adidas AG provided funding for this study.

### COULD SKIN TEMPERATURE PREDICT ANKLE EVERSION AFTER RUNNING?

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Introduction Ankle eversion is one of the most studied variables in running biomechanics due to its potential relationship with increased injury risk (Hreljac, 2004). Moreover, the assessment of ankle eversion is of great interest for athletes when purchasing footwear. Measuring skin temperature via infrared thermography could be a non-invasive, easy, and quick tool to predict ankle eversion during running. Therefore, the aim of this study was to analyze the relationship between the skin temperature of the plantar surface and ankle eversion during running. Methods Twenty runners (14 males, 6 females) with a neutral-pronated foot contact (7-15° of maximum ankle eversion) participated in the study. Runners carried out a 5-minute maximal aerobic speed test (MAS) (García-Pérez et al, 2014) in order to individualize their laboratory running test. In the laboratory test, participants warmed up for 10 minutes at 60% of their MAS followed by 20 minutes at 80% of their MAS. Skin temperature of 2 Regions Of Interest (ROI's) of the right foot sole (1: Medial foot sole; 2: Lateral foot sole) was measured using infrared thermography (FLIR E60 camera) before (after 10 minutes of thermal adaptation) and after running. Symmetry (difference between medial and lateral ROIs) of absolute values and variation of the skin temperature (difference between after and before running) were assessed. 2D kinematic analysis was performed with two high speed cameras (125 Hz) (MotionScope®) to measure ankle eversion at contact time (ECT) and maximum ankle eversion during stance phase (MAE) of the right foot. Four reflective markers were placed on the lower leg following Clarke et al (1983) model (1: Lower calcaneus; 2: Upper calcaneus; 3: Achilles tendon; 4: Gastrocnemius). Correlations were observed between skin temperature variables and ECT ( $p>0.05$  and  $r<0.05$ ). However, there was a positive relationship between the skin temperature variation symmetry and MAE ( $r=0.7$  and  $p=0.001$ ;  $MAE = 0.1 \times \text{skin temperature variation symmetry} - 1.3$ ). Discussion The present study has investigated the relation between skin temperature of the right feet sole and the ankle eversion of runners. The lack of correlation found between ECT and the variation of skin temperature of the feet soles suggested that this kinematic variable had no influence on skin temperature. However, the positive correlation between MAE and skin temperature variation symmetry, showed the potential of the infrared thermography to predict the type of foot contact during running. However, further research looking at runners with different foot type motion is necessary to corroborate these findings. References Clarke TE et al. (1983). Med Sci Sports Exerc, 15(5), 376-381. García-Pérez JA et al. (2014). Gait Posture, 38(4), 929-933. Hreljac, A (2004). Med Sci Sports Exerc, 36(5), 845-849. Acknowledgements This study was supported by the Spanish Government (DEP2013-48420-P)

## Mini-Orals

### MO-SH01 Coaching & Talent Monitoring

#### ELITE KENDO PLAYER EXHIBITS A HIGHER EXECUTIVE FUNCTION

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Introduction Talent identification and development in open skill sports should be based on not only physical functions but also executive functions (e.g. shifting, inhibition and updating). Kendo (Japanese fencing) is a traditional Japanese martial art where two players fight using bamboo swords. Since several studies have demonstrated that experienced fencers have enhanced executive functions with inhibitory response compared to non-athlete (e.g. Taddei et al., MSSE, 2012), executive functions should be important for exhibiting high performance in kendo. It is, however, still unclear the extent to which executive function is enhanced and the role it plays in exceptional elite fencing/kendo players compared to sub-elite, and which type of executive functions is specifically enhanced. Thus, here we addressed these issues by examining the executive functions of elite-Japanese kendo players, including a World champion, and teased-out the relationship between kendo performance and executive function. Method Twenty nine young, healthy male kendo players were divided into elite ( $n=16$ ) and sub-elite ( $n=13$ ) groups, based on their performance in a kendo club competition at the University of Tsukuba. All players performed 6 cognitive tasks (shifting, inhibition, and updating each by 2 tasks). Shifting task used color and shape task switching paradigm (C/S-TSP) and letter and digit task switching paradigm (L/D-TSP); inhibition task used flanker task (FT) and Stroop color-word task (SCWT); while updating task used spatial working memory task (SWMT) and verbal working memory task (VWMT). TSP consisted of three different inter-trial interval (50, 650, 1250 ms). Switch cost (reaction time delay between switch trials and non-switch trials) was calculated as an indicator of shifting ability. Results The switch cost of L/D-TSP (shifting) at the shortest interval (50 ms) was significantly lower in the elite group compared to the sub-elite group (paired t-test;  $p<0.01$ ). However, no difference was noted in the other two longer inter-trial intervals (650 ms, 1250 ms), and no significant difference was observed in C/S-TSP (shifting), FT (inhibition), CWST (inhibition), SWMT (updating), as well as VWMT (updating) between the two groups (elite vs. -elite). Discussion The present study is the first to demonstrate that elite kendo players have outstanding shifting capabilities under high-speed conditions. This may be due to the fact that kendo players need to continuously evaluate the situation of the game or shift their mental state (go on offense, defense or wait to make a move) in a dynamically changing, high speed game in order to earn an 'ippon' (valid strike). The findings of the current study has two key

implications in this sports: it reveals the impact of executive cognition in: 1) optimal shifting-based training protocol of kendo players and; 2) recruiting high caliber talent in this global-expanding sports (kendo). Contact hsoya@taiiku.tsukuba.ac.jp

### AN ONLINE TRAINING DIARY TO MONITOR ELITE ATHLETES RESPONSE DURING A 21-DAY TRAINING CAMP

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**INTRODUCTION** Best competition performances in endurance sports are often achieved following a taper phase, which is typically completed after periods of heavy training or training camps (TC) (Aubry et al. 2014). This deliberate overload period may or may not bring to functional overreaching (FO) and recently it has been shown that performance gains were better achieved after an overload period without the presence of FO (Aubry et al. 2014). Therefore, the aim of the present study was to determine if FO is necessary to improve performance in elite open-water athletes. **METHODS** Eight elite open-water swimmers (3 male and 5 female;  $24.2 \pm 6.1$  yrs) participated in the study and were followed during a 21-day TC and a 7-day taper by means of an online training diary (www.spartanova.com), and a weekly profile of mood state. The diary includes both objective and subjective data reported on a 10 cm visual analogue scale. Based on their individual response, according to previous literature (Piacentini et al. 2015), athletes were divided in a FO group and acute fatigue group (AF). Changes in training volume (TV), session RPE (sRPE) (RPE<sub>min</sub>) and Total Mood (TM=depression+fatigue+tension+anger-vigour) during the TC were compared using Friedman's ANOVA test ( $p < 0.05$ ). **RESULTS** Five athletes showed signs of FO and 3 of AF. Despite a similar significant increase in TV during the TC (34%-wk1, 47%-wk2, 12%-wk3;  $2(4)=22.20$   $p < 0.000$ ), sRPE showed a different trend, increasing more in the FO group (52%-wk1, 81%-wk2, 7%-wk3;  $2(4)=16.00$   $p = 0.003$ ); TM did not change significantly in either group, however it increased by 49% at the end of the TC in the FO group while it decreased by 33% in the AF. After the TC, athletes tapered (TV reduction of 60%) and a subgroup of 4 athletes competed in a 10-km race, winning three medals and 1 personal best. Two of the athletes were in the FO group and 2 in the AF. **DISCUSSION** Athletes showed a different response to the TC. Five athletes showed mood disturbances and an increase in the OR signal and were considered FO (Piacentini et al. 2015), but restored all parameters after 1 wk of tapering. Two athletes in this group won a medal in the world cup race. Other 3 athletes showed modest signs of FO and improved their overall mood during the training camp. However, 2 from the AF achieved a medal and a personal best during the 10-km open water competition, confirming that each athlete must be monitored and treated as an individual, despite similar training workloads. **REFERENCES** Aubry et al. (2014). MSSE 46 (9): 1769-77. Piacentini MF, Meeusen R (2015). IJSP 10 (4): 524-27. **CONTACT** r.baldassarre@uniroma4.it

### IS PERFORMANCE AT YOUNG AGE A GOOD PREDICTOR OF LATER SUCCESS?

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**Introduction** Most countries attempt to develop systematic structures to identify gifted talented athletes and to promote their development in certain sports. However, forecasting years in advance for the next generation of sport experts is challenging. The aim of this study is to facilitate talent identification and development program by identify a critical age at which athletes should start to perform in international competitions, and to what extent it is reliable to use junior success as a criterion to predict senior success. **Methods** The preliminary research consists of a European analysis of four sports: judo, tennis, gymnastics and athletics. This case study uses a top down approach to collect data in answering the question: how did senior elite athletes performed during youth tournaments? The sport specific principles were chosen in consultation with representatives of the Flemish Sport Federations. We focused first on correlations between performances on youth tournaments and professional level. Second, we shed light on how elite athletes performed in the selected youth tournaments (top down approach). **Results** The conducted correlations were all significant but ranged from very weak-to-weak correlations. As a result, junior athletes with better performances at the selected youth tournaments appear to have a slightly greater chance to be successful at the elite athlete level. Secondly, we conclude that there is an uncertainty about the relationship of performances on youth tournaments and success of elite athletes. The result also reveals that a third of all world-class athletes for athletics, judo as well as gymnastics did not perform or participate in the selected youth tournaments. **Discussion** These results indicate the general good to put into perspective the relative importance of performances at young ages. Moreover, a mixture of physical and mental skills into appropriate action is common for all sports and each sport is marked by a singularity of required sport-specific elements for successful performance (Baker & Horton, 2004). The ages at which transitions occur as well as the duration of the stages are sport-specific (Wylleman, Alfermann, & Lavalée, 2004). Therefore, it should be indicated that the youth performance sports index is only one out of many parameters evaluating the development of young athletes. **Reference** Abbott, A., & Collins, D. (2002). 157-178. Baker, J., & Horton, S. (2004). 211-228. Brouwers, J., De Bosscher, V., Schallée, H., Truyens, J., & Sofiriadou, P. (2010). 21-25. Howe, M., Davidson, J., & Sloboda, J. (1998). 399-442. Martindale, R. J., Collins, D., & Daubney, J. (2005). 353-375. Wylleman, P., Alfermann, D., & Lavalée, D. (2004). 7-20. **Contact** li.pingwei@vub.ac.be

### COMPARATIVE ANTHROPOMETRIC AND PHYSICAL CHARACTERISTICS OF YOUTH FOOTBALL PLAYERS AT THE VARIOUS STAGES OF AN INTERNATIONAL FOOTBALL TALENT SCREENING AND SELECTION PROGRAM.

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**Introduction:** This study compares the baseline anthropometric and physical performance characteristics of youth football players at the various levels of a four-stage international humanitarian football talent screening and selection project (Aspire Football Dreams) which aims to inspire hope in children in developing countries. Over the past 9 years, ~4.6 million boys from 19 developing countries across Africa, Asia and Latin America have registered for the project. This study includes data from the first 4 years of the project (2007-2010) as it takes a minimum 4 years to progress to Stage 4. **Methods:** Players were categorised based on the highest selection stage they achieved; Stage 1 - Country Finals (n=1823), Stage 2 - World Finals (n=49), Stage 3 - Educational and Sports Development Scholarship (n=64), Stage 4 - Professional Contract (n=20). Player progression was decided by a panel of coaches/staff based on a myriad of factors including technical, tactical, physical, psychological measures and predicted future potential. Only a limited number of players progress at any stage and they could opt to drop out at any time. Minimum age to progress to Stage 4 is 18 years old. Three anthropometric (height, seated height and body mass) and three physical performance measures (counter movement jump (CMJ) using a KMS jump mat, 40 m sprint with 10 m splits to assess peak velocity (m/s) using an electronic timing gate system, and a 20 metre multi stage shuttle run test) were assessed on all players during Stage 1. These measures were used for all subsequent analyses. **Results:** ANOVA analysis showed

that players that progressed to Stage 3 were significantly ( $p \leq 0.05$ ); taller (167.5 vs. 171.1 cm), heavier (55.8 vs. 59.0 kg), faster (40 m sprint – 5.67 vs. 5.43 s), more powerful (CMJ – 37.1 vs. 39.9 cm) and displayed greater endurance (20 m Shuttle score – 11.55 vs. 12.45 level) than those players who did not progress beyond Stage 1. Those players selected to Stage 4 failed to show any significant differences from the other stages which is likely due to the relatively low number of players ( $n=20$ ) progressing to this stage. Conclusion: These results suggest anthropometric and physical performance characteristics play an important role in the earlier stages of the selection program (Stages 1 to 3). However when it comes to the selection of players for a professional contract at Stage 4, other non-physical measures (i.e., technical skills, tactical understanding, personality, attitude etc.) become equally if not more important. Email: andrea.price@aspire.qa

## NOVEL METHOD FOR ASSESSMENT OF DURABILITY OF SAILING PROTECTIVE GARMENTS IN SIMULATED ENVIRONMENTS

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Competitive sailing is one of the extreme sports which is performed at high speeds in challenging weather and environmental conditions with strenuous physical demands placed on the athlete. Sailing garments need to satisfy numerous performance requirements, such as being ergonomically and thermo physiologically comfortable, highly aerodynamic, light weight, protect from UV radiation and the elements, and most importantly be strong to withstand constant abrasion and flexing but also with durability to withstand these rigours over the life of the garment. The fabrics and materials comprising these garments must remain waterproof after dynamic three-dimensional abrasion, multi-directional impact and extended wear and tear both in dry and especially wet conditions. Any leaks in these garments are generally considered a fail by most sailors and the garment would then to be replaced. Standard bench top tests exist for testing the materials for such attributes as abrasion resistance, puncture and tear resistance, generally separately for each attribute. In addition standardised hydrostatic head testing is common; however it does not give any indication as to how the fabric or material will perform in protecting the athlete after extended periods of use, especially in wet conditions. Waterproofing and breathability are two selected critical attributes that were addressed in the present study. Suitable novel experimental methodology, instrumentation and methods were developed to assess durability of these attributes for a number of materials containing breathable membranes, after prolonged simulated use in wet conditions. Results clearly indicate that the performance of the materials intended for sailing apparel must be considered not only as separate attributes in dry conditions but also in combination in dynamic wet conditions.

## VALIDITY AND RELIABILITY OF A NEW 16 HZ GLOBAL POSITIONING SYSTEM.

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Introduction Recently, studies reported that training load monitoring and the appropriately graded prescription of high training loads should improve players' fitness, which in turn may protect against injury (Gabbett 2016). In elite team sports, most of the sports scientist use Global positioning systems (GPS) to quantify training loads but some limitations have been raised concerning validity and reliability of GPS for measuring high-velocity activities and accelerations. Thus, the aim of this study was to assess the validity and reliability of a new 16 Hz GPS. Méthods Six Sensoreverywhere V2 GPS units (Digital simulation, Paris, France) were attached to a custom-made steal sled and pushed by an athlete performing linear 60-m run at four various constant speed ( $1.00 \pm 0.02$ ,  $2.00 \pm 0.11$ ,  $3.8 \pm 0.17$  and  $6.11 \pm 0.8$  m.s<sup>-1</sup>). Velocity was measured with 4 timings gates placed from 20-m to 40-m, separated by 5-m to ensure that speed was kept constant by the athlete. In order to assess maximal speed and acceleration, a radar was also placed at the start of the track for the sprinting condition. Results. There was a trivial bias between velocity measured with the GPS and the timing gates ( $0.11$ ,  $\pm 0.04$  m.s<sup>-1</sup>) and a trivial Typical Error of Measurement (TEM,  $0.04$ ,  $\pm 0.01$  m.s<sup>-1</sup> 90% confidence intervals). There was a low between-units TEM over the various constant speed tested ( $0.01$ ,  $\pm 0.01$  to  $0.04$ ,  $\pm 0.04$  m.s<sup>-1</sup> and  $0.5$ ,  $\pm 0.15$  to  $0.6$ ,  $\pm 0.35\%$  from walk to sprint respectively). Furthermore, assesment of both maximal speed and acceleration recorded during the sprint condition showed trivial between-units TEM (respectively  $0.06$ ,  $\pm 0.03\%$  and  $3.1$ ,  $\pm 6.4\%$ ). Conclusion This study was the first to analyze the validity and reliability of the Sensoreverywhere V2 16Hz GPS units. The results report low bias level and TEM confirming the validity of 16 Hz GPS for measuring speed over a range of velocities. Furthermore, high level of reliability have been reported in this study, confirming that increased sampling frequency seems to overcome limitations suggested concerning both high-velocity and acceleration monitoring in athletes (Scott et al. 2015). Therefore, 16 Hz GPS technology could be used to monitor training loads in team sports teams and seems to offers alternatives for the assessment of maximal speed and/or acceleration. Gabbett, T.J., 2016. The training-injury prevention paradox: should athletes be training smarter and harder? British journal of sports medicine. Scott, M.T.U., Scott, T.J.U. & Kelly, V.G., 2015. The validity and Reliability of Global Positioning Systems In Team Sport: A Brief Review. The Journal of Strength & Conditioning Research.

## ATTITUDE TOWARDS CONFLICT SITUATIONS IN A HANDBALL TEAM AMONG COACHES

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The aim of the study was to ascertain the attitude of handball coaches towards conflict situations with regard to selected socio-demographic characteristics. The sample consisted of 58 Slovenian handball coaches working in youth teams. Many differences were discovered between groups of participants. Female coaches held a higher degree of education compared to their male colleagues, and more of them were single (all younger than 31 years). More than half of all participants are involved in an emotional relationship and have children of their own. Generally speaking, coaches have a relatively neutral attitude towards conflicts; they admit their presence, but do not always act as to prevent them from happening. They do not immediately exclude a conflictive player from the team, but try to influence her/him. A conflict with the players or the team management does not divert them from their activity. Female coaches are "more tolerant" of conflicts in their team and seldom intervene between players. Older coaches tend to choose extreme statements. They admit the presence of conflicts, but do not seek reasons for them, often leaving the players to settle the conflict by themselves. Coaches involved in an emotional relationship are slightly more "tolerant" of conflicts. Less experienced coaches perceive conflicts as "less useful" compared to more experienced coaches, while professional coaches agree to a greater extent that conflicts must always be solved. Higher educated coaches tend to notice more conflicts, which probably comes as a consequence of their greater self-criticality. They more frequently see positive sides of conflicts and try to discover the causes for conflict arise.

**JUDO COACHES' VISUAL SEARCH STRATEGIES FROM "HAJIME" TO FIRST CONTACT**

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**Introduction** Athletes' visual search strategies are dependent upon ability and task demands. Yet, there is limited research into coaches' visual search strategies, and no understanding of judo coaches' visual search strategies when observing fights. The current research investigated judo coaches' visual search strategies from the beginning of fights to the first contact between athletes. **Methods** Twenty qualified coaches viewed footage of fights recorded from a position adjacent to the coach's chair at an international event. Judo athletes compete wearing white or blue judogi, and coaches were instructed to coach the athlete wearing white in all fights. Coaches' eye movements were recorded with SensoMotoric Instruments (SMI) Eye Tracking Glasses. Eye movements were mapped frame-by-frame to areas of interest (AOIs) using SMI BeGaze software. **Results** Significantly more time was spent fixating on the athletes in comparison to the referee, scoreboard, and irrelevant areas ( $p < 0.02$ ). There was no significant difference between time spent fixating on each athlete, or time spent fixating on the athletes and the space between them. Time spent fixating on the space between the athletes was significantly greater than that spent on the referee and irrelevant areas ( $p < 0.02$ ). There were a greater number of fixations on the athletes compared to the referee, scoreboard, and irrelevant areas ( $p < 0.002$ ). There was no significant difference in the number of fixations on each athlete, or in the number of fixations on the athletes and the space between them. The number of fixations on the space between the athletes was greater than those on the referee and irrelevant areas ( $p < 0.007$ ). **Discussion** Coaches fixated more frequently and for longer on the athletes and the space between them. No significant difference between fixation frequency and duration between athletes and the space between them suggests that the space and the athletes are of comparable importance to the coach. Research suggests that central areas act as anchors for visual search, with peripheral vision obtaining information from other areas (e.g., Milazzo et al., 2015; Piras et al., 2014). Results from the current study suggest that judo coaches may utilise the space between the athletes as an anchor for their visual search. Future research should investigate the pattern of visual search to better understand how coaches use this space. **References** Milazzo, N. et al. (2015). Do karate fighters use situational probability information to improve decision-making performance during on-mat tasks? *J Sports Sci*, DOI: 10.1080/02640414.2015.1122824 Piras, A. et al. (2014). Visual search strategy in judo fighters during the execution of the first grip. *Int J Sports Sci Coaching*, 9, 185-197 Contact: paul.robertson@student.anglia.ac.uk

**MODELLING BATTING EXPERTISE FROM THE PERSPECTIVE OF HIGH PERFORMANCE COACHES**

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Cricket coaching literature on developing batting expertise has largely focused on the individual, and typically, technical features of batting. Research in cricket batting has addressed developmental factors of expertise (Weissensteiner, et al., 2009) or the perceptual advantage of expert batters (Muller & Abernethy, 2006). Little attention has been paid to the importance of the individual-environment relationship in expert behaviour. In order to address this missing ingredient, one on one, in-depth, semi-structured interviews were undertaken by the primary researcher with eight high performance coaches (e.g., international or state) who were purposively sampled from Cricket Australia or State Cricket associations. Six of these coaches had played international cricket as batsmen, one played state level and one a first grade player. Interviews were transcribed verbatim and coded separately by the first and second author after each interview. The third author then reviewed all codes and provided feedback. Strategies used to enhance validity included; sampling coaches of different high performance levels and retrospective member checking with coaches. Key themes that emerged include expert's superior knowledge of, and attunement to internal (e.g., emotions) and external (e.g. pitch type, field settings) information. This informs their intentions, perceptions and actions to achieve the task goal at any game moment. A skilful batter has time to execute their action and is in 'rhythm' with the bowler through attunement to specifying information sources. Experts also adapt to and manipulate the performance environment. Self-evaluative processes, through between-ball routines provide opportunity to reflect, re-evaluate and plan for the next delivery. Examples include; changing stance, forcing field changes or manipulating bowler's emotions. These results highlight the importance of capturing the experiential knowledge of high performance coaches that cannot be obtained through traditional laboratory based studies. For cricket batting coaches, this work emphasizes the importance of designing learning environments that enable players to better understand their own performance in the context of emergent dynamic game-based constraints. Müller, S., & Abernethy, B. (2006). Batting with occluded vision: An in situ examination of the information pick-up and interceptive skills of high-and low-skilled cricket batsmen. *Journal of Science and Medicine in Sport*, 9(6), 446-458. Weissensteiner, J., Abernethy, B., & Farrow, D. (2009). Towards the development of a conceptual model of expertise in cricket batting: A grounded theory approach. *Journal of applied sport psychology*, 21(3), 276-292.

**Mini-Orals****MO-PM07 Team Sports****ACTIVITY PROFILES AND FATIGUE IN INTERNATIONAL FEMALE TEAM HANDBALL USING PLAYER LOAD™**

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**Introduction** Handball matches place diverse physical demands on players, which may result in fatigue and decreased activity levels. However, previous speed-based methods of quantifying player activity may not be sensitive for capturing short-lasting handball-specific movements. Therefore, the aim was to examine activity profiles of a female handball team and individual player profiles, using inertial measurement units (IMUs). Development of fatigue, indicated by temporal or transient declines in activity, was of special interest. **Methods** Match data was obtained from one female national team in nine international matches ( $n=85$  individual player files), using the Catapult OptimEye S5 (Catapult Sports, Australia). Player Load™/min, an accelerometer-derived measure of intensity, was analyzed for 5- and 10-min periods. Team activity levels represent intensity of the players on the field in the given period (minimum one-min field time), and are presented as a percentage of their match average. Individual player activity levels are based on periods with a minimum of 60% field time, and are expressed as a percentage of their average in these 5-min periods. Magnitude based inferences were used to de-



scribe probabilities of substantial differences between single or pooled periods. Results A high initial intensity was observed for team profiles (110% of match mean), and for players with 2 or more consecutive periods of play (107% of 5-min mean). Substantial declines in Player Load™/min were observed throughout matches for the team (91% of match mean in the least intense period), and for players with several consecutive periods of field time (90% of 5-min mean in the seventh period). Intensity increased substantially in the final five min of the first half for team profiles, and the first ten min of the second half were substantially lower than the corresponding first half period. Activity levels were substantially lower in the five min after a player's most intense period, and were partly restored in the subsequent 5-min period. Conclusions Declines as observed in activity profiles for the team and individual players may be indicative of temporal and transient fatigue during handball matches. Underlying mechanisms were not accounted for, yet situational factors and pacing strategies are suggested as possible contributing factors, based on previous team-sport studies. References Michalsik LB, Madsen K, Aagaard P (2014). Match performance and physiological capacity of female elite team handball players. *Int J Sports Med*, 35(7), 595-607. Karcher C, Buchheit M (2014). On-court demands of elite handball, with special reference to playing positions. *Sports Med*, 44(6), 797-814. Edwards AM, Noakes TD (2009). Dehydration: cause of fatigue or sign of pacing in elite soccer? *Sports Med*, 39(1), 1-13. Contact eirik.h.wik@gmail.com

## DEFENSIVE BALANCE IN ELITE FOOTBALL: MAKING RELIABLE OBSERVATIONS

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Introduction It has been found that teams show anti-phase coordination during goal-scoring opportunities in elite football (soccer; Moura et al., 2016). These contrasting movements can be interpreted as a perturbation of the defensive team's balance in relation to the offensive one. The concept of defensive balance has been introduced before and deemed crucial for the efficacy of playing styles (Tenga et al., 2010). The aim of this study was to determine the reliability of expert observations of defensive balance to possibly extract patterns within successful attacking sequences. Methods Ten performance analysts, coaches, and scouts (7±5yrs of experience with match analysis) analysed five clips involving goal-scoring opportunities in matches between different elite international teams in a randomised order. The defensive balance within the defending team was rated in 1s-intervals on a 5-point scale. A slope of every four consecutive log-transformed ratings was calculated to determine the time window where defensive balance was disturbed most strongly (SLP). After every clip, participants also had to indicate which second they deemed decisive during the attacking sequence (SEC). Agreement was calculated as the percentage of ratings corresponding to the mode, the most reported rating for one variable, and statistically tested with a paired samples T-test. Results Ratings of defensive balance in 1s-intervals agreed by 58.2±3.8% between participants. The conversion of these ratings led to an agreement of 52.0±23.9% for SLP. A tendency towards a significantly higher agreement was found compared to SEC (36.0±11.4%; P=0.08). By including those ratings within 1s of the mode, the agreement of SLP and SEC increased to 70.0±14.1% and 50.0±18.7%, respectively. This allowance did not significantly change the agreement within methods (P=0.07&P=0.14), however the agreement within SLP was significantly higher than that within SEC after allowing for a 1s-variance (P=0.05). Discussion The method that used the second-by-second ratings of defensive balance and transformed those into a slope describing the change in balance over a 4s-window (SLP), proved to be more reliable when allowing a 1s-deviation from the mode compared to a self-selected time frame (SEC). This shows that the concept of defensive balance requires more than merely subjective ratings of experts. The strong agreement within SLP could enable indicating what player actions are most detrimental to a team's defensive balance. This might provide useful information towards improving team performance and the quality of opposition scouting. References Moura FA, Van Emmerik REA, Santana J, Cunha SA (2016). *J Sports Sci*, In Press. Tenga A, Holme I, Ronglan LT, Bahr R (2010). *J Sports Sci*, 28(3), 245-255. Contact emiel.schulze@uni-saarland.de

## PRESEASON INTERNAL AND EXTERNAL LOAD OF A PROFESSIONAL BASKETBALL TEAM

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Introduction Training load calculation has become an important topic in team sports to design better training schedules and to achieve a better performance, while avoiding overtraining and injuries. Internal and external loads are necessary to describe both, the structure of the game or practice and the effect caused by that load over the players (Wallace et al. 2014). Our work combined different methods to assess load dynamics during the six weeks of the preseason of a professional basketball team. Methods Six professional basketball players participated in the study. Rate of perceived exertion (RPE), heart rate variability (HRV), modified summated heart rate zones (mSHRZ), overall distance covered (LOAD), high intensity efforts (HIE) and HIE to active time ratio (HIEr) were registered during the six pre-season weeks of a Spanish professional basketball team. Two practices, consisting in weight lifting and shootaround, were not considered in the study. Results HRV and RPE internal load markers showed a large negative correlation ( $r = -0.80$ ) while in-session internal mSHRZ and external HIEr showed also a large but positive correlation ( $r = 0.52$ ), according to Cohen's convention. Both LOAD and HIE increased throughout the preseason period. Discussion Although some relations have been found between internal and external load markers, it is common to observe that those parameters progress in different ways (Scanlan et al. 2014). Internal off-session load markers had a good agreement while seemed not to be well correlated with external load markers, more than probably due to the quality and quantity of the resting period and because physical improvements were not taken into account (Wallace et al., 2014). LOAD and HIEr and their ratio (HIEr/LOAD) increased during the preseason, especially during the last three weeks of the period, as observed in some other works. Internal and external load seem to give different information that must be taken into account to improve training design (Manzi et al., 2010; Scanlan et al., 2014). References Manzi, V., D'Ottavio, S., Impellizzeri, F. M., Chaouachi, A., Chamari, K., & Castagna, C. (2010). *Journal of Strength and Conditioning Research / National Strength & Conditioning Association*, 24(5), 1399-406. Scanlan, A. T., Wen, N., Tucker, P. S., & Dalbo, V. J. (2014). *Journal of Strength and Conditioning Research / National Strength & Conditioning Association*, 28(9), 2397-405. Wallace, L. K., Slatery, K. M., Impellizzeri, F. M., & Coutts, A. J. (2014). *Journal of Strength and Conditioning Research / National Strength & Conditioning Association*, 28(8), 2330-7. Contact: dani.moreno@dmtrainingpro.com

## REPEATED-SPRINT RUNNING IN HYPOXIA ALTERS COGNITIVE FUNCTION IN TEAM-SPORT ATHLETES

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**Introduction** Repeated-sprint training in hypoxia (RSH) further improves repeated-sprint ability compared with training in normoxia (RSN; Faiss et al. 2013). Although these findings suggest that RSH is valuable for team-sport athletes, further research is required to ensure that there are no undesirable effects associated with RSH. For example, Li et al. (2000) demonstrated that 1 h of passive exposure to altitude can impact cognitive function which may predispose athletes to reduced neuromuscular control and risk of injury (Swanik et al. 2007). The purpose of this study was to determine the effects of RSH on cognitive performance in team-sport athletes. **Methods** Male team-sport athletes ( $n=12$ , 24 (5) yr) performed a computer-based cognitive test battery assessing choice reaction time (identification task; IDN) and spatial memory (one card learning task; OCL) before and after repeated-sprint running (4 sets  $\times$  4, 4-s sprints; i.e., RSR444). Subjects performed the RSR444 on a non-motorized treadmill in normobaric normoxia (20.9%O<sub>2</sub>) and hypoxia (14.5%O<sub>2</sub>). Results Peak speed and distance achieved during Set 1 and Set 2 of the RSR444 were not different between conditions ( $p>0.05$ ). However, both peak speed and distance achieved during Set 3 and Set 4 were lower in hypoxia compared with normoxia ( $p<0.05$ ). Mean SpO<sub>2</sub> was 94.5(1.8)% in normoxia and 79.4 (4.0)% in hypoxia after the RSR444. There were no differences in the mean reaction time (RT) for the IDN ( $p=0.34$ ) or the OCL accuracy score ( $p=0.49$ ) before the RSR444 between the two conditions. After the RSR444, no changes were observed in RT for the IDN in either normoxia ( $p=0.55$ ) or hypoxia ( $p=0.18$ ). The OCL accuracy score did not change after the RSR444 in normoxia ( $p=0.54$ ) but accuracy was lower after the RSR444 in hypoxia ( $p=0.03$ ). **Discussion** The findings of the present study demonstrate that simple cognitive tasks (i.e., IDN) are not affected by repeated-sprint running in either normoxic or hypoxic environments. In contrast, repeated-sprint running decreases performance of complex cognitive tasks (i.e., OCL accuracy) when performed in hypoxia but not normoxia. Given the negative relationship between cognitive function and noncontact lower-limb injury in athletes (Swanik et al. 2007) coaches should be considerate of the effects of hypoxia on cognitive function when prescribing RSH. **References** 1. Faiss, Girard, Millet (2013) Br J Sports Med 47:145-150 2. Li, Wu, Fu, Shen, Yang, Wu (2000) Space Med Med Eng 13:235-239 3. Swanik, Covassin, Stearne, Schatz (2007) Am J Sports Med 35:943-948 jaime.morrison@griffithuni.edu.au

## BALANCE CONTROL UNDER PHYSICAL LOAD AT YOUTH ELITE SOCCER PLAYERS

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**Introduction** Balance control (BC) plays a decisive role in the realisation of soccer-specific skills (Chew-Bullock et al., 2012; Béraud & Gahéry, 1997). Fatiguing exercise can impair BC (Douris et al., 2011). Hence, it is aim of the quasi-experimental study to investigate, how BC is influenced by increasing load. **Methods** Male youth elite soccer players, separated in load group (L;  $n=15$ ; 13.5 $\pm$ 0.1 y, 50.6 $\pm$ 1.8 kg, 165 $\pm$ 2 cm) and in control (C;  $n=11$ ; 14.1 $\pm$ 0.2 y, 45.8 $\pm$ 2.6 kg, 158 $\pm$ 3 cm) previously performed a physical test to determine the heart rate(HR)max. The L carried out a stepwise incremental running protocol (starting with 7.2 km/h by 1.4 km/h increase every 5 min until volitional exhaustion). After the warm-up and between each 5 min load, a balance test (BT) was performed. The C performed the BT after the warm-up and 6 times every 5 min in rest conditions. Posturographic data were collected by means of BT for 32 s; first with preferred and then with non-preferred leg on a swinging platform (Posturomed, Haider Bioswing®, GER) under standardised conditions (Bruhn et al., 2001). The mean acceleration of both legs (am) were calculated and subsequently analysed. Three-five months later, the L repeated test series. HR in both group; blood lactate (BL) and oxygen consumption (O<sub>2</sub>) were measured in L. ANOVA with repeated measures was used. Results HR-values of the C after warm-up were 115 $\pm$ 14 bpm (57 $\pm$ 6% HRmax) and in average for rest conditions 100 $\pm$ 11 bpm (50 $\pm$ 5% HRmax). In contrast, HR-values of the L progressively ascended and achieved 193 $\pm$ 8 bpm (100 $\pm$ 3% HRmax) in the exhausting load. Maximal BL and O<sub>2</sub> were 6.0 $\pm$ 1.7 mmol/l and 2.9 $\pm$ 0.5 l/min (94 $\pm$ 5% O<sub>2</sub>max). The C constantly improved am-values from 15.6 $\pm$ 5.6 mm/s<sup>2</sup> (warm-up) to 5.5 $\pm$ 1.0 mm/s<sup>2</sup> (last try). The L improved BC from 8.8 $\pm$ 3.7 mm/s<sup>2</sup> (warm-up) to 7.1 $\pm$ 2.5 mm/s<sup>2</sup> (penultimate try). However, after the exhaustion step deteriorated a little am-values 7.2 $\pm$ 2.5 mm/s<sup>2</sup>. Same behaviour could be held in the second test series. **Discussion** Youth soccer players show compensatory skills to maintain BC under stress conditions. Only under very exhausting loads they were not able to sustain the quality of BC. Results of the study could be used for training methodology of technique and coordination skills. **References** Béraud, P. & Gahéry, Y. (1997). Neuroscience Letters, 226 (1), 5–8. Bruhn, et al. (2001). European Journal of Sports Traumatology and Related Research, 23 (2), 82–89. Chew-Bullock, et al. (2012). Human Movement Science, 31 (6), 1615–1623. Douris, et al. (2011). Journal of strength and conditioning research, 25 (12), 3299–3305. Contact spo09jrx@studserv.uni-leipzig.de

## MODELING LONGITUDINAL CHANGES IN ISOKINETIC AND ISOMETRIC STRENGTH OF THE KNEE IN ADOLESCENT SOCCER PLAYERS

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1: UC (Coimbra, Portugal), 2: UC (Ghent, Belgium), 3: UP (Porto, Portugal), 4: UT (Texas, EUA) **Introduction** This study examined the contributions of growth, estimated body composition and skeletal maturity to developmental changes in isometric and isokinetic strength of the knee extensors and flexors in a mixed-longitudinal sample of youth soccer players. **Methods** 67 Belgian players with chronological ages (CA) 10.5 to 13.6 years at baseline were followed on three to five occasions over five years. Stature, body mass, skinfold thicknesses, isometric strength of the knee extensors (ImKE) and knee flexors (ImKF), and isokinetic knee extension (IsoKE) and flexion (IsoKF) using a concentric protocol (180°/s) were measured. Skinfolds were used to predict % of fat; fat mass (FM) and fat-free mass (FFM) derived. Skeletal age (SA) was estimated with the TW2 RUS method. Multilevel random effects regression analyses were used to derive developmental polynomial models (MLwIn 2.02). Results In four significant longitudinal models, an increase of 1 year in chronological age predicted 10.7N (ImKE), 2.7N (ImKF), 5.4N.m (IsoKE) and 2.7N.m (IsoKF), respectively. A gain of 1 kg of FM corresponded to an increment of 1.4N in ImKE, while a gain of 1 kg of FFM corresponded to an increase of 2.1N (ImKF), 1.4N.m (IsoKE) and 1.6 N.m (IsoKF). An SA classified as average (on time) or advanced (early) corresponded to advantage of 5.2N or 6.5N in ImKE, respectively. **Discussion** The different knee strength outputs had distinct developmental models across adolescence, but CA and CA squared were predictors in three of the four measures. SA contributed to longitudinal changes in isometric extensor strength, while body composition, especially FM, contributed to longitudinal changes in dynamic strength protocols. The results suggested a potentially important role for allometric multilevel modeling in partitioning effects attributed to indicators of body size, maturity status and training. **References** Nevill, AM, Holder, RL, Baxter-Jones, A, Round, JM, Jones, DA (1998). Modeling developmental changes in strength and aerobic power in children. J Appl Physiol, 84(3), 963-970. Ras-

bash, J, Browne, W, Goldstein, H, Yang, M, Plewis, I, Draper, D, . . . Woodhouse, E (1999). A user's guide to MLwiN: London : Institute of Education. Contact joapedromarquesduarte@gmail.com

### TRAINING INDUCED CHANGES IN EXTERNAL LOAD ON ACADEMY SOCCER PLAYERS

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**Introduction** A combination of GPS and accelerometry data can quantify the external load experienced by an athlete to analyse performance and monitor training load. The aim of this study was to determine the effect of a training intervention on external load and sport-specific fitness in soccer players. **Methods** Nine Academy soccer players (age  $17 \pm 1$ , height  $1.76 \pm 0.84$  m and mass  $68.3 \pm 7.5$  kg) completed a 6-week gym- (2x1 hours per week) and field-based training intervention (2x1 hours per week) with a focus on eccentric and deceleration exercises. Pre and post-intervention measures of anaerobic capacity were determined by a Triple 120 m test (Holloway et al., 2008) modified for soccer players. The modified T120 consisted of 3 bouts of 12 x 10 m shuttle sprints with a chest-to-floor drop and 5 toe-taps on the 1st, 5th and 9th shuttle. Bouts were separated by 1 minute low intensity active recovery. Players wore GPS and accelerometer monitors (Catapult Optimeye S5) during the tests. Time to complete modified T120, average bout time, Player Load (external load) and Player Load/min were calculated (recovery periods excluded from all parameters). **Results** Paired t-tests identified significant reductions in the time to complete the modified T120 (119.91s to 116.96s,  $p=0.033$ ), mean time per bout (39.97s to 38.99s,  $p=0.033$ ) and Player Load (54.4 to 52.6,  $p=0.045$ ) following the intervention. **Discussion** The reduced external load is indicative of an improved economy of movement during the modified T120. Potentially, the load associated with accelerating and decelerating during the modified T120, which are physically demanding actions and key determinants of soccer performance (Osgnach et al., 2010), might have been reduced following training. This is likely due to improved damping of ground reaction forces through the lower limb as a result of eccentric training. The reduced external load is particularly interesting given the faster performance of the modified T120 test observed. This is in agreement with Akenhead et al., (2013) who previously observed reduced PL at constant pace following training. This study provides a basis for assessing external load alongside variations in physical performance and internal load. **References** Akenhead, R., Hayes, P.R., Thompson, K.G. and French, D. (2013). Diminutions of acceleration and deceleration output during professional football match play. *Journal of Science and Medicine in Sport*, 16(6), pp.556-561. Holloway, K.M., Meir, R.A., Brooks, L.O. and Phillips, C.J. (2008). The triple-120 meter shuttle test: a sport-specific test for assessing anaerobic endurance fitness in rugby league players. *The Journal of Strength & Conditioning Research*, 22(2), pp.633-639. Osgnach, C., Poser, S., Bernardini, R., Rinaldo, R. and Di Prampero, P.E. (2010). Energy cost and metabolic power in elite soccer: a new match analysis approach. *Med Sci Sports Exerc*, 42(1), pp.170-178.

### THE IMPACT OF YOUTH SOCCER TRAINING & MATCH-PLAY ON THE HABITUAL SLEEPING PATTERN OF YOUTH SOCCER PLAYERS.

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**Introduction** Sleep is often regarded as one of the most important recovery strategies available to athletes. It is suggested that the sleep of athletes is sub-optimal. This may relate to factors associated with sports performance that may impact sleep (Leeder, et al, 2012). The current study was designed to investigate the habitual sleeping patterns of youth soccer players and to identify potential factors related to the physical demands of the sport that may affect sleep. **Methods** Sleep was collected over a 14-day in-season period during the soccer season within the habitual setting of the players. Sleep was detected using a commercially available EEG wireless sleep monitor (Zeo Inc, Newton, MA). Each collected sleep variable; time of lights out (TOLo), time of final awakening (TOFA), sleep onset latency (SOL), total sleep time (TST) and time spent in wake (TWAKE) was compared for a specific day within the training schedule (i.e. match day (MD), the number of days away from the next match MD- 5, MD-4, MD-3, MD-2, MD-1 and recovery days (M+1)) and to training/match load metrics such as total distance (TD) and high-speed distance (>5.5 m/s) (HSD) collected from a GPS system (STATSports Viper, Ltd). The data were analysed using linear mixed models to assess the effects of the schedule and physical load on the sleep variables. **Results** The youth soccer players displayed an average SOL of  $29 \pm 23$  min, a TST of  $462 \pm 72$  min and TWAKE of  $14 \pm 2$ . The TST was lower (~66 min) on the recovery days following the match day (M+1) in comparison to the training days preceding the match (M-1 & M-2) ( $p < 0.05$ ). SOL and TWAKE were not affected by the type of day in the schedule ( $p > 0.1$ ). A 100m increase in HSD increased TWAKE by 2 min (0.06 to 3 min,  $p = 0.0015$ ) and also delayed TOFA by 8 min (3 to 15 min,  $p = 0.00009$ ). **Discussion** The youth soccer players attained a sufficient sleep quantity to maintain healthy function (Ferrara & De Gennaro, 2001), though may fall short of the >8 h sleep recommendation for athletes. Sleep loss on designated recovery days following the match day may impact the process of recovery. Our findings indicate an increase in training intensity (HSD) may increase the level of disturbance (TWAKE) each night. **References** Ferrara, M., & De Gennaro, L. (2001). How much sleep do we need? *Sports Medicine Reviews*, 5(2), 155-179. Leeder, J., et al. (2012). Sleep duration and quality in elite athletes measured using wristwatch actigraphy. *Journal of Sports Sciences*, 30(6), 541- 545. Contact: c.turner3@2009.ljmu.ac.uk

## Mini-Orals

### MO-PM53 Coaching: Training Effects

#### TRAINING VOLUME IN DIFFERENT SPORTS IN FUNCTION SEX AND AGE

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**Introduction** Training load can be determined by its relationship between training intensity and volume (Laursen, 2010). The volume can be varied in function several aspects: athlete's characteristics, sport, type of periodization, among others. The aim of this study was to analyse the volume of training in several sports in function of sex and age. **Methods** 302 athletes (male,  $n=132$ ; female,  $n=170$ ) of different sports participated in this study (artistic gymnastics, athletics, basketball, beach volleyball, golf, judo, shooting, swimming, table tennis, tennis and volleyball). The athletes were classified by sex, sport and age (younger: 20 years old or under, medians: between 21 and 30

years, older: 31 years old or above). The athletes completed a questionnaire about the training volume and competition. A one-way ANOVA with a Bonferroni post-hoc test was used to establish differences by sex, sport and age group. Results There was no differences between males and females in any item. The younger athletes train more time per week than medians ( $16.89 \pm 4.80$  hour vs  $15.40 \pm 4.92$  hour,  $p < .001$ ), who train more time than older athletes ( $12.87 \pm 4.31$  hour;  $p < .001$ ). Artistic gymnastic athletes and swimmers shown the longer training time per week ( $20.07 \pm 4.07$  hour;  $20.13 \pm 4.17$  hour, respectively). Discussion The volume of training per week is lower than the recommendation for elite athletes (25-30 hours per week) (Baker et al. 2003). This recommendation is not met by either males or females. In regards to age, younger athletes train more hours per week than older athletes, this could indicate the relevance of the training intensity in older athletes (Tota et al., 2015). The volume of training per week is lower than the recommendation for elite athletes (25-30 hours per week) (Baker et al. 2003). This recommendation is not met in either males or females. In regards to the age, the younger athletes train more time per week than older athletes, this could indicate the relevance of the training intensity in older athletes (Tota et al., 2015). Finally, artistic gymnastic athletes and swimmers reported more training hours per week than other athletes. That could be explained by high physical, technical and psychological demands of this two sports. References Baker J., Cote, J., Abernethy, B. (2003). J Appl Sport Psych, 15(1), 12–25. Laursen, P. B. (2010). Scand J Med Sci Sports, 20, 1–10. Tota, L., Maciejczyk, M., Pokora, I., Cempla, J., Pilch, W., Pałka, T. (2015). J Hum Kinet, 49, 149-158.

## WEIGHTLIFTER TRAINING PROCESS DESIGN TAILORED TO INDIVIDUAL GENETIC TRAITS

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**Introduction** It is known that efforts to mobilize individual strength qualities in a weightlifter may be limited by specific genetic traits of the athlete's body. Training process design with an emphasis on the workloads and intensities tailored to the specific genetic traits of weightlifters may provide a basis for the training process being managed in a most efficient manner. This idea was the prime reason for the study to analyze genetic traits of elite weightlifters and compare them with their adaptation progress under variable training workloads. **Methods** We applied a DNA genetic analysis based on polymerase chain reaction (PCR) data flow generated in a real-time mode to identify and rate the genetic-traits-specific performance efficiency of elite weightlifters in the training process. Furthermore, we developed and applied a special Sport 3.0 Computer Software for analysis of the training workloads under the study. This software was designed to provide data on the workload values, variations and correlations in the course of the subject athletes' training cycles. Subject to the tests and analysis were 110 professional athletes who were tested for ACE, ACTN3, PGC1a and MSTN genes. The test data were processed using regular mathematical statistic tools. **Study results** The athletes tested with SS genotype of PGC1a gene were found to demand the lowest workloads [to attain the same result] in the macro-cycle training process versus that of the athletes tested with other genotypes of the same gene. The athletes having a heterozygote or tested with LL genotype of MSTN gene also showed better performance in adaptation to the training workloads over the training process macro-cycle ( $P < 0.01$ ). **Discussion** The elite athletes tested with SS genotype of PGC1a gene were found to comprise 21.6% of the total sample. This genetic trait appears to give them advantage in the macro-cycle training process as they require 1.5 lower training workloads in the process [to achieve the same result] versus the athletes tested with some other genotypes (Aksenov M.O., 2015). We copied the athletes' individual training workload data records from their training logs and input these data into the application Sport 3.0 Computer Software to rate the workloads versus the tested genotypes. The study data and analysis confirmed the athletes tested with LL genotype and heterozygote in MSTN gene also having an adaptation advantage in the process (Akhmetov I.I., 2015). **References** Aksenov M.O. (2015). Correlation of adaptation rate of athletes and intensity of training load within mesocycle (case study of powerlifting). Arctic Dialogue in the Global World: Proceedings of the Joint Science and Education Conference. Ulan-Ude: BSU. 493-494. Akhmetov I.I., Rogozkin V.A. (2013). The Role of PGC-1 $\alpha$  in the Regulation of Skeletal Muscle Metabolism. Hum Physiol. 39(4), 441-449. **Acknowledgements** The work was done within the framework of the state order of the Ministry of Education and Science of the Russian Federation, the project #3842. Contact: 6730@mail.ru

## COMPARISON OF INTRA-ABDOMINAL PRESSURE IN MAXIMAL ARM STROKE, LEG KICK AND WHOLE BODY SWIMMING

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**Introduction** Arm stroke (A) and leg kick (K) training as well as whole body swimming (S) have been used in the daily training regime. Since intra-abdominal pressure (IAP) as an index of trunk stability in S increases with swimming speed (Moriyama et al., 2014b), it is suggested that to enhance IAP is important for improving swimming performance. However, IAP in S with front crawl swimming has been already determined (Moriyama et al. 2014a,b), but not those in A and K. Therefore, this study aimed to determine how extent IAP increases in maximal A and K, and to compare them to that in maximal S. **Methods** Eleven well trained competitive collegiate female swimmers (height  $1.61 \pm 0.04$  m, weight  $54.9 \pm 5.8$  kg, maximal IAP in the Valsalva maneuver  $11.7 \pm 4.8$  kPa) participated in this study. Subjects performed A, K and S with maximal effort in a normal swimming pool. IAP was taken as the difference between minimum and maximum values using the mean of 3 stable front crawl stroke cycles. IAP in A, K and S were normalized based on the maximal voluntary IAP obtained with the Valsalva maneuver (%maxIAP). **Results** IAP and %maxIAP in S ( $2.7 \pm 0.5$  kPa,  $25.7 \pm 8.7$  %) were significantly higher than those in both A ( $1.1 \pm 0.5$  kPa,  $9.5 \pm 2.4$  %) and K ( $1.8 \pm 0.5$  kPa,  $17.3 \pm 8.1$  %), and furthermore those in K were significantly higher than in A. IAP in A and K corresponded to 39.9 % and 66.8 % of that in S, respectively. On the other hand, when IAP in S was compared to the sum of IAP in A and K ( $2.9 \pm 0.8$  kPa), no significant difference was found between them. **Discussion** In this experiment, IAP in A and K were significantly lower than that in S, and that in K was significantly higher than that in A. However, no significant difference was observed in IAP between S and the sum of A and K. It has been suggested that an increase in IAP is responsible for the action of the upper and/or lower limbs (Harman et al. 1988), intensity and velocity of movement (Cresswell et al. 1994). Our findings agree with suggestion in previous studies, and imply that IAP in front crawl swimming depends on amount of muscle activity on each limbs involved in A and K. **References** Cresswell AG and Thorstensson A. (1994). Eur J Appl Physiol, 68(4), 315-321. Harman EA, Frykman PN, Clagett ER, Kraemer WJ. (1988). Med Sci Sports Exerc, 20(2), 195-201. Moriyama S, Kanazawa S, Yamagata K, Kitagawa Y, Ogita F, Takahashi H, Hirano Y. (2014a). J Exerc Sports Physiol, 21(1), 9-15 (in Japanese). Moriyama S, Kanazawa S, Yamagata K, Kitagawa Y, Ogita F, Takahashi H, Hirano Y. (2014b). Int J Sports Med, 35(2), 159-63. Contact moriyama.shinichiro@gmail.com



## EFFECT OF THE TRAINING PROGRAM APPLIED TO ELITE WRESTLERS ON SOME PHYSICAL, PHYSIOLOGICAL AND BIO-CHEMICAL PARAMETERS

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**INTRODUCTION** Until today wrestling training programs have been prepared either single-ended or double-ended. For since wrestling championships organized in the senior, junior and schoolboy categories are held in the form of one or two tournaments a year, these two programs have kept their validity. However, today, it has become a necessity to prepare multi-ended programs especially for elite wrestlers. The most important reason for this is the increase in the number of tournaments in a year in which elite wrestlers are required to show the highest performance. Therefore, the purpose of the study was to determine if the three-month training program applied to the elite wrestlers had any effects on some physical, physiological and biochemical parameters. **METHODS** 21 male freestyle wrestlers (mean  $\pm$  SD; age  $19.5 \pm 2.7$  year, height  $172.6 \pm 7.6$  cm, weight  $80.6 \pm 16.5$  kg), who have been performing wrestling for approximately 9 years, volunteered in the present study. The subjects were applied in the three-month training program which was planned according to double-ended training periodisation. At the beginning and end of the program, the subjects were administered the body composition measurement, vertical jump test, handgrip strength test and biochemical analysis (Rbc, Hct, Hb and blood glucose). **RESULTS** At the beginning and end of the training program was determined respectively that the subjects' average vertical jumps were  $39.8 \pm 4.3$  cm and  $42.1 \pm 3.9$  cm, right paw strengths  $49.8 \pm 7.9$  and  $53.5 \pm 8.1$  kg ( $p < 0.05$ ), left paw strengths  $46.3 \pm 7.5$  and  $51.1 \pm 7.4$  kg, RBC  $4.41 \pm 0.01$  ( $\times 10^{12}/l$ ) and  $4.57 \pm 0.02$  ( $\times 10^{12}/l$ ), HCT between  $0.369 \pm 0.001$  and  $0.401 \pm 0.002$  (l/l), Hb  $132.1 \pm 0.35$  and  $135.5 \pm 0.52$  g/l, blood glucose resting  $97 \pm 5.11$  and  $88 \pm 4.45$  mg/cm<sup>3</sup> ( $p < 0.05$ ). **DISCUSSION** Mirzai et al.1 found that the two different training programs which they applied to the wrestlers increased strength, hypertrophy, anaerobic force and endurance in them. Some studies indicate that strength increase affects other characteristics of performance (endurance, speed and the like) in a positive way.2,3. It is observed that the positive effects which the training program applied in our study had on the wrestlers' anaerobic force and static strengths are similar to those of the above-mentioned studies. In conclusion, qualitatively and quantitatively detailed, different training programs applied to wrestlers have positive effects on wrestlers' biochemical, physical and physiological characteristics. For this reason, it is suggested that training programs be prepared by sport scientists and trainers via considering these effects of training programs. **REFERENCES** 1.Mirzaei B, Arazai H, Curby D, Barbas I, Moghaddam Mg, Hosseini Y. (2012) *Int J Wrestling Stud*, 2(1), 41 (2012). 2.Wenzel RR, Perfetto EM. (1992) *J Appl Sport Sci Res*, 6, 82. 3.Wilson GJ, Newton RU, Murphy Aj, Humphries BJ (1993). *Med Sci Sports Exerc*, 25, 1279.

## ASSESSMENT OF AEROBIC AND ANAEROBIC CAPACITY OF SWIMMERS. A PILOT STUDY

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**Introduction** Significant modulations of the body's ability to produce energy through the aerobic and anaerobic metabolism occur during adolescence. The measurement of lactic acid in different swimming events is of particular scientific interest and is also a useful tool for coaches in order to assess anaerobic capacity of the swimmers (Avlonitou, 1996). The purpose of the present study is to identify differences between swimmers of various distances: a) short, b) medium and c) long, during a 100m effort of maximum intensity and a 400m effort in each swimmer's individual lactate threshold intensity (Olbrecht, 2000). **Methods** The sample consisted of  $n=16$  swimmers (12 male, aged  $16.1 \pm 1.5$  years, and 10 female, aged  $15.4 \pm 0.7$  years). The sample was divided in swimmers of short, medium and long distances. All swimmers swam in different sessions a) 100m freestyle swimming of maximum intensity and b) 400m freestyle swimming in each swimmer's individual lactate threshold intensity. Immediately after each effort capillary blood samples were taken at the 3rd, 5th and 7th minute of passive recovery and were analyzed by the automatic analyzer Scout Lactate Germany. Heart rate was measured with a Polar Finlande device and performance time with a handheld stopwatch Seiko Water Resistant 10bar S140. **Results** Anova analysis showed no statistically significant differences between the three groups of swimmers (short, medium and long distances) for the measured variables of the 100m and 400m freestyle. A statistically significant difference was observed only in heart rate of short distance swimmers for the 100m effort compared to the two other groups (187.0, 177.6, and 162.0 beats/min, for short, middle and long distance swimmers respectively, Sig. .005). Lack of significant results may be due to small number of sample or maybe the sample did not try much. **Discussion** Such measurements are useful for swimming coaches in order to access performance characteristics of the swimmer during a racing year. Future researches should focus on larger sample in order to achieve more accurate results. **References** Avlonitou E. (1996). *J Sport Med Phys Fit*, 36, 24-30. Olbrecht J. (2000). *The Science of Swimming*. Luton, England. Contact: vthano@phed.uoa.gr

## RECOVERY STRATEGIES IN GERMAN ELITE JUNIOR TENNIS PLAYERS

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**Introduction** Tennis is characterised with high psychophysiological demands through a year-round high number of matches. Elite junior tennis players participate in up to 25 tournaments (i.e. 50-120 single matches) and devote a great amount of training (i.e. 20h/week)[1]. Therefore, the use of recovery strategies (RS) on a daily basis might be beneficial to reduce fatigue and accelerate recovery, even in young ages. Therefore, the aim of the study was to investigate the RS implemented in German elite junior tennis players. **Methods** During the biannual German Physical Condition Tennis Testing [2] 235 elite junior tennis players participated in a questionnaire obtaining quantity and frequency of the following RS: active recovery (AR), to shower (SH), ice bath (ICE), foam rolling (FR), 'regeneration drink' (RD), rest and nap (NAP), compression apparel (CA), food (FO), massage (MAS), listening to music (MU), sauna (SAU), stretching (STR). Frequency was investigated using 3 levels: regularly, occasionally, never. 192 (118 male, 74 female; age 10-18) of the initial 235 questionnaires were completed without missing values. Differences between sex and age-groups (U12,U14,U16,U18) were analysed using Chi<sup>2</sup>-Tests for nominal data (quantity of RS), Kruskal-Wallis and U-Test for ordinal data (frequency of RS). Effect size (ES) was interpreted as small 0.1, moderate 0.3, large 0.5. **Results** Descriptive analysis showed that 'common' RS (SH 97%, FO 95%, AR 94%, STR 91%, MU 90%, NAP 89%) were used more often than 'sophisticated' RS (MAS 60%, FR 60%, RD 57%, SAU 30%, CA 23%, ICE 18%). A similar ranking was observed for both sexes. Overall 'traditional' RS were used more regularly, whereas 'modern' RS were used more occasionally. Male athletes showed higher quantity (ES=0.22,  $p < .01$ ) and frequency (ES=0.20,  $p < .01$ ) in RD, as well as a higher quantity in NAP (ES=0.24,  $p < .01$ ). Age-group differences were found both in quantity and frequency in FR (moderate, ES=0.43-0.48,  $p < .001$ ), STR and SAU (small, ES=0.24-0.29,  $p < .05$ ). Older athletes used FR more often and regularly (ES=0.16-0.50,  $p < .05$ ) with no difference between U16 and U18. U18 used SAU most often and regularly (ES=0.18-38,  $p < .05$ ), while in STR U12 showed smaller values in quantity and frequency to U14 and U16 (ES=0.17-

0.28,  $p < .05$ ). Discussion Results indicate that RS are highly implemented in German elite junior tennis players with a tendency to 'common' RS being favoured. Observed differences were predominantly of small size. Only FR data indicated subsequent increase in use with age. In conclusion we suggest that further investigations should focus on the effectiveness of the players individual recovery routines. References 1 Fernandez-Fernandez J, et al (2015) *Int J Sports Med*, 36(1), 22-8. 2 Ulbricht A, et al (2015) *J Med Sci Tennis*, 20(1), 6-16. Contact raed.sibai@rub.de

## Mini-Orals

### MO-PM43 Training & Testing 1

#### LOADED VERTICAL JUMP AS INDICATOR OF SWIMMING START PERFORMANCE

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**Introduction** Swimming start performance, commonly defined as the time to 15m, is a good predictor of overall race time in the four swimming strokes (Mason & Cossor, 2000). The horizontal take-off velocity of the push-off is the variable that most influences swimming start time (Tor et al., 2015). Previous studies have also proved the importance of possessing high levels of lower body strength and power to optimise swimming start performance (West et al., 2011). In this regard, we aimed to examine the correlation of different dry land strength and power tests with swimming start performance in experienced female swimmers. **Methods** Twenty-one international level female swimmers performed different dry land strength (leg extension maximal voluntary isometric contractions) and power tests (squat jumps with additional loads of 0%, 25%, 50%, 75% and 100% of swimmers' body weight [BW]) as well as a maximum freestyle swimming start on a single testing day. Correlations between the time to 15m, several variables collected with a force plate during the start push-off phase, and the dry land tests were quantified through Pearson's linear correlation coefficients ( $r$ ). **Results** The time to 15m was inversely correlated to the peak velocity reached during the loaded squat jump with 25–100% of BW ( $r = -0.63$  to  $-0.68$ ), while no significant correlations were observed neither for the unloaded squat jump ( $r = -0.23$ ) or the isometric test ( $r = -0.11$  to  $-0.15$ ). The horizontal take-off velocity ( $r = -0.56$ ), average horizontal force ( $r = -0.62$ ), and average horizontal acceleration ( $r = -0.58$ ) were the push-off variables most related to 15m time. However, only the horizontal take-off velocity was significantly correlated with the squat jump peak velocity ( $r = -0.45$  to  $-0.64$ ). **Discussion** Our results are consistent with previous studies indicating the need of possessing high levels of lower-limb muscular power to optimise swimming start performance (West et al., 2011). The assessment of the peak velocity during vertical jumps with external loads relative to BW seems to be a good indicator of both horizontal take-off velocity and swimming start time. References Mason B & Cossor J (2000). XVIII ISBS Proceedings 75–82. Tor E, et al. (2015). *J Sports Sci*, 33, 1313–1321. West DJ, et al. (2011). *J Strength Cond Res*, 25, 950–955. Contact mbelen@ugr.es

#### MONITORING PHYSICAL ABILITIES AND SEASONAL FLUCTUATIONS IN ELITE YOUTH SOCCER PLAYERS

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**Introduction** The quantification of fitness levels and players physical characteristics is increasingly important in youth soccer. Monitoring seasonal variations across different age groups is key for the long-term development of players' physical abilities and talent identification (Deprez, 2015). The aim of this study was to determine the physical characteristics of elite-level youth soccer players across different age groups, evaluating between role differences and in-season variations of physical abilities. **Methods** 252 youth soccer players' were assessed across four competitive seasons. The players, ranging from U14 to U17 age groups, performed the Yo-Yo intermittent recovery test level 1 (YYIR1), a counter-movement jump test with arm swing (CMJA) and a 20m sprint test three times during the competitive season (Pre-season, T1; Mid-season, T2; End-season, T3). Players who performed all 3 test sessions (612 observations) were considered for analysis. Differences between age groups, season period and playing position were analyzed using repeated-measure ANOVAs for each dependent variable and Bonferroni post-hoc analysis. **Results** Significant differences were found between age groups for YYIR1 ( $2470 \pm 374$  vs  $2280 \pm 469$ ,  $1960 \pm 500$ ,  $1370 \pm 473$  m for U17 vs U16, U15 and U14 respectively,  $p < 0.003$ ) and sprint performance (U17,  $2.85 \pm 0.09$ ; U16,  $2.89 \pm 0.11$ ; U15,  $2.95 \pm 0.11$  and U14,  $3.02 \pm 0.14$  s;  $p < 0.018$ ). U14 and U15 were not significantly different for CMJA ( $p = 0.228$ ), but both were significantly lower than U16 and U17 ( $p < 0.036$ ). CMJA performance was significantly greater in U17 than all other age groups (U17,  $45.3 \pm 4.8$ ; U16,  $43.2 \pm 4.9$ ; U15,  $41.8 \pm 4.2$ ; U14,  $41.0 \pm 4.8$  cm). Within-season changes were significant for YYIR1 and CMJA ( $T3 > T2 > T1$ ,  $p < 0.001$  and  $p < 0.039$  respectively). Sprint times improved significantly between T1 and T2 ( $-1.2\%$ ,  $p = 0.003$ ) with only a trend between T2 and T3 ( $-0.8\%$ ,  $p = 0.069$ ). Each of the physical tests noted significant differences for player position: midfielders CMJA and sprint ability were significantly lower ( $p < 0.003$ ) than attackers (AT), central defenders (DC) and wingers. AT performed significantly better than DC across all 3 physical tests ( $p < 0.017$ ). **Discussion** These findings highlight the significant physical differences that exist between different age groups in youth soccer. In-season training and physical development can significantly impact upon these performance variables. Monitoring the development in elite-level youth soccer can facilitate both players' selection and individualization of the training process in accordance with players' physical characteristics. References Deprez D, Buchheit M, Franssen J, Pion J, Lenoir M, Philippaerts RM, Vaeyens R. (2015). *J Sports Sci Med*, 14(2), 418-26.

#### PHYSIOLOGICAL PROFILE OF MALE AUSTRIAN NATIONAL TEAM LACROSSE PLAYERS

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**INTRODUCTION** The knowledge of the physiological requirements of lacrosse athletes is quite limited. Lacrosse is characterized by skill, speed, agility, strength, flexibility, and a mixture of aerobic and anaerobic activity (Collins et al., 2014). This study aims to describe the fitness profile of male Austrian national team lacrosse athletes. Further, it compares the evaluated profile with existing research of US

intercollegiate lacrosse athletes. METHODS A lacrosse specific fitness test battery was created to represent basic health-related fitness parameter. Including cardiovascular endurance (1-mile run), maximal strength (1 repetition maximum for bench press BP and back squat BS), speed (40-yard sprint), agility (t-run test), lower body power (vertical jump) and anthropometric analysis (height, weight and skinfold measurement). All tests were performed based on scientific guidelines (e.g. Baechle & Earle, 2008). Further, a lacrosse specific test (wall ball test) was developed to assess passing and catching skills. A total of 18 male Austrian national team lacrosse players were tested. The differences between collected mean values and existing NCAA college lacrosse athletes (e.g. Gutowski & Rosene, 2011) were evaluated by a 1-sample t-test. Statistical significance was set at  $p < 0.05$ . RESULTS Anthropometric analysis showed no significant differences in height ( $1.81 \pm 0.66$ m) and body mass ( $83.17 \pm 9.20$ kg), but lower body fat values ( $11.41 \pm 3.85\%$ ) in the observed group. The physiological mean values were significant lower for vertical jump ( $50 \pm 6.41$ cm,  $p = 0.00$ ), BP ( $74.9 \pm 14.10$ kg,  $p = 0.00$ ) and BS ( $103.2 \pm 16.48$ kg,  $p = 0.00$ ). Higher t-run ( $10.6 \pm 0.62$ s,  $p = 0.00$ ), 1-mile run ( $394.56 \pm 42.66$ s,  $p = 0.00$ ) and lower 40-yd sprint ( $5.13 \pm 0.18$ s,  $p = 0.00$ ) times were determined. No normative values exist for the wall ball test ( $18.88 \pm 7.25$ rep). DISCUSSION It can be concluded that male US college lacrosse players have a higher overall fitness than their Austrian counterparts. According to uniform test guidelines future studies should focus to create a physiological profile of European male and female lacrosse players. Compared with values for US collegiate lacrosse athletes these results would show possible weaknesses among international lacrosse players. This could lead to implement proper athletic strength and conditioning programs for European lacrosse athletes to increase performance and reduce injuries. REFERENCES Baechle, T.R. & Earle R.E. eds. Essentials of Strength Training and Conditioning. 3rd ed. Champaign, IL: Human Kinetics, 2008 Collins, S.M., Silberlicht, M., Perzinski, C., Smith, S.P., & Davidson, P.W. (2014). J Strength Cond Res, 28(9), 2673–2679. Gutowski, A.E., & Rosene, J.M. (2011). Strength Cond J, 33(2), 16–22. CONTACT richard.hauer@univie.ac.at

### RELIABILITY OF A NOVEL POSTERIOR LIMB ISOMETRIC MUSCLE TEST IN FOOTBALL PLAYERS

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Introduction Fatigue and strength deficits are important predisposing factors for hamstring strains (1). McCall et al (2) demonstrated the reliability of a posterior lower limb test performed on a portable force platform as a practical tool to monitor posterior limb isometric peak force (PL-IPF) in team sport athletes. They also showed that this test performed in two supine positions, was sensitive to match induced fatigue in footballers. However, evidence suggests that hamstring fatigue following simulated football is greatest close to full knee extension (3) and the majority of hamstring strains are thought to occur to the biceps femoris in an extended position (1). Therefore, we aimed to determine the reliability of a test which assesses PL-IPF in such a position. Methods Fourteen semi-professional male football players were tested twice, on consecutive weeks. PL-IPF was measured with two tests, both performed in a standing position with the tested leg positioned on a portable force platform at 90° hip flexion and 20° knee flexion (90:20). The non-tested leg, upper back and head were positioned against a wall and the arms were either (i) crossed on chest, palms placed over the contralateral acromion (AC); or (ii) next to trunk against the wall, elbows fully extended and palms in pronated position (AW). Results There was no effect of test protocol or leg on PL-IPF. Differences between repeated trials displayed trivial or small effect sizes in both positions and in both dominant (DOM) and non-dominant (NON) legs; AW-DOM; CV=12.4%, ICC=0.63,  $p = .044$ . AW-NON; CV=12.2%, ICC=0.82,  $p = .002$ . AC-DOM; CV=14.5%, ICC=0.71;  $p = .018$ . AC-NON; CV=9.2%, ICC=0.90;  $p = .001$ . Discussion Both versions of the 90:20 showed good-to-high reliability with the AC position slightly superior. In all conditions, except for the AW-DOM, CV's were close to 10% and ICC's to 0.75, qualifying values often used to define a variable as reliable (4). The 90:20 can be considered a reliable means to rapidly assess PL-IPF with the biceps femoris in an extended position. Further research should evaluate the capacity of the 90:20 to detect post-competition fatigue and to compare muscle activation in the 90:20 versus supine tests (2). References 1. Mendiguchia J, Alentorn-Geli E, Brughelli M. Br J Sports Med. 2012 Feb;46(2):81-5 2. McCall, A, Nedelec M, Carling C, Le Gall F, Berthoin S, Dupont G.. J Sports Sci. 2015;33:1298-1304 3. Cohen DD, Zhao B, Okwera B, Matthews MJ, Delestrat A. Int J Sports Physiol Perform. 2014;10:325-331 4. Brughelli, M., & Van Leemputte, M. J Strength Cond Res. 2013;27:76–82

### HIGH TEST-RETEST RELIABILITY OF TEST-DURATION AND VO2MAX WITH A SOFTWARE SUPPORTED RAMP-TEST FOR ROWING ERGOMETRY

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Introduction Wind braked ergometers like the Concept 2 rowing ergometer do not allow external control of power, because the athlete himself has to create the demanded resistance by acceleration of the fly wheel to a corresponding angular velocity. To improve discipline specific maximal oxygen uptake (VO2max) measurements, we developed a software supported ramp test protocol for wind braked rowing ergometers. The test allows a continuous and linear increase of power and contains an automatic termination criterion. The purpose of this study was to quantify the test-retest-reliability of test duration and VO2max when the test is terminated automatically. Methods Five female (height  $173.1 \pm 1.9$  cm, mass  $64.7 \pm 7.7$  kg, VO2max  $3.4 \pm 0.17$  l•min<sup>-1</sup>) and 5 male ( $184.0 \pm 6.3$  cm,  $73.9 \pm 6.6$  kg,  $4.2 \pm 0.50$  l•min<sup>-1</sup>) competitive rowers underwent a familiarization session and two consecutive ramp tests separated by one day up to automatic test termination on a Concept 2 rowing ergometer. Tests started with 160 W in male and 120 W in female rowers and increased by 30, 25, or 20 W•min<sup>-1</sup>, depending on individual fitness to allow for a test duration of 8 to 12 min. The ergometer was modified with a load cell for force measurement and a rotary transducer (FES, Berlin). An external computer visualized exact power output in real time. A warning occurred when the average of two strokes was more than 7 W below target power. The test was terminated with the fifth warning. To prevent premature dropout, warnings were deleted after four consecutive strokes within  $\pm 7$  W of target power. VO2max was measured with a metabolic analyzer (Ergostick, Geratherm respiratory). Test-retest reliability of test duration and VO2max were determined by typical error of measurement (TE), intraclass correlation coefficient (ICC), and minimal detectable change (MDC). Results Test-retest reliability of test duration amounted to TE = 2.8% (95 CI 1.9 – 5.2), ICC = 0.96 and MDC = 7.8%. VO2max was TE = 4.8% (95 CI 3.3 – 8.9), ICC = 0.93 and MDC = 13.3%. Discussion The results showed a high reliability of test duration. The MDC of 4.8% indicates that a noticeable change in test duration corresponds to an increase of 37 s in a rower who was able to perform for 8 min before dropout e. g. a baseline test, equaling to approx. 19 W max power. Reliability of VO2max was lower, but within the expected range. This results underlines that differences in VO2max have to be relatively high to ensure relevant changes in ability. We conclude that the automatic test termination is feasible and allows an objective and reliable cessation of the ramp test. Kay.Winkert@uniklinik-ulm.de

## EVALUATION OF THE EFFECTS OF CORE TRAINING ON THE CORE STRENGTH, STATIC AND DYNAMIC BALANCE CHARACTERISTICS OF TENNIS ATHLETES IN THE 8-14 AGE GROUP

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The purpose of this study is to investigate the effects of core training performed regularly for 12 weeks on the core strength and the static and dynamic balance characteristics of male tennis athletes in the 8-14 age group. Nineteen male tennis athletes (the mean age was  $10.68 \pm 2.18$ , mean length was  $146.85 \pm 15.06$  cm, and mean body weight was  $43.34 \pm 16.97$  kg) attending in the Pamukkale Tennis Club were included in the study on a voluntary basis. Athletes participating in the study were divided into experimental group ( $n=10$ ) and the control group ( $n=9$ ) by randomized method once classified according to their age group. In the study, an experimental method with a pre-test and post-test design pattern was used, and the experimental group performed core training 3 days a week for 12 weeks in addition to tennis training, whereas the control group continued to the regular tennis training, without any intervention. Core strength, static and dynamic balance test measurements of the experimental and control groups were carried out twice, before and after 12-week training program. Data were analyzed using SPSS (Ver.20) package program. The values obtained by the pre-test and post-test were compared statistically by means of Paired sample t-test and Wilcoxon Two-Related-Samples test, after looking at the normality distribution with the Shapiro-Wilk test. A probability level of  $p < 0.05$  was used to indicate statistical significance for all statistical methods. As a result of the 12 weeks of core training program, the mean core strength of the experimental group was  $146.70 \pm 28.77$  s after the training, whereas it was  $120.50 \pm 26.30$  s before the training ( $p < 0.05$ ). And, the mean core strength in the control group was  $85.44 \pm 25.49$  after the training, whereas it was  $80.11 \pm 36.12$  s before the training ( $p > 0.05$ ). According to these results, the applied core training was found to increase the core strength significantly. However, no significant difference was found between the experimental and control groups in terms of mean static and dynamic balance values before and after training ( $p > 0.05$ ). As a result, the core training was found to have a positive effect, in terms of sporting performance, on the core strength and balance of tennis athletes. However, further studies should be conducted with core training models designed differently to better understand the relationship between the core training and balance performance.

## TAPERING STRATEGIES FOR 20-KILOMETER RUNNING: PRACTICAL CASE OF JAPANESE UNIVERSITY MALE DISTANCE RUNNERS

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Introduction Taper is defined as a reduction in training load during the final days before a competition, with the aim of optimizing performance. The most efficient strategies are exponential training volume reduction from the overload training period (OT) to the taper training period (TT) without altering training intensity or frequency (Bosquet et al., 2007). Tapering strategies based on this theory are applied to many sports, but it has not been established that training intensity changes for the specific situation. Therefore, the purpose of this study was to clarify the relationships between the changes in training load from OT to TT and the 20-km race performance in Japanese university male distance runners. Methods Eleven male university long-distance runners (maximal oxygen uptake:  $VO_{2max} 71.7 \pm 4.2$  ml  $kg^{-1}$   $min^{-1}$ ) participated in this study. They completed a 4-week OT and 1-week TT before a 20-km race. Running distances and training sessions per week were regarded as training volume and training frequency, respectively. Training intensities were divided into four zones; [zone1]  $\leq$  Lactate threshold < [zone2]  $\leq$  Onset of blood lactate accumulation < [zone3]  $\leq$   $VO_{2max}$  < [zone4] based on the results of maximal and submaximal incremental tests. The tapering achievement ratio was evaluated by comparing the 20-km race time and predicted 20-km time calculated by using the seasonal 5000-m best time (Riegel, 1981). The percentages of training volume at each intensity of overall training in OT and TT, and the ratio of TT/OT for those percentages were calculated. Results The 20-km race time was significantly lower than the predicted 20-km time ( $63.9 \pm 1.5$  and  $65.1 \pm 2.0$  min, respectively,  $p < 0.05$ ), the tapering achievement ratio was  $101.9 \pm 1.8\%$ . The percentages of training volume were  $69.6 \pm 2.2$ ,  $15.4 \pm 1.4$ ,  $13.3 \pm 1.2$  and  $1.7 \pm 0.2\%$  during OT and  $85.6 \pm 4.2$ ,  $2.8 \pm 3.9$ ,  $11.1 \pm 1.9$  and  $0.5 \pm 0.5\%$  during TT at [zone1], [zone2], [zone3] and [zone4], respectively. The percentages of training volume at intensity [zone2] + [zone3], corresponding with running velocity during the 20-km race, of overall training in OT and TT were  $28.7 \pm 2.1$  and  $13.9 \pm 4.3\%$ , respectively. We observed a significant positive relationship in the tapering achievement ratio and the ratio of TT/OT ( $p < 0.05$ ,  $r = 0.75$ ). Discussion The tapering achievement ratio was related to the ratio of TT/OT. These results suggest that training at an intensity near target race pace should be maintained during the taper training period even if 20-km race is the aim. References Bosquet L, Montpetit J, Arvisais D, Mujika I. (2007) Effects of tapering on performance: A meta-analysis. *Med Sci Sports Exerc*, 39, 1358-1365. Riegel P. (1981) Athletic records and human endurance. *American scientist*, 69, 285-290. Contact watarun800@gmail.com

## Mini-Orals

### MO-PM48 Rehabilitation: Physiotherapy

#### QUANTIFYING RETURN TO FITNESS AFTER KNEE INJURY USING GAIT ACCELEROMETRY

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INTRODUCTION The assessment of rehabilitation status for musculoskeletal injuries, in both sports and clinical arenas is still predominantly by measures based on observation and palpation [1]. Whilst errors stemming from the subjectivity of these approaches can be reduced through diligent use of standardised criteria [2] they cannot be completely removed and marked variability between assessors is common [3]. To address this we present an objective approach that uses quantitative, accelerometry-based metrics to create a scoring system for recovery from knee injury. METHODS The test subject was a 19 year-old male who had recently undergone knee surgery to repair a severely torn right meniscus. At 11, 19 and 48 weeks post-surgery gait analysis of treadmill running was performed, using ankle mounted accelerometers on both legs. The radial acceleration component was collected at 40 Hz and comparative assessment of left and right leg motion obtained from frequency and correlation analyses. RESULTS The acceleration frequency spectra from the injured leg



displayed increased power in the higher harmonic components due to the altered gait. The prominence of these frequency components decreased as the subject recovered from injury. Cross correlation of the left and right ankle acceleration traces of a 90 second running sequence provided a quantitative recovery score based on the similarity of left and right limb gait. The recovery score when running at a speed of 15 km hr<sup>-1</sup> progressed from 16% at week 11 to 31% at week 19 and 57% at week 48. The score at week 48 when walking at a speed of 4 km hr<sup>-1</sup> was 91%. CONCLUSIONS The alterations to leg motion in walking and running caused by knee injury can be measured using ankle mounted accelerometers. Cross-correlation of accelerometer traces from injured and non-injured legs provides an integrative measure of the similarity of movement between limbs, conveniently scaled between 0 to 100% that can be used for quantitative assessment of return from injury. REFERENCES 1. Hegedus EJ et. al. Br. J. Sports Med. 2015; 49(10):642-8. 2. Myer GD et. al. J. Orthop. Sports Phys. Ther. 2006; 36(6):385-402. 3. Billis EV et. al. Man. Ther. 2003; 8(4):223-232. CONTACT: h.d.summers@swansea.ac.uk

### **SINGLE DROP JUMP COMPENSATION MECHANISM BEFORE AND 6 MONTH AFTER ACL RECONSTRUCTION SURGERY.**

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Introduction In athletes arises after an injury of the anterior cruciate ligament, the question of when he can return to his sport again. The return time is very individual and depends on many factors. There are a variety of tests to determine the earliest possible time of return by individual tests or combined tests. An on-going study examines the sport ability after anterior cruciate ligament reconstruction preoperative and 6 month after anterior cruciate ligament. The project examines the postoperative recovery of sports ability. The aim of this work is to preoperatively identify the existing deficit to the not injured side and compare the results after 6 month rehabilitation phase. Method 7 athletes, moderate activity level (age: 23.4 ± 2.8 years, m = 5, w = 2) with isolated anterior cruciate ligament injury were examined preoperatively. In addition to the collected questionnaires of thigh circumference, the isometric force of knee extensors and flexors, and the one-legged landing characteristics (20 cm jump height) was captured on a force plate and a three-dimensional motion analysis system. Three isometric strength values for the knee extensors and flexors per side were measured and averaged. Results Preoperatively we found a reduced thigh circumference of 4.3 ± 14.2 mm on the injured leg. After 6 month the value increased to 14.5 ± 16.6 mm. Percentage of force (extensors to flexors) of the injured side before surgery was 58.2 ± 19.8% and after 41.5 ± 7.4%. Sound side: 49.3 ± 10.3% to 50.4 ± 12.5%. Sagittal knee angle at landing was 17.8° ± 5.4 at the beginning and after 19.7 ± 2.9°. Sound side: 15.2 ± 5.0° to 18 ± 2.6°. Max. knee angle in the landing phase was 34.0 ± 14.0° and 47.0 ± 10.9°. Sound side: 37.3 ± 13.5 to 48.4 ± 11.8°. Sagittal knee moment changed from 1062 ± 1030 to 2078 ± 1000 Nm and frontal knee angle moment from 318.4 ± 374.4 to 606.7 ± 445.8 Nm. sound side: 1668.6 ± 971.46 to 2536 ± 1004 Nm and 252 ± 307 to 590 ± 416 Nm. Discussion Preoperatively reduced moments were present at the injured side, combined with a higher landing angle at the knee. After 6 month there exists a higher landing ROM in the injured leg and similar to the sound side. The relationship of extensor to flexor force has further decreased on the injured leg. From these results we can conclude that the force development and the force relationship on the injured side are still reduced. On the other hand we found an adjustment of the landing strategy to the non-injured leg. Overall, no symmetry of values between the injured and non-injured leg has been established and further training is absolutely necessary to be fully operational again.

### **NEW METHODOLOGICAL APPROACH TO RTD EVALUATION IN RELATION TO HAMSTRING STRAIN INJURIES IN FEMALE ATHLETES. A PRELIMINARY STUDY.**

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Introduction Hamstring strain incidence is associated with high speed running actions. Isokinetic dynamometer is described as a useful tool for strength evaluation throughout the rehabilitation process. The rate of torque development (RTD) is valid to assess muscle central motor output during contraction (Marshall et al., 2014). The RTD examination could check the neuromuscular system status after having undergone the rehabilitation process. The objective of this study was to describe the hamstrings peak torque (PT) and RTD in athletes who sustained medial or lateral hamstring strain injury after fulfilling a criterion-based rehabilitation protocol. Methods 4 female track and field athletes (Age 17-3 years [mean ± SD]; height 165 ± 8 cm; weight 65 ± 13 kg) who suffered a medial or lateral hamstring strain conducted an isometric strength testing evaluation using an isokinetic device (HUMAC NORM Isokinetic Extremity System, CSMi, Stoughton, MA) at the end of the rehabilitation period. The PT (N.m) and RTD (N.m/s during the first 200 ms) were recorded for both healthy and injured limbs at 15° (for lateral hamstring) and 90° (for medial hamstring) knee flexion angular position. RTD calculations were automatically processed with the implementation of a self customized program (Matlab v. 7.5.0.342 [R2007b] USA). Results Hamstrings PT did not differ between the injured and healthy limbs, (mean ± SD 149,67 ± 41,17N vs. 149,75 ± 15,63N respectively [P=0,18]). Time for PT was 2327,5 ± 1202,6 ms vs. 2260 ± 872,9 ms for injured and healthy limb, respectively [P=0,136]. Finally, there was a significant reduction in maximal RTD in the injured limb in comparison to the healthy limb (778,87 ± 196 vs. 903,5 ± 253,69 N.m/s respectively [P=0,006]). Discussion The observed RTD reduction in the hamstring strained limbs after completing the rehabilitation process could constitute a lasting neuromechanical deficit in hamstring muscles post injury, related to previously described risk factors for hamstring injury, such as neuromuscular inhibition (Fyfe et al., 2013). Despite the successful strength recovery and return to sport, neuromuscular impairment persists in terms of lower RTD ability in the hamstring injured limb. These results may be associated with the high hamstring injury recurrence rates (Marshall et al., 2014). References Marshall PWM, Lovell R, Jeppesen GK, Andersen K, Siegler JC. (2014). PLoS ONE, 9(7):e102753. Fyfe JJ, Opar DA, Williams MD, Shield AJ. (2013). J Electromyogr Kinesiol, 23 (3), 523–30. Contact ederbikandi@gmail.com

### **EIGHT WEEKS OF HOME-BASED BALANCE TRAINING NOT AS EFFECTIVE AS THERAPIST-SUPERVISED TRAINING DURING DUAL TASKS**

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Objectives: To assess the effect of balance training on dual-tasking gait, and to investigate if a home-based programme is comparable to a therapist-supervised programme. Background: Parkinson's disease often manifests as a loss of automaticity, and as a result gait dysfunction occurs. Difficulties with gait are aggravated when paired with a secondary cognitive task, leading to possible unsafe ambulation. Dual-tasking is an essential part of independent-living and thus important to understand what effect it has on gait, and if possible

improvements in dynamic balance can influence it. Therefore this study sets out to explore the effect of balance training, at home or with a therapist, on dual-tasking gait. Methods: This experimental study included 39 participants with mild to moderate Parkinson's disease (H&Y I-III), divided into a Therapist-supervised group (n=23, age 65.4±8.3yrs) and a Home-based group (n=16, age 64.9±7.1yrs), based on a sample of convenience. Both groups followed 8 weeks of balance training, with the Therapist-supervised group attending classes with an exercise therapist, and the Home-based group followed a series of guided DVDs at home with their caregiver. Primary outcome measures included mobility and gait parameters, assessed with the modified instrumented Timed-up-and-Go (ITUG), and dual-tasking ability, assessed with the instrumented cognitive Timed-up-and-Go (CTUG), from which dual-task interference was calculated. Secondary outcome measures included perceived fear of falling, assessed with the International Fall Efficacy Scale (FES-I), and disease severity, assessed with Unified Parkinson's Disease Rating Scale (UPDRS). Results: The Home-based group showed a significant decrease in UPDRS III scores ( $p<0.001$ ) after the intervention, and also showed significantly increased dual-task interference for duration, stride velocity, cadence and time in double support ( $p<0.005$ ). The Therapist-supervised group maintained their disease severity and dual-task interference after the intervention ( $p>0.05$ ). Conclusions: The dual-task interference showed that, unlike the Therapist-supervised group, the Home-based group was unable to maintain their gait performance when a secondary task was applied. This study has revealed that eight weeks of balance training with a therapist is more likely to maintain and improve gait during dual-tasking than without the presence of a therapist performed at home.

### EFFECT OF HOME-BASED VIRTUAL REALITY-AUGMENTED EXERCISE THERAPY

VILLIGER, M., LIVIERO, J., STOOP, R., AWAI, L., CURT, A., PYK, P., HOHENAUER, E., CLIJSEN, R., ENG, K., BOLLIGER, M.

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**Introduction** After injury of the brain or spinal cord, functional recovery is reduced as severed axons are restricted in their capacity to spontaneously regenerate, and compensatory fibre growth is limited. Key factors influencing successful rehabilitation and functional recovery include variety in training, intensive movement repetition, task-relevant feedback and a motivating training environment. Technologies which can provide all of these features, independent of the patient's location, may thus provide significant benefits for rehabilitation. We hypothesize that home-based and unsupervised virtual reality (VR)-augmented lower limb rehabilitation training is feasible with incomplete spinal cord injury (iSCI) patients and improves motor functions (e.g. mobility - transfer ability, strength, balance). **Methods** For our study we used a prototype of a mobile lower limb VR training system (YouKicker®) combining action observation and movement execution using motivating training scenarios. Patients using YouKicker controlled virtual representations of their legs and feet designed to facilitate the observation of goal-directed actions presumed to activate overlapping cortical networks. Clinically relevant movements were trained in different scenarios, as specified in design discussions with therapists. We have previously tested a stationary version of the system on iSCI patients and found significant improvements in lower limb function (Villiger et al. 2013). Ten subjects with iSCI completed a home-based training program with the VR device over four weeks. Before and after training, mobility (clinical outcomes) and gait quality (kinematic outcomes) were assessed. **Results** Results revealed that subjects with iSCI performed significantly better in (a) functional mobility combined with balance and lower limb muscle strength and in (b) gait quality, i.e. gait parameters, foot dorsiflexion and in-trail coordination. **Discussion** Following iSCI training with a home-based VR training device without supervision can induce positive training effects, comparable to the stationary training device, and might be useful as a rehabilitation tool. Follow-up studies should include a RCT design and other disease patterns, e.g. neurological disorders or orthopedic diseases. **Reference** - Villiger M, Bohl D, Kiper D, Pyk P, Spillmann J, Meilick B, Curt A, Hepp-Reymond MC, Hotz-Boendermaker S and Eng K. (2013). Virtual Reality-Augmented Neurorehabilitation Improves Motor Function and Reduces Neuropathic Pain in Patients With Incomplete Spinal Cord Injury. *Neurorehabil Neural Repair*, 27, 675-83. Contact Dr. Michael Villiger, michael.villiger@gmail.com

### FELDENKRAIS METHOD IMPROVED THE FUNCTIONALITY AND BALANCE IN PEOPLE WITH INTELLECTUAL DISABILITY

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**INTRODUCTION** The Feldenkrais Method (FM) is an exploratory learning approach for the improvement of body awareness and movement organization. For the first time in history, most people with intellectual disability (ID) can now expect to live as long as their non-disabled peers (1). Due to this fact, aging process and related functional problems use to occur earlier in people with ID. Different authors suggested that the FM improves the balance, reducing the risk of falls in elderly populations (2). We hypothesized that the FM could be helpful to improve the balance and functionality of men and women with ID who show signs of an early aging process. **METHODS** People with ID were recruited from a company for job integration. They were divided in Experimental Group (EG) and Control Group (CG). Participants of the EG received 30 FM class during 9 months. Participants of the CG did not received any intervention. Height, weight, Short Performance Physical Battery (SPPB) and postural stability (Winposture platform) were analyzed before and after the programme. The protocol was fully approved by the Human Research Ethics Committee of the University of the Basque Country. **RESULTS** The average age of participants (n=32) was 48.96 ± 7.49 years old. After the programme, significant changes were not observed in anthropometry. The EG improved the performance in all of the tests of the SPPB. In the chair stand test ( $p<0.005$ ) and in the total score of the battery ( $p<0.005$ ) the results were significantly better at the end of the intervention for this group. The CG showed a non-significant improvement of the total score of the SPPB. The analysis of the postural stability showed significant decreases?? ( $p<0.05$ ) in the total area (mm<sup>2</sup>) and in the speed (mm/s) for the EG. Significant changes were not found for the CG in the postural stability test. **DISCUSSION** The results of this study showed that the FM contributes to the improvement of body balance and functionality in people with ID between 40 and 60 years old. According to previous studies (3) FM could be considered as an adequate tool in ageing population, both as a preventative approach and for people at risk of falls. **ACKNOWLEDGMENTS** This work was facilitated by an agreement between the Regional Government Bizkaiko Foru Aldundia / Diputación Foral de Bizkaia, Lantegi Batuak and the University of Basque Country (UPV/EHU). **REFERENCES** 1) Fisher, K., & Kettl, P. (2005). Aging with mental retardation. *Geriatrics*, 60(4). 2) Gopal Nambi, S., Trivedi, P. S., Momin, S. M., Patel, S., & Pancholi, D. P. (2014). Comparative Effect of Pilates and Feldenkrais Intervention on Functional Balance and Quality of Life in Ambulatory Geriatric Population: A Randomized Controlled Study. *International Journal of Health Sciences and Research (IJHSR)*, 4(3), 71-77. 3) Hillier, S., & Worley, A. (2015). The effectiveness of the feldenkrais method: a systematic review of the evidence. *Evidence-Based Complementary and Alternative Medicine*, 2015.

**SCHROTH EXERCISE FOR THREE CURVE BALANCED IDIOPATHIC SCOLIOSIS**

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**Introduction** The Lehnert-Schroth classification has been recently widely used and simplified approach to classify into seven types of curvature (Weiss, 2010). Among the seven curve patterns, the most common pattern is the 3 curved balanced (3C) which has three blocks (Shoulder block, Thoracic-Ribcage block, Lumbo-pelvic) of the human body on coronal and transverse section, each block represents a respective twisted form (Lehnert Schroth, 2007). However, previous studies have not considered these curve patterns when approaching the scoliosis patient in exercise. The purpose of this study was to investigate the effects of schroth exercise on thoracic and lumbar spine Cobb's angle and the hip joint range of motion in 3C idiopathic scoliosis patients. **Methods** Total 35 subjects (Male: 7, Female: 28, Age:  $18.07 \pm 5.85$  years, Height:  $162.73 \pm 8.10$  cm, Weight:  $49.59 \pm 9.33$  kg) who have 3C idiopathic scoliosis (above  $10^\circ$  of Cobb's angle) participated in this study. 3C scoliosis specific schroth exercise program consisted of physio-logic, 3D made easy, fifty times and muscle cylinder, for three times a week, for 12 weeks. Thoracic and lumbar spine Cobb's angle and the hip joint internal and external rotation range of motion (ROM) were measured before and after schroth exercise. Results Thoracic and lumbar spine Cobb's angle were significantly decreased after exercise compared to before ( $p < .001$ , respectively). Hip joint internal rotation ROM (Lt.  $p < .001$ , Rt.  $p < .05$ ) and external rotation ROM (Lt.  $p < .001$ , Rt.  $p < .001$ ) were significantly increased after exercise compared to before. **Discussion** Schreiber et al. (2011) reported that classifying patients' curve types determine the appropriate exercise prescription for a patient. In this study, we demonstrated that schroth exercise decreases thoracic and lumbar spine in Cobb's angle and increases hip joint internal and external rotation ROM in 3C idiopathic scoliosis patients. Therefore, we suggest that the efficient treatment of idiopathic scoliosis is not only an accurate classification but also needs to individually curve a specific exercise. **References** Weiss.HR. (2010). Scoliosis. 5, 22. Lehnert Schroth C. (2007). Urban & Fischer Munich Schreiber S, Parent EC, Watkins EM, Hedden DM. (2012). Scoliosis. 7, O53. Contact [hoseh28@dankook.ac.kr]

**EFFECTS OF THERAPEUTIC EXERCISE ON CLINICAL EVALUATION AND MAGNETIC RESONANCE IMAGING IN A PATIENT WITH MULTILEVEL DISC HERNIATION: A CASE REPORT**

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**Introduction** Lumbar disc herniation (LDH) is a common health problem that mainly occurs in younger adults, and leads to degenerative lumbar spinal disease in older adults (Jonsson and Stromqvist, 1995). LDH most typically manifests as low back and radicular leg pain, muscle spasm and nerve functional deficits, and causes both physical and social functional impairment (Ye et al., 2015). Although several exercise programs to improve functioning and pain in patients with lumbar disc herniation have been suggested (Gencay-Can et al., 2010), it is still controversial whether therapeutic exercise plays a major role in improving multilevel LDH. This study tested the hypothesis that therapeutic exercise would be improve clinical evaluation (pain, disability, physical function) and herniated lumbar discs by using magnetic resonance imaging (MRI) in a patient with multilevel disc herniation. **Methods** A 43-year-old female presented with low back pain, radicular pain in the right lower extremity and multilevel LDH (L3-L4, L4-L5, L5-S1). The therapeutic exercise program consisted of lumbar joint mobilization, lumbar spine flexion-distraction, abdominal bridge, plank, side plank and single-leg extensions from 4-point kneeling position for 40 minutes, three times a week, for 12-week. Clinical evaluation (low back and radicular pain, lumbar disability, lumbar range of motion; ROM, lumbar isometric strength and endurance, functional movement screen; FMS) was measured pre, after 6-week (post) and 12-week (post 1), and MRI examination was carried out pre and post 1 of therapeutic exercise. Results Low back and radicular pain, and lumbar disability decreased at post and post 1 compared to at pre. Lumbar ROM increased at flexion, extension and lateral flexion of both sides. Lumbar isometric strength and endurance, and FMS improved at post and post 1 compared to at pre. The sizes of the herniated mass were reductions on MRI after post 1 compared to at pre. **Discussion** Dzierzanowski et al. (2013) reported that exercise can reduce pain and improve functional abilities by improving the range of movement, muscle strength and body posture in single-level LDH patients. In this study, we demonstrated that therapeutic exercise decrease low back and radicular pain, improve functional capacity and sizes of the herniated mass by increasing range of motion of the spine and muscle strength in a multilevel LDH patient. These findings have clinical implications for therapeutic exercise in a patient with multilevel disc herniation. **References** Jonsson B, Stromqvist B. (1995). Eur Spine J. 4, 202-205. Ye C, Ren J, Zhang J, Wang C, Liu Z, Li F, Sun T. (2015). Int J Clin Exp Med. 8(6), 9869-9875. Gencay-Can A, Gunendi Z, Suleyman Can S, Sepici V, Çeviker N. (2010). Eur J Phys Rehabil Med. 46(4), 489-96. Dzierzanowski M, Dzierzanowski M, Maćkowiak P, Słomko W, Radzińska A, Kaźmierczak U, Strojek K, Srokowski G, Zukow W. (2013). Adv Clin Exp Med. 22, 421-30. Contact [hoseh28@dankook.ac.kr]

**EFFECT OF TOE EXERCISES ON THE MEDIAL LONGITUDINAL ARCH OF THE FOOT**

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**Introduction** At the European College of Sport Science (ECSS) congresses in Barcelona 2013 and Amsterdam 2014, we presented on the morphologic relationship between toe exercises and the medial longitudinal arch (MLA). In that study, we showed the relationship between the lesser toe exercise (LTE) and the MLA. However, that study used a cross-sectional method. Hence, the purpose of this study was to examine the relationship between interphalangeal joint position and MLA using the longitudinal method. **Methods** We evaluated 40 feet of 40 participants (20 men and 20 women; mean age,  $20.6 [0.6]$  years; mean height,  $164.9 [8.4]$  centimeters [cm]; mean weight,  $57.7 [10.1]$  kilograms [kg]) who had not been hospitalized for foot or ankle injuries in the past 6 months. They were grouped ( $n = 10$  per group) into the great toe flexor exercise (GTE), lesser toe flexor exercise (LTE), towel-curl exercise (TCE), and control groups. The parameters were the modified navicular drop test and arch height (AH) and range of motion of ankle dorsiflexion in knee extension position (DF). The modified navicular drop test (NDT) we developed was set at 20% of foot weight bearing while seated. Its high reliability was confirmed previously as evidenced by intraclass correlation coefficients 0.88 (1.1) and 0.86 (2.1). AH was developed by Williams (Williams 2000). In the GTE group, participants were seated and a three kg weight was placed on their distal thigh. They tilted their trunk forward and then raised their heels with their great toes, performing three sets of ten repetitions of the exercise per day. Similarly, the LTE group performed the exercise using their lesser toes. The TCE group performed complete extension and then flexion of the toes for three minutes three times per day. The control group performed their usual daily life activities. We compared the parameter values before and after the 5-week intervention. For statistical analysis, we performed the Wilcoxon signed-rank and post hoc tests (Kruskal-Wallis and Mann-Whitney tests) using IBM SPSS Statistics 20 software. A  $p < 0.05$  was considered statistically significant. This study was approved by the Ethics

Committees for Human Research of Waseda University and Gumma Paz College. Results In the GTE group, none of the parameter values significantly changed. The NDT score significantly changed from 5.1 to 3.1 mm ( $p = 0.007$ ) in the LTE group but not in the TCE group, where the DF significantly changed from  $9.8^\circ$  to  $13.3^\circ$  ( $p = 0.012$ ). Discussion The result of TCE was similar to our earlier studies. However, it was unclear that DF changed. On the other hand, GTE did not show a morphologic relationship with MLA. In contrast, LTE increased the rigidity of MLA. Anatomically, the first tarsometatarsal joint and second to fifth tarsometatarsal joints have independent articular capsules, respectively. It was suggested that different kinematics might exist in the great toe and lesser toes.

## Mini-Orals

### MO-PM50 Training & Testing: Jumping

#### RELIABILITY OF COUNTER-MOVEMENT JUMP PERFORMANCE, CYCLE ERGOMETER SPRINT PERFORMANCE AND CREATINE KINASE CONCENTRATION IN TEAM SPORT ATHLETES: INTEREST FOR FATIGUE MONITORING

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**Introduction** With elite sport becoming more competitive over the years, the volume and frequency of training required for competitive performance has increased concurrently. Given the importance of ensuring that athletes still train and compete in a non-fatigued state to allow optimal loading (Wehbe et al. 2014), athletes fatigue monitoring is required. Thus, the aim of this study was to assess the reliability of regularly test used in elite team-sport setup. **Methods** Twelve sub-elite rugby union players ( $179 \pm 3$  cm;  $80.2 \pm 7.2$  kg) carried out a complete fatigue assessment session on four occasions. To assess intra-day reliability, 2 trials were performed in the same day, inter-spaced with 30-min of recovery. Inter-day reliability was measured with the same protocol repeated on two separate days. Each trial consisted of a standardized warm-up, 4 counter-movement jumps (CMJ) measured with a linear-encoder (Gymware, Kinetic Performance Technologies, Australia), a blood Creatine Kinase [CK] measurement (Reflotron, Roche, France) and two maximal 6-second sprint cycle efforts on a Wattbike Pro (UK) separate by a 1-minute semi-active recovery. **Results** The intra-day and inter-day typical error of estimate (TEM) for peak velocity measured during the CMJ ( $0.12, \pm 0.3$  and  $0.12, \pm 0.3$  m.s<sup>-1</sup>) and coefficient of variation (CV) ( $3.6, \pm 1.0$  and  $3.6, \pm 0.9$  %) were small and intra-class correlation (ICC) were very large ( $0.90$  and  $0.91$  respectively). Intra-day and inter-day TEM for mean power measured during the CMJ ( $297.0, \pm 76.7$  and  $404.1, \pm 104.4$  watts) and CV ( $8.2, \pm 2.2$  and  $13.4, \pm 3.7$  %) were small to moderate. Mean power measured during the cycling sprint reported small TEM and CV (respectively  $30.5, \pm 7.9$  watts and  $3.0, \pm 0.9$  % for the intra-day condition and  $33.2, \pm 9.0$  watts and  $3.2, \pm 0.9$  % for the inter-day condition). Furthermore, ICCs were very large for the intra-day and inter-day conditions ( $0.95$  and  $0.94$  respectively). Lastly, for [CK], Intra-day and inter-day TEM and CV were considered as small (respectively for intra-day  $32.9, \pm 8.2$  UA and  $14.3, \pm 3.8$  % and for inter-day,  $65.7, \pm 46.6$  UA and  $10.6, \pm 8.2$  %) and ICC were very large ( $0.99$  for both conditions) **Discussion** Peak velocity assessment during the CMJ, mean power recorded during a cycle ergometer sprint test as well as [CK] monitoring were highly reliable in sub-elite rugby players. Sport scientists working with team-sport players could use these data to track meaningful changes in performance over time and monitor fatigue. Wehbe, G. et al., 2014. Neuromuscular Fatigue Monitoring in Team Sport Athletes Using a Cycle Ergometer Test. *Int J Sports Physiol Perform*.

#### INTRA-RATER AND INTER-RATER RELIABILITY WHEN MEASURING HIP, KNEE AND ANKLE JOINT ANGLES DURING SINGLE-LEG LANDING USING SILICONCOACH.

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**Background** to the study: Landing is a frequently performed task in sports. The landing technique used by the individual has important implications not only for the achievement of the tasks following the landing but also to decrease the forces transmitted to the body and the body's ability to absorb these forces. As a result, the landing techniques used by athletes may increase the chance of Anterior Cruciate Ligament (ACL) injury during landing from a jump. SiliconCOACH is a tool that has been designed to analyse movement and joint position. This software is able to provide immediate objective feedback which can be used in a clinical setting. However, the reliability of using this tool to measure lower limb-joint angles during functional activities, such as a SLL has not been established. **Objective:** To assess intra-rater and inter-rater reliability when measuring hip, knee and ankle joint angles during single-leg landing (SLL), 30 cm drop jump using SiliconCOACH software. **Methods:** Twenty subjects, 18 males and 2 females with an average age 24.40 years, participated in the study. Seven reflective markers were placed over specific bony landmarks in lower limb for each subject. Three raters used SiliconCOACH three times to calculate hip, knee and ankle joint angles, during SLL. **Results:** ICC values of using the siliconCOACH programme to measure hip, knee and ankle-joint angles during SLL for intra and inter-rater reliability were very high and varied from  $0.97$  to  $0.99$ . The standard error of measurements (SEM) was generally very low and varied from  $0.53^\circ$  to  $1.38^\circ$ . Repeated measurements of ANOVA indicate that there was no significant difference in all measurements P-value was varied from ( $0.12$  to  $0.95$ ). **Conclusion:** The study demonstrated that SiliconCOACH software has high inter and intra-rater reliability for measuring hip, knee and ankle joint angles during SLL in a relatively young and healthy population.

#### IS JUMPING HEIGHT OF SJ AND CMJ EFFECT MUSCLE ACTIVITY?

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**Introduction** Success in volleyball depends primarily on a player's strength, speed, and endurance, together with his body's peak mechanical power output. **Methods** The study included 12 male Turkish volleyball players ( $20.13 \pm 1.92$  age;  $178 \pm 4.97$  cm;  $72.44 \pm 6.76$  kg;  $22.92 \pm 1.57$  kg/m<sup>2</sup>; Sports Experience:  $9.2 \pm 3.4$  year; Total Sport Hours/Week: 12 hours: 4 days\*3 h per week) from the Faculty of Sport Science. The knee extensor and flexor EMG activity and different vertical jumping [Squat Jump (SJ) and Countermovement Jump (CMJ)] performance characteristics of male volleyball players were measured. EMG sensors were applied and participants performed maximum voluntary isometric contractions (MVICs) of the Rectus Femoris (RF), Vastus Lateralis (VL), Vastus Medialis (VM), and long head of the



Biceps Femoris (BF) muscles before exercise testing. EMG activity was recorded during the SJ and CMJ test (Delsys Trigno, Boston, MA). A wireless 3D inertial measurement unit (IMU) (Sensorize, Rome, Italy) was secured to the trunk at the L5 level by an elastic belt for the determining of jumping height. The CMJ tests were performed in the following order: (a) upright standing posture, (b) making a preliminary downward movement through knee and hip flexion [self-selected, called the preferred position (CMJPREF)], (c) followed by an immediate, forceful extension of the knee and hip joints propelling the subject vertically off the ground and (d) prior to take-off, extending the ankles to their maximum range (full plantar flexion) to ensure proper mechanics (Price, 2005). The squat jump test started from a stationary semi-squatting position with 90° of knee joint flexion and involved only knee extension (Earp et al., 2010). Six jumps (separated by a three min rest) were used to record jumping height. To minimize the effect of arm swing on jump performance, the participants were asked to keep their hands on their hips (Rodacki et al., 2002). The size of linear relation between physical structure and variables of sole was examined by calculating Pearson's coefficient. Discussion Jumping height of SJ ( $37.72 \pm 1.53$  cm) and BF muscle activity ( $19.42 \pm 13.34$ ) for the high jumping height have a correlation negatively ( $r = -.593$ ;  $p = .055$ ). Jumping height of CMJ ( $42.00 \pm 0.96$  cm) and the VL muscle activity ( $55.04 \pm 44.86$ ) for the high jumping height have a correlation coefficient ( $r = -.573$ ;  $p = 0.70$ ). According to these data there is a correlation between jumping height and muscle activity, but there is no statistically significant difference. References Price, RG. (2005). The Ultimate Guide to Weight Training for Volleyball Cleveland: Price World Enterprises. Earp, JE, Joseph, M, Kraemer, WJ, Newton, RU, Comstock, BA, Fragala, MS, et al. (2010). Lower-body muscle structure and its role in jump performance during squat, countermovement, and depth drop jumps. *J Strength Cond Res*, 24:722-729. Rodacki, ALF, Fowler, NE, Bennett, SJ. (2002). Vertical jump coordination: fatigue effects. *Med Sci Sports Exerc*, 34:105–116. Contact leonarici@anadolu.edu.tr

## APPLICATION OF ACCELEROMETRIC SYSTEM FOR DETERMINATION OF STIFFNESS DURING HOPPING

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**Introduction** Leg stiffness represents a variable which has an effect on vertical jump effectiveness (Struzik and Zawadzki, 2013). However, currently there are several computation methods, but they do not necessarily yield the same values for leg stiffness. Therefore, it is essential that the simplicity of the equipment used does not affect measurement reliability. The aim of this study is to compare values of stiffness recorded in a laboratory environment and using the Myotest accelerometer during hopping task. **Methods** The measurements were performed in a group of 30 untrained female students from the university school of physical education. Each study participant performed three sets of 5 hops (3 highest hops were analysed) according to the manual for the Myotest system. Further analysis focused on the test with the highest mean height of hops obtained by each participant. Leg stiffness was determined based on the measurement using the Myotest accelerometer, force platforms and the BTS SMART system for motion analysis. Leg stiffness was determined using the methodology developed by Struzik and Zawadzki (2013) as a ratio of changes in the value of ground reaction forces to the respective changes in the height of the greater trochanter of the femur, separately for the countermovement (amortization) and take-off phases. **Results** According to the methodology of Struzik and Zawadzki (2013) mean value ( $\pm$  SD) of leg stiffness in the countermovement phase ( $K_c$ ) was  $14.2 \pm 6.4$  whereas in the take-off phase, this value was ( $K_t$ )  $15.2 \pm 5.7$  kN/m. Furthermore, leg stiffness determined using the Myotest ( $K_m$ ) was  $30.7 \pm 13.3$  kN/m. However, the values show certain relationships that can be described by means of the following equations:  $K_c = 0.4286 \cdot K_m + 1.0952$  ( $R^2 = 0.79$ ) and  $K_t = 0.3726 \cdot K_m + 3.8124$  ( $R^2 = 0.76$ ). **Discussion** The relationships between leg stiffness in the countermovement and take-off phases and the stiffness evaluated using the Myotest allow for conclusion that, despite the significantly overestimated value of stiffness, Myotest accelerometer can be used for determination of its 'contractual value'. Therefore, this measurement offers only an approximate value that can provide information about changes in leg stiffness e.g. following training. The overestimated value can result both from inaccuracy of determination of contact time and flight time by the Myotest accelerometer (Choukou et al. 2014) and from the use of the equation of Dalleau et al. (2004), which assumes that the movement of the center of mass has a harmonic profile. **References** Choukou M-A, Laffaye G, Taiar R. (2014). *Biol Sport*, 31(1), 55-62. Dalleau G, Belli A, Viale F, Lacour J-R, Bourdin M. (2004). *Int J Sports Med*, 25(3), 170-176. Struzik A, Zawadzki J. (2013). *Acta Bioeng Biomech*, 15(2), 113-118. Contact artur.struzik@awf.wroc.pl

## CHARACTERISTICS OF ASYMMETRY BETWEEN TAKEOFF LEGS DURING RUNNING AND STANDING JUMPS WITH SINGLE LEG

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**INTRODUCTION** In basketball, an ability of running single leg jump (RSJ) is a determinant for achieving high competitive activities, because RSJ is frequently used for example rebounding at a higher position. It is known that the athletes have a dominant takeoff leg (D-leg) during RSJ (Schiltz et al., 2009). It has been suggested that drop jump (DJ) and repeated rebound jump (RJ) from standing position are effective training to improve the RSJ ability. Thus, these jumps also have a possibility to improve an asymmetry of RSJ between takeoff legs. The present study aimed to clarify the feature of asymmetry between the D-leg and the non-dominant leg (ND-leg) in jumping variables and kinetics of lower limbs during RSJ and standing jumps. **METHODS** Seven healthy male collegiate basketball players performed a maximal RSJ, RJ, DJ and squat jump without counter movement (SQJ) using D-leg and ND-leg each three times in random order. The 3-dimensional data and ground reaction force were recorded using 12 cameras infrared motion analysis system (500 Hz) and 2 force platforms (2000 Hz). We estimated jump height (JH), jump index, running velocity (RV), decreasing horizontal velocity ( $\Delta$ HV), reactive strength (%SQJ) and joint torque of the takeoff leg. We calculated asymmetry index of these variables. **RESULTS** JH, jump index, %SQJ and  $\Delta$ HV were significantly higher in the D-leg than ND-leg during RSJ and DJ ( $p < 0.05$ ). The peak torques of ankle and knee were significantly greater in the D-leg than ND-leg during RSJ and DJ ( $p < 0.05$ ). **DISCUSSION**  $\Delta$ HV was higher in the D-leg than the ND-leg during RSJ but there were no significant asymmetry of RV. High jumpers generally could jump high as RV was higher within the optimal RV (Greig and Yeadon, 2000). The current results indicated that the asymmetry of RSJ was attributed to the ability to effectively transmit RV to JH. %SQJ were higher in the D-leg than the ND-leg during RSJ and DJ. %SQJ which estimated a SSC ability indicated a factor to jump high (Ritzdorf, 2009). The ankle and knee torques were greater in the D-leg than the ND-leg. It is important to jump high that mechanical output about the plantarflexion and knee extensor reached large during DJ (Bobbert et al., 1987). The asymmetries between the legs during RSJ and DJ were attributed to whether the plantarflexion and knee extension torque were greater generated. These findings indicated that DJ may be useful for improving the asymmetry of RSJ. **REFERENCES** Bobbert MF, Huijing PA, van Ingen Schenau GJ. (1987). *Med Sci Sports Exerc*, 19(4), 332-338. Greig MP, Yeadon MR. (2000). *J Appl Biomech*, 16(4), 367-378. Ritzdorf W. (2009). *New Studies Athlet*, 24(3), 31-34. Schiltz M, Lehance C, Maquet D, Bury T, Crielgaard JM, Croisier JL. (2009). *J Athl Train*, 44(1), 39-47. CONTACT t-sugi@nifs-k.ac.jp

## SHORT-TERM ADAPTATIONS TO COMPLEX TRAINING ON SPRINT AND VERTICAL JUMP IN TRAINED ATHLETES: A META-ANALYSIS.

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**Introduction** In most sports, the capacity to maximize power production is fundamental and the improvement of sprint and vertical jump (VJ) are important goals. Recently, Complex Training (CT) has emerged as a training method aimed at developing athletes' strength and power. It consists of alternating similar heavy resistance exercises with plyometrics/power ones, set for set, in the same session (1, 2). In trained athletes, little is known about the short-term adaptations to CT. Hence, this meta-analysis aimed to investigate to what extent CT might improve athletes' sprint and VJ performance. **Methods** 5 studies (8 CT intervention groups) were included regarding sprint adaptations and a total of 6 studies (8 CT groups) were included concerning VJ. **Inclusion criteria:** 1) at least one CT intervention group; 2) training protocols  $\geq 4$ -wks; 3) sample of trained athletes; 4) sprint or VJ as an outcome variable. Mean $\pm$ SD and sample size data were extracted from all included papers. Effect size (ES) of the intervention was calculated by the pre- and post-intervention differences in CT-trained participants. For controlled trials, the ES of the CT was also calculated by the difference in performance after the intervention between CT-trained and CG. **Results** Significant pre-post increments in sprint and VJ performance ( $p < .05$ ) after CT and also between intervention and CG ( $p < .05$ ). Subgroup analysis indicated that the duration of intervention ( $\geq 6$ -wks;  $p < .05$ ) was the only potential moderating factor explaining the differences found in sprint time. On VJ, intracomplex rest interval (ICRI) ( $\geq 3$  min;  $p < .05$ ) was the one factor potentially explaining the differences obtained. Age, skill level, type of jump or sprint testing, exercise characteristics and sport modality didn't show statistical significance. **Discussion** The main conclusions indicate that CT is an effective method to increase both sprint and VJ performance in trained athletes. Regarding sprint, longer durations of intervention ( $\geq 6$  weeks) possibly explain pre-post differences, supporting previous findings with different resistance training programs (3). On VJ, the main moderating factor was the ICRI, with intervals longer than 3 min resulting in higher gains in CMJ height. This finding is in line with previous research (4) and supports the idea that the balance between fatigue and potentiation is not favorable when short ICRI are provided (4). **References** 1. Ebben WP. Complex training: a brief review. *J Sports Sci Med* 2002 Jun;1(2):42-6. 2. Ebben WP, Watts PB. A Review of Combined Weight Training and Plyometric Training Modes: Complex Training. *Strength Cond J* 1998;20(5):18-27. 3. Bolger R, Lyons M, Harrison AJ, Kenny IC. Sprinting Performance and Resistance-Based Training Interventions: A Systematic Review. *J Strength Cond Res* 2015;29(4):1146-56. 4. Wilson JM, Duncan NM, Marin PJ, Brown LE, Loenneke JP, Wilson SMC, et al. Meta-Analysis of Postactivation Potentiation and Power: Effects of Conditioning Activity, Volume, Gender, Rest Periods, and Training Status. *J Strength Cond Res* 2013 Mar;27(3):854-9.

## IS THE REDUCED SPIKE-JUMP PERFORMANCE IN ELITE FEMALE VOLLEYBALL PLAYERS DETERMINED ONLY BY SEX DIFFERENCES IN ANATOMY, STRENGTH, AND POWER?

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**INTRODUCTION:** Strength, power, and anatomical differences between women and men are well known. However, in complex movements like the volleyball spike-jump, sex differences in performance may be due to technique. The aim of the study was 1) to detect sex dependent differences in kinematics, kinetics, and muscular activation patterns in the volleyball spike-jump and their impact on performance and 2) to propose sex specific training adaptations based on results of the study. **METHODS:** Fourteen female and male elite volleyball players performed spike-jumps with maximal jump height (JH). The subjects had to spike a volleyball suspended on a rope from the ceiling. Data was collected through a Vicon motion capturing system (Vicon Nexus 1.8) with eight MX13 cameras (250Hz) utilizing a cluster marker set, two AMTI force plates (2000Hz), and surface EMG (2000Hz) on five lower body muscles. A full body 3D-model was programmed in Visual3D for data filtering, calculation of kinematics and the center of mass (CoM), vertical and horizontal forces as well as for EMG rectification, filtering, and peak normalization to determine muscular activation patterns. **RESULTS:** Females approached the spike-jump significantly ( $P < 0.05$ ) slower with a shorter penultimate step compared to men. In females, we measured a lower maximal horizontal force and a greater jump angle from the first contacted force plate. Both correlated negatively with the approach speed and JH. Female participants had higher vertical CoM during approach, less reduced joint angle and smaller range of motion in the hip and knees during the last step, resulting in shorter acceleration distance and lower maximal joint velocity in the hip and knees. Differences in activation timing, mean activation, and the occurrence of maximal hip and knee velocity correlated with the approach speed and JH. Furthermore, greater time difference between right and left foot at the take off in female participants contributed to lower JH. **DISCUSSION:** The results suggest that differences in JH cannot be referred only to strength abilities but also to technical skills. The approach phases before the actual upward motion seem to have a great impact on the jump performance. They revealed numerous differences between women and men and can be expected to respond well to training intervention. Increasing approach speed and acceleration distance seems to be beneficial. To convert horizontal approach speed into vertical momentum, minor adjustments in the jump angle and muscular activation may be necessary, especially in the right leg (right-handed players).

## EFFECT OF A MOUNTAIN HALF-MARATHON RACE ON VERTICAL JUMPING MECHANICS

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**Introduction** The mountain half-marathon (MHM) distance is of particularly increasing popularity among runners (Running USA's Annual Half-Marathon Report 2014) most likely because it allows the long distance challenge with lower training load than marathons or ultramarathons. Although a variety of biological fatigued parameters has been studied after long distance running, there is notably scarce information about the changes of jumping mechanics (Millet, 2011). The purpose of the study was to examine the changes of counter-movement jumping (CMJ) mechanics after a mountain half-marathon (MHM) race. **Methods** Twenty seven runners (41.3 $\pm$ 3.8 yrs) who completed a MHM (23,5 km, positive altitude 1007,5 m), performed CMJs (forceplate Kistler:9286AA, 750 Hz) before (Pre) and at 2 time points after the race (Post 1 and Post 2). Analysis included the ground reaction force (GRF) variables of instantaneous mechanics and GRF ensemble averaged curve mechanics for displacement, vertical force, anterior-posterior force, velocity and power. Differences were tested with repeated measures ANOVAs followed by pairwise comparison among Pre, Post 1 and Post 2 ( $p < 0.05$ ). **Results** Overall there was lowering of jump height (Post 1 -4.1%  $p > 0.05$ , Post 2: -7.9  $p < 0.05$ ) with significant reductions in CMJ instantaneous mechanics. The eccentric changes preceded the concentric ones, Fz peaked later during contact time and Fx was reduced throughout contact time. The ensemble averaging curve analysis revealed an altered force-velocity relation and time intervals of significant pre-post differences for the

examined time-curves and displacement-loops. Discussion The MHM race changed significantly the CMJ mechanics with notable differences in the timing as well as the magnitude of the examined instantaneous and ensemble averaged mechanics. The absence of significance hump height decrease may be attributed to post-activation potentiation. The finding that the eccentric changes preceded the concentric ones may be associated to the impact of the intense eccentric muscular action imposed during the downhill sections of the mountain race. These changes are most likely due to peripheral neuromuscular fatigue (Martin et al. 2010), as a combined result of the race duration, the altitude inclines and declines, as well as, the variable racing terrain. References Millet (2011). *Sports Med*, 41, 489-506. Martin V, Kerhervé H, Messonnier LA, Banfi JC, Geyssant A, Bonnefoy R, Féasson L, Millet GY. (2010). *Appl Physiol*, 108, 1224-1233. Running USA's Annual Half-Marathon Report (2014). <http://www.runningusa.org/index.cfm?fuseaction=news.details&ArticleId=333> Email: cbountol@phed.uoa.gr

#### KINEMATIC AND DYNAMIC ANALYSIS OF POWER CLEANING - FUNDAMENTALS OF A PERFORMANCE DIAGNOSTIC TOOL TO DETERMINE JUMP PERFORMANCE.

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Introduction To determine jumping abilities in team sports and athletics, mostly isometric strength test and vertical jumps (e.g. CMJ, SJ, DJ) are performed. However, the gained results can only partially be transferred to training settings. Hence, coaches and athletes need more detailed information to align training. Exercises from the Olympic weightlifting (snatch and clean) have similar force-time curves to jumps (Corlock et al., 2004; Garhammer, 1993). Thus, the aim of this study was to analyse the kinematics and dynamics of the snatch and clean and to detect potential correlations between performance-determining parameters of jumping and power cleaning. Methods 11 athletes (4 female, 7 male, age 26+/-4yrs) performed vertical jumps (CMJ and SJ with arms akimbo), power cleans at 60, 70, and 80% of 1 RM and maximal isometric contractions in a leg press with a knee angle of 110°. The kinematics of the jumps and the power clean movements were recorded with Vicon cameras (200Hz) and the dynamics were measured with two AMTI force plates (1000 Hz). Based on these data, joint angles and moments in the sagittal plane of the knee, hip, and ankle joints were calculated. Correlations between the different variables of the power clean, the jumps, and the isometric leg press were analysed using bivariate Pearson correlation. The difference in dynamics and kinematics due to the weight conditions in power cleans and CMJ, and in power cleans and leg press were analysed via univariate ANOVA. Results Increasing weight in power clean, Fmax ( $r=.707$ ,  $p=.008$ ) and Fexpl ( $r=.588$ ,  $p=.029$ ) showed significant correlations to CMJ height. No significant correlations were found between isometric Fmax in leg press ( $r=.309$ ,  $p=.178$ ) and CMJ height. Power cleans The differences between dynamic (max. power output) and kinematic (max velocity of the bar) ( $r=.576$ ,  $p=0.032$ ) of the power clean indicate that the optimal training weight should be set at 70% of 1RM. Discussion Our results serve as basis for the development of performance diagnostic tools which gives coaches and athletes the possibility to align their training purposefully and efficiently. Moreover, with the help of future training intervention studies, detailed statements can be made for optimal training weight. A deeper understanding of the source of the force generation in ankle, knee, and hip angle might improve diagnostic tools, possibly including the analysis of individual muscle potentials. References Corlock JN, Smith SL, Hartmann MJ, Morris RT, Ciroslan DA, Pierce KC, Newton RU, Harman EA, Sands WA, Stone MH (2004). *J Strength Cond Res*, 18 (3), 534-539. Garhammer J (1993). *J Strength Cond Res*, 7 (2), 76-89

### Mini-Orals

#### MO-SH08 Psychology: Mixed Session

##### KNOWLEDGE OF PHYSICAL ACTIVITY RECOMMENDATION AND STAGES OF PHYSICAL ACTIVITY BEHAVIOR CHANGE

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Objective: Based on Trans-theoretical Model, the current study aimed to investigate the association between an individual's knowledge of PA recommendation and PA behavior change. Methods: Three separate studies were conducted: in the first study, Physical Activity Stage of Change Questionnaire was translated and validated among 304 Chinese university students; in the second study, Chinese university students' knowledge of international PA recommendation, PA stage distribution and self-reported PA level were surveyed with a large sample of 10022 students and the association among knowledge, PA stages and PA level were explored in a cross-sectional design; in the third study, the effect of knowledge of PA recommendation on PA behavior change was tested in a randomized controlled experimental design with a sample of 308 students. Results: It was found that Chinese version Physical Activity Stage of Change Questionnaire has good psychometric properties; Only 4.31% of the students correctly recalled the international PA recommendation; only 20.30% of the students meet recommended level of PA, with 10.8% of them in the stage of Pre-contemplation, while 33.6%, 25.9%, 10.2% and 19.5% are in the stages of Contemplation, Preparation, Action and Maintenance respectively. Non parametric Mann Whitney U test result indicated that those with the knowledge of PA recommendation have significantly higher PA stage of change than those without knowledge. Intervention design of presenting PA recommendations to students without the knowledge of PA recommendation brought about significant shift in students' PA stages of change. Conclusions: Knowledge of PA recommendation is significantly associated with PA stages of change and knowledge of PA recommendation is able to bring about significant positive shift in PA stages. But subsequent further analysis illustrated that the degree of change depends on the baseline stage of an individual, those in their earlier stages such as Pre-contemplation benefit more from the exposure to the recommendation compared with those in their higher stages.

## EFFECTS OF USING THE MOBILE MOTION ADVISOR IN PHYSICAL EDUCATION LESSONS: MOTIVATION AND AMOTIVATION

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**INTRODUCTION** According to Ntoumanis (2001), a way to improve intrinsic motivation of students in physical education (PE) is to emphasise improvements based on self-referenced standards, which gives them a feeling of competence. To test motivational effects of a sports app, Preuschl et al. (2015) set up a virtual game - Beat my Activity (BMA) - to be played simultaneously to sports games using a mobile feedback system comprising a smart phone and a stride sensor - the Mobile Motion Advisor (MoMA). BMA incorporates automated feedback based on the individual capabilities and gives everyone in a heterogeneous group of students the chance of winning.

**METHODS** By using a German version of the SMS-28 test for PE (Granero-Gallegos et al., 2014), the motivation of the students of two classes was measured at the beginning and the end of a semester. Only data of individuals who filled out the questionnaires at both instants is presented here. The intervention group (IG,  $n=12$ , age= $16\pm0.7$  yrs, body mass= $75\pm22.5$  kg) played BMA simultaneously to small sided games during their PE classes. The control group (CG,  $n=17$ , age= $16\pm0.8$  yrs, body mass= $69\pm18$  kg) had their normal PE lessons. Both classes were taught by the same teachers. In the SMS-28, questions are answered on a 7 scale level. Each item is related to one of the three factors that are measured: amotivation (4 items), extrinsic (12 items) and intrinsic motivation (12 items). To see if differences in the changes of the students' motivation over the course of one semester between the IG and the CG occur, an analysis of variance with repeated measures was performed on the sum of items per factor using SPSS 22 (SPSS Inc., Chicago, Illinois).

**RESULTS** The analysis of variance with repeated measures did not reveal significant differences ( $p < 0.05$ ) on the state of motivation between IG and CG. The average of the sum of items measuring amotivation rose from 9.94 to 11.4 in the CG and sank from 10.3 to 9.3 in the IG. Extrinsic motivation sank from 40.1 to 37.1 in the CG and from 51.7 to 47.0 in the IG, and intrinsic motivation sank from 46.8 to 41.2 in the CG and rose from 59.2 to 60.0 in the IG.

**DISCUSSION** The virtual game BMA is played simultaneously to a real game. As the BMA's rating of the individual efforts is communicated through a handheld device only, it might not be as valuable for the individual as the respect perceived when scoring a goal. Using the MoMA over a semester might therefore not alter the state of motivation of a class of high school students.

**REFERENCES** Granero-Gallegos, A. (2014). *J Sports Sci Med*, 13, 801-807. Ntoumanis, N. (2001). *Brit J Educ Psychol*, 71, 225 – 242. Preuschl, E. et al. (2015). *Proc 10th Int Symp Comp Sci Sports (ISCSS)*. 153-156. Cham: Springer.

## THE ASSOCIATION BETWEEN PHYSICAL ACTIVITY, FITNESS AND BODY IMAGE IN ADOLESCENCE AND YOUNG ADULTHOOD - AN EIGHT-YEAR FOLLOW-UP STUDY

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**Background:** Body image dissatisfaction has been linked with a range of adverse psychosocial outcomes in both sexes and has become an important public health issue. Dissatisfaction with one's body has been found among all body sizes. From adolescence to young adulthood individuals go through major developmental changes, which are often accompanied by increased awareness of physical appearance. **Aim:** The aim of current study was to examine if physical activity and fitness relate to body image differently across sex and age. **Methods:** Same participants were measured initially at age 15 ( $n = 385$ , 190 females and 195 males) and again at age 23 ( $n = 201$ , 92 females and 109 males). Physical activity was assessed objectively, fitness both objectively and subjectively, and body image with Offers Self-Image Questionnaire. Structural equation modeling was used to examine the association between physical activity, fitness and body image; covariates included skinfold thickness, body mass index, socioeconomic status, anxiety, and depression. **Results:** No change was found in body image from adolescence to young adulthood, within sex. Physical activity and aerobic fitness decreased from age 15 to age 23 within sex. Fewer reported their fitness as good or excellent at follow-up than did so at baseline. Factors associated with body image in adolescence were self-reported fitness and depression among females and for males it were skinfold thickness and aerobic fitness. In young adulthood self-reported fitness, depression and body mass index associated with female body image, whereas skinfold thickness, depression, body mass index and self-reported fitness did so among males. **Conclusion:** Results suggest that the relationship of physical activity and fitness to body image is not fixed across this critical age period. Therefore, intervention methods needed to improve body image might need to be tailored to young peoples' age and sex.

## CAN MUSIC BOOSTS YOUR BRAIN AS SPORT? COMPARING DRUMMERS, NO-DRUMMER MUSICIANS AND ATHLETES

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**Introduction** Both playing sport and a musical instrument seem to produce plastic reorganization of the brain, which affects sensory-motor cognitive functions (Pascual-Leone, 2001; Erickson et al., 2015). The benefits of sport have usually been associated to the aerobic fitness (Erickson et al., 2015); on the other hand, playing music requires a variable amount of aerobic expenditure, depending on the instrument played (De La Rue et al., 2013). Therefore, the advantages on sensory-motor cognitive functions may differ, being minimum for players of static instruments (e.g. piano and violin) and maximum in drums players, since their aerobic costs are similar to those of athletes. To test this hypothesis we compared brain activity and behavioral performance of high-level athletes, drummers and no-drummer musicians using a perceptual decision-making task during electroencephalogram (EEG) recording. **Methods** We enrolled 48 healthy young adults (age  $29\pm5$  yrs.) equally divided into four age-matched groups: high-level drummers, non-drummer musicians, athletes and controls (non-athletes and non-musicians). Musicians and athletes were matched for years of practice. Participants performed a visual Go/No-Go task, and their cortical activity was recorded by a 64-channel EEG. Event-related potentials (ERP) and behavioral performance (response time and accuracy) were analyzed. **Results** Behavioral results showed that drummers and athletes were faster than other groups. At ERP level, the pre-stimulus activity in motor-related regions was larger in athletes than musicians and controls. After stimulus onset, drummers significantly differed from the other groups, showing the largest prefrontal positivity (pP), an ERP component related to the stimulus-response mapping process. **Discussion** Drummers and athletes showed comparable response time, likely due to similar high-energy expenditure. ERP results suggested that this behavioral advantage might be mediated by different cortical processes: athletes showed stronger motor preparation before stimulus onset, whereas drummers showed more intense sensory-motor mapping processes after stimulus onset. **References** De La Rue, S. E., Draper, S. B., Potter, C. R., & Smith, M. S. (2013). Energy expenditure in rock/pop drumming. *International journal of sports medicine*, 34(10), 868-872. Erickson, K. I., Hillman, C. H., & Kramer, A. F. (2015). Physi-



cal activity, brain, and cognition. *Current Opinion in Behavioral Sciences*, 4, 27-32. Pascual-Leone, A. (2001). The brain that plays music and is changed by it. *Annals of the New York Academy of Sciences*, 930(1), 315-329. Contact v.bianco@uniroma4.it

### **PREDICTION OF EXERCISE IMAGERY ON VITALITY: THE MEDIATING EFFECT OF BASIC PSYCHOLOGICAL NEEDS AMONG COLLEGE STUDENTS**

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**Introduction** There has been increased interest and research given to the role of imagery in exercise (Giacobbi et al., 2005). Hall (1995) proposed that imagery may influence exercise participation through its effects on motivation. From the self-determination theory perspective, events that satisfy the basic needs provide the energy to maintain or enhance vitality. Therefore, the aim of this study was to examine whether the prediction of exercise imagery on vitality is mediated by basic needs among college students. **Methods** The participants were 189 college students (95 males, 78 females, mean age  $19.74 \pm 1.24$ ) recruited from 3 universities in Northern Taiwan. Participants were requested to complete Exercise Imagery Questionnaire (Hausenblas et al., 1999) and Psychological Need Satisfaction in Exercise Scale (Wilson et al., 2006) and Subjective Vitality Scales (Ryan & Frederick, 1997). **Results** The results showed that exercise imagery positively predicted subjective vitality ( $R^2=20\%$ ) and basic psychological needs (autonomy  $R^2=30\%$ , competence  $R^2=27\%$ , relatedness  $R^2=18\%$ ). In addition, in terms of the mediating effect of basic psychological needs, the prediction of exercise imagery on subjective vitality was only mediated by competence but not relatedness and autonomy. **Discussion** According to these results, exercise imagery predicted subjective vitality. Moreover, one of the basic needs, competence, played as a mediator. In other words, exercise imagery positively influenced college student competence and then positively predicted their subjective vitality. The results of this study suggested that exercisers will be encouraged using exercise imagery to enhance competence and subsequently to enhance their subjective vitality. **References** Giacobbi, P. R., Hausenblas, H. A., & Penfield, R. D. (2005). Further Refinement in the measurement of exercise imagery: The exercise imagery inventory. *Measurement in Physical Education and Exercise Science*, 9(4), 251-266. Hall, C. R. (1995). The motivational function of mental imagery for participation in sport and exercise. In J. Annett, B. Cripps, & H. Steinberg (Eds.), *Exercise addiction: Motivation for participation in sport and exercise* (pp. 15-21). Leicester, UK: British Psychological Society. Hausenblas, H. A., Hall, C. R., Rodgers, W. M., & Munroe, K. J. (1999). Exercise imagery: Its nature and measurement. *Journal of Applied Sport Psychology*, 11(2), 171-180. Ryan, R. M., & Frederick, C. M. (1997). On energy, personality and health: Subjective vitality as a dynamic reflection of well-being. *Journal of Personality*, 65, 529-565. Wilson, P. M., Rogers, W. T., Rodgers, W. M., & Wild, T. C. (2006). The psychological need satisfaction in exercise scale. *Journal of Sport & Exercise Psychology*, 28, 231-251.

### **CHARACTERISTICS OF AUTOBIOGRAPHICAL MEMORIES IN ATHLETES COMPARED NON-ATHLETES**

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**Introduction** Current behaviors might be understood and even defined by analyzing autobiographical memories such as "formative images" and "proto-experiences in sports." This study aimed to clarify characteristics of athletes' autobiographical memories by comparing them to those of non-athletes, and to investigate the role that autobiographical memories play in athletes' identity development and commitment toward sports. **Methods** Participants were 230 university student athletes who had participated in competitive athletics for an extended period of time (athlete group) and 141 university students (non-athlete group). Self-administered semi-structured questionnaires were distributed to participants. Questions focused on the content of formative images and memorable childhood play experiences, as well as the impact of proto-experiences in sports on one's current self. **Results & Discussion** Content of formative scenes: While nearly 50% of formative images reported among the athlete group comprised various types of play and physical activity (formative images), over 50% of those reported among the non-athlete group were simple or generic scenes. Formative images recalled by the athletes were likely to involve their participation in the scene, but this element was largely absent from the non-athletes. Content of memorable childhood play experiences: Responses were evaluated based on how "space" and "dynamism" were expressed in them. Many of the athletes reported that they engaged in competitive and highly active physical activity from early childhood, which coincided with their reported formative images. The association of these early experiences suggests a potential developmental path into later participation in competitive sports. Influence of proto-experiences in sports on one's current self: Among athletes, the influence of early memorable sports experiences on their current selves was reported to be "inspiration/continued interest" (17.0%), "aspiration/motivation" (22.2%), "perseverance/improved achievement" (14.3%), and "enjoyment" (18.7%). It seems possible that these childhood experiences were driving forces behind athletes' engagement with competitive sports later in their lives. However, many (39%) non-athletes reported an "unknown" linkage between their proto-experiences in sports and some current involvement with sports. Nearly 10% of the non-athletes even reported some negative feelings about continuing sports activities, going so far as to say that they give sports a "wide berth" in their current lives. **References** Okuda A., Nakagomi S., Suzuki A. (2015) Analysis of the proto-scenery in the autobiographies of top athletes. *Bulletin of Biwako-Gakuin University Biwako-Gakuin College*, 6:69-78. Contact okuda@newton.ac.jp

### **PREDISPOSITION TO BIGOREXIA AND EXERCISE ADDICTION: A COMPARISON BETWEEN SPORT SCIENCES STUDENTS AND OTHER STUDENTS**

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**INTRODUCTION** The Bigorexia (or Reverse Anorexia), is part of Body Dysmorphic Disorders. Subjects who suffer of Bigorexia are disappointed about their body dimensions and their muscles. Sports people and bodybuilders are more involved in this problem than other categories. A 2014 research (Bo et al., 2014) points out that bigorexia is often linked to exercise addiction and it may influence the choice to attend the University of Sport Sciences. The aims of this work are: 1- evaluate if Milan Sport Sciences students suffer of bigorexia in comparison with a group of students of Biology. 2- verify if there are any associations between bigorexia and exercise addiction between the two groups. **METHODS** 100 students of Sport Sciences and 102 of Biology responded to 3 questionnaires: MDDI for bigorexia (Hildebrandt et al., 2006), Veale test (De Coverley Veale et al., 1987) and Zaitz one (Zaitz et al. 1989) for exercise addiction. Mann Whitney Rank sum test was used to evaluate the significant differences between the groups. **RESULTS** 9% of Sport Sciences students are at risk of Bigorexia against 1.9% of Biology students ( $P<0.05$ ). Among potential bigorexia predisposed students 63.6% are at risk of exercise addiction ( $P<0.05$ ). Analyzing only the exercise addiction test, it is noticed that 42% of Sport Sciences students are at risk against 10.7% of Biolo-

gy students ( $P < 0.05$ ). **DISCUSSION** The data underline that there is a bigger risk for the group of Sport Sciences both for bigorexia and exercise addiction. Every type of sports people are involved, and not only bodybuilders. Moreover is verified the connection between bigorexia and exercise addiction. The limit of the study is the use of tests, because although they are valid methods of evaluation, they don't guarantee the presence of the illness. For more assurances are necessary individuals interviews between the person and a psychologist. **REFERENCES** Bo S at all Journal of Translation Medicine, 2014; 12: 221-224 Hildebrandt T at all Comprehensive Psychiatry, 2006; 47: 127-135 De Coverley Veale MB, British Journal of Addiction, 1987; 82: 735-740 Santarnecchi E et al Body Image, 2012; 9: 396-403 Zaitz D, Idea today 1989; 7

### THE ANTICIPATORY STRESS RESPONSE TO SPORT COMPETITION; A META-ANALYSIS OF CORTISOL REACTIVITY

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**Introduction** Athletes anticipating sport competition regular experience distinct emotional and physiological changes as a result of expected psychosocial stress. Specifically salivary cortisol, an indicator of hypothalamic-pituitary-adrenal (HPA) axis activation, is examined as an objective measure of stress and mediator in attentional processes. Situational factors influencing the cortisol reactivity in laboratory environments are well documented (Dickerson & Kemeny, 2004). However, inconsistent findings are reported in cortisol reactivity in real sport competition. Factors such as gender, age and habituation are attributed to this variation in reactivity. Therefore, the aim of this meta-analysis is to examine cortisol reactivity in athletes anticipating competing in real sport competitions. **Method** The databases PubMed, PsycINFO, SPORTDiscus and Scopus were searched with key words cortisol, stress and sport competition. Studies were included when cortisol was assessed in saliva, collected before sport competition with a time-matched resting sample. Participant characteristics, mean, SD of cortisol and collection time were extracted. A random effect meta-analysis was conducted based on Hedges g effect sizes of rest to pre-competition cortisol followed by moderator analysis. **Results** The search identified 1391 records. Based on title and abstract, 1261 studies were excluded. 130 studies were fully screened from which 25 studies with 27 effect sizes and 348 participants (age  $23.7 \pm 7$ , 67% male, 51% team sport) were included. Analysis showed a large significant increase in cortisol reactivity ( $g = 0.85$ ,  $se = 0.13$ ,  $p < 0.001$ ). A fail-safe N of 734 studies suggested no publication bias. Males had a trend for greater cortisol reactivity ( $g = 1.07$ ) than females ( $g = 0.56$ ,  $p = 0.07$ ). There was an indication that reactivity was reduced in international athletes ( $g = 0.50$ ) compared to national ( $g = 0.85$ ) and regional athletes ( $g = 1.12$ ) albeit not significant ( $p = 0.3$ ). There was no significant difference between cortisol reactivity in AM compared to PM competitions ( $p = 0.25$ ) and between individual and team sport athletes ( $p = 0.5$ ). Regression analysis identified a negative correlation between collection time and reactivity ( $Q = 6.85$ ,  $p < .01$ ), indicating greater cortisol reactivity when cortisol is collected closer to the start of competition. **Conclusion** Anticipating sport competition results in a significant increase in salivary cortisol. However, this effect is reduced when cortisol is collected further away from starting the competition. There is an indication that elite athletes have reduced cortisol reactivity compared to less elite athletes due to habituation, where female athletes tend to have lower cortisol reactivity than male athletes. **References:** Dickerson & Kemeny, 2004. doi:10.1037/0033-2909.130.3.355

### RELATIONS BETWEEN EMOTIONALLY STRESSED AIMING-TASKS AND REVERSAL THEORY: HEART RATE AND HEMODYNAMIC RESPONSES OF PREFRONTAL AREA STUDY

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**Introduction** In this study, using differential difficulties of darts tasks, we investigated to compare the emotional shift seen in the continuous performance of tasks in psychophysiological indices, and be shown to correspond to the reversal theory of Apter (1984), which has been described in the subjective 2 axis of emotional arousal and hedonic tone. **Methods** Subjects: 10 college-aged women ( $19.7 \pm 0.7$  years). **Procedure:** authorized the board (distance 237cm, height 237cm) was used as darts (20g). A reference circle for the each subjects, was set to a distance of half from the center of the 12 throwing darts. There were two aiming-tasks using differential difficulties of darts targets; 1) Easy (E) task: scoring area was set to 1.5 times of the reference circle radius, which was 5,3,1 points from the center at regular intervals in 3 equally divisions on a concentric circle. 2) Difficult (D) task: scoring area was set to the reference circle, and score range was the same. **Physiological indices:** Oxygen dynamics of the left forehead value (the prefrontal cortex), the two-wavelength by the semiconductor laser (780nm, 830nm) by using blood oxygen monitor (BOM-L1, Omega Wave), Oxy-Hb, deOxy-Hb Total-Hb were measured. In addition, continuously measured blood flow between the probes (FLOW), blood volume (MASS), blood flow velocity (VELOCITY) (omega flow FLO-C1, Omega Wave, 780nm) was attached. They are all used to determine the average value from the set 1-throw after the beginning of two seconds before until after two seconds of 3-throw, and the amount of change from at rest and its set representative value was calculated. ECG is derived from chest bipolar lead (ECG100C, Biopack Systems) sampling by 200Hz, and the R-R interval was acquired. **Psychological indices:** Each subject asked their psychological states for the next block (3-throw  $\times$  4 sets) in the 'anxiety', 'boring', 'excitement', and 'relax'. **Results and Discussion** 1. Capture the activation of the prefrontal cortex: A difference to the skin blood flow was observed between the tasks. Prefrontal cortex, regardless of the degree of difficulty is activated. 2. Operation of arousal level: By degree of difficulty of the tasks, arousal level has shown significant difference. D task was said to be a higher activation 'challenge'. 3. Awakening indicator of the autonomic nervous system, heart rate: Slightly correlated with increased anxiety, excitement in the D task was observed. 4. Slightly negative correlation with the increase of boredom was observed in E task. 5. Reversal theory: 'Anxiety' was a negative emotion that occurs when not accompanied by skill in the tasks. Slight association was observed in the activation of the brain and the activation of this emotion. **References** Apter, M. J. (1989). Reversal theory: Motivation, emotion and personality. viii 208 pp. Doi, H., Nishitani, S., and Shinohara, K. (2013). NIRS as a tool for assaying emotional function in the prefrontal cortex. *Frontiers in Human Neuroscience*. 7, 770. Contact satoko@cc.nara-wu.ac.jp

### THE EFFECT OF INCREASING PHYSIOLOGICAL AROUSAL ON BADMINTON SHORT SERVE ACCURACY DURING COMPETITION AND PRACTICE

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**Introduction** Perceptual-motor performance has been suggested to be negatively impacted in situations where physiological arousal is increasing and cognitive anxiety is high compared to when cognitive anxiety is low (Duncan et al., 2016). In such cases, competition has been used to elicit high anxiety and practice low anxiety. The aim of this study was to examine the effect of increasing physiological

arousal on badminton short serve accuracy during competition and practice. Methods Following ethical approval, informed consent and familiarisation, 19 competitive badminton players (10 males; 9 females, mean $\pm$ SD playing experience: 7.3 $\pm$ 3y, mean $\pm$ SD age: 19 $\pm$ 1 y) participated in this counterbalanced study. Players completed the Edwards et al (2005) short serve accuracy test pre and post, the Bottoms et al (2012) Badminton fatigue protocol on two occasions; competition (high cognitive anxiety) and practice (low cognitive anxiety). Heart rate (HR) was monitored throughout and RPE was assessed at 6 points during the 33min protocol. Cognitive anxiety, somatic anxiety and self-confidence were measured pre and post the fatigue protocol and prior to completion of the badminton short-serve test. Results Results from a 2(competition vs practice) X 2(pre vs post) way repeated measures ANOVA revealed a significant main effect for competition vs practice where short serve performance was significantly poorer in competition compared to practice ( $P = .025$ ). Cognitive anxiety intensity increased pre to post fatigue in competition ( $P = .001$ ) but not practice ( $P = .521$ ) conditions. Somatic anxiety intensity increased pre to post for both conditions ( $P = .008$ ). HR was not different between conditions ( $P = .460$ ). RPE was significantly higher in competition compared to practice ( $P = .01$ ). HR and RPE increased with duration of the fatigue protocol irrespective of condition (both  $P = .001$ ). There were no changes in self-confidence across time or condition ( $P > .05$ ). Discussion These results suggest that badminton service performance is negatively affected in conditions where cognitive anxiety is high (competition) compared to when cognitive anxiety is low (practice). RPE was also higher where cognitive anxiety was high (competition) despite no differences in actual physiological load during the fatigue protocol. As such, we propose that the relationship between perceptual change and cognitive anxiety is the decisive factor in predicting decrements in badminton short serve performance. References Bottoms L. et al. (2012). J Sports Sci, 30: 285-293. Duncan MJ. et al. (2016). Eur J Sport Sci, 16, 27-35. Edwards B. et al. (2005). Ergonomics, 48, 1488-1498.

## Mini-Orals

### MO-SH04 Sociology & Philosophy

#### INVESTIGATING THE ATTITUDES OF LICENSED ATHLETES IN TURKEY TOWARDS MULTICULTURALISM

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1: BEU (Zonguldak, Turkey), 2: GU (Ankara, Turkey), 3: GOPU (Tokat, Turkey) Introduction Sports has assumed substantial roles that help prevent conflicts with its pacifist quality, multicultural disposition, international uniform rules and universal practices that enable persons to compete in equal conditions regardless of the differences in their races, religions, languages, and ideologies. In this respect, sports harbors multiculturalism. From this point of view, the aim of this study was to present the attitudes of licensed athletes in Turkey towards multiculturalism and analyze them with regard to some variables. Methods The sample of the study is comprised of 397 licensed athletes in Turkey. The "Munroe Multicultural Attitude Scale" developed by Munroe and Pearson (2006) and adapted into Turkish by Polat (2012) was used as data collection tool. The scale comprising of three sub-dimensions including know, care, and act (Polat, 2012). In data analysis, the descriptive statistics of multiculturalism attitude scores of licensed athletes was put forward. Besides, Independent t-test, One-way ANOVA and Tukey test was used to compare other variables. Results According to the results, there was a significant difference between the attitudes of female and male athletes towards multiculturalism ( $t=2.43$ ;  $p<0.05$ ) and in the sub-dimensions of know ( $t=2.93$ ;  $p<0.05$ ) and act ( $t=2.40$ ;  $p<0.05$ ) according to the results of the t-test conducted for the purpose of testing the impact of the gender of the athletes on their attitudes towards multiculturalism. While it was seen that the attitude of female athletes towards multiculturalism ( $3.80\pm0.60$ ) was more positive than that of the male athletes ( $3.62\pm0.71$ ). Discussion It was seen that the attitude of female athletes towards multiculturalism ( $3.80\pm0.60$ ) was more positive than that of the male athletes ( $3.62\pm0.71$ ), which is concordant with various studies conducted for multiculturalism. In related studies (Demircioğlu and Özdemir, 2014), it was seen that females had a more positive attitude than males did. Similarly, females were detected to be more understanding towards differences in political view in a study where the state of being tolerant towards multiculturalism was investigated as regards gender (Çoban, Karaman & Doğan, 2010). References Çoban, A.E., Karaman, N.G., & Doğan, T. (2010). Öğretmen adaylarının kültürel farklılıklara yönelik bakış açılarının çeşitli demografik değişkenlere göre incelenmesi. Abant İzzet Baysal Üniversitesi Dergisi, 10(1): 125-131. Demircioğlu, E. & Özdemir, M. (2014). Pedagojik formasyon öğrencilerinin çok kültürlü eğitime yönelik tutumlarının bazı değişkenlere göre incelenmesi. Ege Eğitim Dergisi, 15(1): 211-232. Munroe, A., Pearson, C. (2006). The Munroe multicultural attitude scale questionnaire: A new instrument for multicultural studies. Educational and Psychological Measurement, 66(3), 816-834. Polat, S. (2012). Attitudes of school principals towards multiculturalism. H.U. Journal of Education, 42, 334-343 Contact ozdemiraliselman@gmail.com

#### A STUDY ON THE CAUSES OF THE SCHOOL SAFETY ACCIDENTS IN KOREA

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In order to identify the causes of the school safety accidents and thus to suggest a prevention policy in Korea, I analyzed the school accident data of total 105,353 cases in Korea obtained from kindergarten to high schools during past two fiscal years of 2102~2013. The accident data of total 105,353 cases were composed of 7029 cases (students: 658,188) for kindergartens, 35,165 cases (students: 2,784,000) for elementary schools, 34,565 cases (students: 1,893,303) for middle schools, and 28,037 cases for high schools. The analysis results of total accidents are as the following. At first, on the basis of their accident-occurring time, those were in the order of 29,868 cases (28.35%) at physical education time, 19,650 cases (18.65%) at lunch time, 18,779 cases (17.82%) at rest or clean up time, 11,199 cases (10.63%) at special activity time, 10,943 cases (10.39%) at class time, 9,071 cases (8.61%) at school event time, and 5,843 (5.55%) at the time of going to or out of school. Second, the activities of students occurred at the moments of accidents were in the order of 38,292 cases (36.36%) during physical activity with ball, 21,331 cases (20.24%) during walking or running, 13,620 cases (12.93%) during exercise, 6,680 cases (6.34%) during eating or rest, 4,594 cases (4.36%) during studying, and 6,533 cases (6.20%) during other activities. Third, the accident types occurred were in the order of 43,462 cases (41.25%) for fall, 40,390 cases (38.34%) for exposure to physical force, 14,258 cases (13.53%) for collision with a person, 6,680 cases (6.34%) for eating or rest, and 7,346 cases (6.87%) for other types. Finally, on the basis of accident positions occurred were in the order of 21,770 cases (20.66%) at head, 21,671 cases (20.57%) at feet, 20,520 cases (19.48%) at hand, 14,283 cases (13.56%) at leg, 12,466 cases (11.83%) at arm, 10,494 cases (9.96%) at tooth, 1,968 cases (1.87%) at thoraco-abdominal, and 2,181 cases (2.07%) at other positions. In summary, the highest number of accidents occurred in physical education class

with using ball, the most common type of accident was falling accidents, and the most frequent accident positions were head and feet. In addition, school accidents occurred most frequently in the middle schools. Consequently, in order to prevent accidents, since school safety accidents occurred in physical education classes especially using ball, safety training was required to prevent school safety accidents. Awareness of the safety precaution was needed because accidents happened at critical positions such as head.

### JAPANESE STUDENT ATHLETES: HOW TO ARRANGE AN ELITE SPORT CAREER WITH HIGHER EDUCATION IN JAPAN

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Dual careers as preparation for the 'Second Career' after retiring from competitive sports have attracted great attention in recent years, which can be seen in growing support measures for the combination of higher education with high-performance sports. Japanese athletes are mostly enrolled in higher education anyway, as competitive sports are institutionalized in universities to a great extent. Therefore, this system and organization of elite sports allows to assume that athletes in Japan find adequate environmental conditions supporting dual careers. However, athletes' Second Careers have often been discussed as a severe problem in Japan. This study tries to investigate the Japanese system concerning the compatibility of higher education with high-performance sports to find out about factors causing difficulties for a smooth transition into 'Second Career'. Interviews with Japanese athletes about their educational and sporting life path were conducted to make out system mechanisms and other decisive factors influencing the career development. These career descriptions were analyzed within the framework of system theory by N. Luhmann focusing on the social inclusion of athletes into the social subsystems of competitive sports and education in the same life period. The results generally showed an adequate environment with appropriate conditions for dual careers in higher education in Japan. However, a tendency to the consciousness that student athletes should concentrate on their sports instead of engaging in education became evident. Athletes often benefit special treatment concerning their studies, like admission and even graduation without requiring educational qualifications. With corporate sports, the Japanese system had been able to ensure occupation for athletes, but due to changing conditions, Japan cannot offer enough 'Second Careers' for their athletes anymore. As a result, this study emphasized creating a Japanese way for dual careers by re-thinking educational approaches for athletes and by re-arranging available environmental conditions in university sports in Japan.

### A STUDY FOR INTRODUCING THE PHILOSOPHY OF LAO-TUZ INTO OLYMPISM\*

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Introduction As you know, after the beginning of Olympics in 1896 in Athens, the games have gotten one of the best splendid world competitions in the world. Though pursuing the motto of Citius, Altius, and Fortius, the Olympics stress its value of admiring fair play, promoting friendship, and then keeping peace through sports every four years. But different from the hope and argument of it, the Olympics are criticised for being repeatedly stained with drug and match-fixing. I think it is due to the tendency of winner-take-all or only focusing winning. Method In this respect, Tokyo Olympics in 2020 being near at hand, this study is intended to inject the philosophy of Lao-tzu & Chuang-tzu into sports games focusing on only the game itself not the winning. It is the reason that its philosophy teaches us a kind of anthropocentrism of free mind and unrestricted person. Developed by the rules and refined system of modern sports, the worldwide sports games have long-standing chronic diseases such as taking medicine, violence and racial discrimination. Like the words in the thesis of Ohryun Kwon(2008:64), the conflicts between religions and nations cannot be dissolved by any more specific and systemized rules. Lao-tzu argued the chaos of human society basically comes from a false recognition and contradictory social system. Purely real nature in human's is inclined to be interrupted wrong by desire for something. "Lao-tzu admits human beings' basic desires are needed but their ethnics and customs are not desirable.(Bongseon Ryu, Dongkyu Kim, 2013:16)." This statement is reconfirmed in Dongjin Joo(2015) : "There will be a possibility to restore a kind of Western sports humanism through connecting it with the Eastern sports philosophy of ancient Las-tzu & Chuang-tzu." Discussion It is essential that a person's mind or philosophy controls his behavior or attitude for objects. The philosophy of Las-tzu & Chuang-tzu, emphasizing the need of win-win strategy in living, could teach us to have fun and enjoy an game itself not being preoccupied with excessive desire of winning. So it is possible to prevent athletes from indulging in such an unfair practice in any sports as using drugs or match-fixing if endowed with the philosophy of Lao-tzu & Chuang-tzu into sports games. Reference Ohryun Kwon(2008). An Oriental Philosophical approach of Sport Ethics, Philosophy of Movement : Journal of Korean Philosophic Society for Sport and Dance, Vol. 16, No. 4, p.64. Bongseon Ryu,Dongkyu Kim(2013). 'Theory of Self-cultivation' in Taekwondo based on 『Dao De Jing(道德經)』 of Laozi(老子), Philosophy of Movement : Journal of Korean Philosophic Society for Sport and Dance 2013, Vol. 21, No. 3, p.16. Contact [ohree60@pusan.ac.kr] \*This work was supported by the Ministry of Education of the Republic of Korea and the National Research Foundation of Korea (NRF-2015S1A5A2A03049870)

### MEANING OF SPORT IN A POSTMODERN CONSUMER SOCIETY

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MEANING OF SPORT IN A POSTMODERN CONSUMER SOCIETY Introduction The purpose of this study is to understand what meaning sports has in consumption driven postmodern consumer society. Postmodern consumer society offers opportunities that can fulfill our private desire and representation at maximum on the mass media world. In this society all things are regarded as consumable goods and their consummation has a social meaning. Sports, therefore, becomes a consume good that offers many social meanings. Results & Discussion First can we find sports eroticism as a new meaning from sports consume in a postmodern consumer society. Sports eroticism is spreading more and more in the sports body, sports wear, sports motion etc. Additionally, sports eroticism plays a roll as an active way of self-expression of sports participants. The second meaning appears in the conception of sports "Simulation" by J. Baudrillard in the postmodern consumer society. An example is the spread of E-sports that is disguising the real existence of sports by image as representation of sports simulacra. In the sport history it has lost real nature of the sport by scientification, technical innovation, institutionalization, and regulation. In this situation the extended sports simulation circumstance and sports real world has become continually enlarged. Sports simulation may, therefore, suggest not only a new viewpoint of sports but also an opportunity of critical thinking that is an essential character of sports. The third meaning we can find is an account on the diffusion of sports participation and the structural transition of the social stratum. A number of sports participants want to elevate from their social standing through sports participation. The concept of



subordinate imitation and superordinate differentiation of the trickle down theory, Diderot unities, and effect theory explains the circulation of the social stratum and mode through sports participation. Contact [Hwpark@jnu.ac.kr]

## DASEIN AND SPORT

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**Abstract:** This text aims to shed light on the overall sense of the present time from a daseinsanalytical perspective. Objectification of the body leads to the adoration of performance as the sole purpose of sport. It is important to realize that the body does not stop with our skin, but enters the outside world as a phenomenon in the form of Dasein. It is necessary to understand the body of the athlete in this respect. The essence of Dasein is a temporal dimension in the form of temporality. What is sport? It is an exhibition of the essence of being, which is will to power. Athletes are puppets in the game, which Heidegger calls 'das Gestell' – the requisition of performances in all areas of our lives and sport is the arena where it is most often seen. Of course it is a semantic space for determining the meaning of sport per se. What reigns in this space? 'Die Machenschaft' reigns there – the technical and mechanical solving of problems that occur in our lives, in order to serve pre-existing systems, which plan and control our lives. Our lives and sport as a whole are pre-arranged forces, which in our time are the source of power. What is this power? It is the manifestation of the essence of being of our time, which is 'der Wille zur Macht', something that F. Nietzsche brought to light. The result of this ontological essence is 'die Uebermaechtigung', i.e. a phenomenon of overpowering, which means only one thing: we need to be stronger tomorrow than we are today, and that is how it must remain without disruption, otherwise we will lose our essence of being, we will simply cease to exist, even if people still see and hear us. This is the most important finding of the times in which we live our unique lives. This postulate is the strongest in sport because the fight against doping is only a mask that accelerates the development of new doping agents for which there are no tests. We live in a time of performance. Literature Heidegger, M. Zollikoner Seminare. Frankfurt am Main : Vittorio Klostermann, 1987. Husserl, E. Vorlesungen zur Phänomenologie des inneren Zeitbewusstseins. Halle : herausgegeben von M. Heidegger Freiburg, 1928. Patočka, J. Pěče o duši I. Praha : Oikumene, 1996.

**15:00 - 16:00**

## Mini-Orals

### MO-PM35 Hormones

#### SALIVARY MARKERS TO OPTIMIZE ATHLETES' PERFORMANCE: EXPLORING THE USE OF AN ORAL FLUID COLLECTOR

DE RYCK, T., VAN BRUAENE, N.

*Labo Nuytfinck*

**Introduction** Sport physicians and coaches are constantly trying to increase athletes' performance. Therefore it is important to understand how athletes respond to the weekly training and varying training intensities. For this, salivary biomarkers are gaining more and more interest, with stability and storage issues of the native saliva as the major drawbacks. In this study, we evaluated an oral fluid collector, which consists of a swab for collection and collection bottle with storage buffer, for its use in sport medicine. **Material and methods** Salivary amylase, cortisol and secretory immunoglobulin A (sIgA) were chosen as key parameters to evaluate the oral fluid collector (OFC). Saliva samples of healthy volunteers were collected both with passive drooling and with the OFC. Using validated assays, concentrations of cortisol and sIgA and the activity of amylase were determined. Furthermore stability of the OFC samples was evaluated at different storage temperatures for different periods of time. To further evaluate the use of the collection device and the interpretation of the assay results a group of athletes was followed during an intensive training program. **Results and conclusion** Significant correlations were found for all parameters between the native and OFC collected saliva. Furthermore stability of the OFC saliva allowed storage of the saliva samples without the need of freezing or cooled transport. This enables athletes to collect samples at home, after training sessions or at competitions, resulting in high quality monitoring of the athletes' response to increased training load, intensity or stress.

#### THE SALIVARY AND PLASMA ANDROGEN RESPONSES OF HEALTHY MALES TO A COMBINED STIMULUS

CREWTHOR, B.1, KILDUFF, L.P.2,6, FINN, C.3,6, COOK, C.J.4,5,6

1: Institute of Sport, Warsaw. 2: Swansea University. 3: University of the West of Scotland. 4: Bangor University. 5: Australian Institute of Sport. 6: Welsh Institute of Performance Science.

**Introduction** Androgens are responsive to physical and psychological stress, but no studies have combined these stimuli to acutely modify dehydroepiandrosterone (DHEA), androstenedione (A4) and testosterone (T) concentrations in different biological fluids. Thus, this study compared the responses of these androgens in saliva and capillary blood to a combined physical and psychological stimulus in healthy men. **Methods** Twelve males completed three treatments using a randomised, cross-over design; 5 × 10 sec cycle sprints followed by watching a 5-minute aggressive video (EXV), the same stimuli implemented in reverse order (VEX), and a control session. Saliva and capillary blood samples were collected before and after each treatment, equating to ~70 minutes. Saliva was tested for DHEA, A4 and T by immunoassay, with blood sulphated DHEA (DHEA-s), A4 and T tested with mass spectrometry. The within-treatment change scores (log-transformed) were assessed using paired T-tests and the between-treatment responses with analysis of variance. **Results** The EXV treatment produced positive changes in salivary A4 (22 ± 21%) and T (28 ± 23%), whereas salivary DHEA (101 ± 44%) and T (33 ± 16%) increased after the VEX session (p < 0.05). The DHEA response to VEX was superior to most other salivary androgens. Only the VEX treatment promoted positive blood DHEA-s (6 ± 7%), A4 (22 ± 8%) and T (11 ± 9%) responses. **Discussion** The combined stimuli increased DHEA, DHEA-s, A4 and T reactivity in saliva and/or blood. The VEX treatment provided the stronger stimulus, possibly as sprint cycling is a potent androgen activator in men (Crewther 2014) and was performed closer to the post-session samples, whereas the video effect is content and population dependent (Crewther 2014). Salivary DHEA was the most responsive (> 3 fold) androgen measure, which could

reflect its role as a precursor to other steroids and the measurement of the biologically active "free" hormone in saliva (Papacosta 2014). Hormonal perturbations have been linked to performance and recovery (Kilduff 2013), so this information could assist with designing warm-up strategies, training workouts and recovery sessions. References Crewther BT, Kilduff LP, Cook CJ (2014). *J Endocrinol Invest*. 37, 1065-1072. Papacosta E, Nassiss GP (2014). *J Sci Med Sport*. 14, 424-434. Kilduff LP, Finn CV, Baker JS, Cook CJ, West DJ (2013). *Int J Sports Physiol Perform*. 8, 677-681. Contact Email: blair.crewther@gmail.com

### **ANABOLIC HORMONES AND THEIR BINDING PROTEINS CONCENTRATIONS IN FEMALE AND MALE ELITE SOCCER PLAYERS IN RELATION TO PHYSICAL PERFORMANCE**

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**Introduction** In professional sport, the endocrine responses have been shown to be the most important factors contributing to the athlete's performance. The mechanism of endocrine factors release depends on the intensity and duration of physical exercise, but little is known about the relationships between hormonal responses and aerobic and anaerobic maximal power in female athletes. The study aimed to analyzed association between exercise-induced growth hormone (GH), testosterone (T), cortisol (C), steroid hormone binding globulin (SHBG), insulin-like growth factor (IGF-1), insulin-like growth factor binding protein-3 (IGFBP-3), catecholamines (E, NE) and some anabolic-catabolic indexes, i.e.: T/C, T/SHBG, and IGF-1/IGFBP-3 in female and male soccer players. The results were compared to maximal power measured during aerobic and anaerobic maximal exercise tests. **Methods** Eighteen female (age  $19.6 \pm 2.6$  yrs, training experience  $6.9 \pm 4.3$  yrs) and eighteen male (age  $21.8 \pm 1.7$  yrs, training experience  $7.2 \pm 2.8$  yrs) soccer players participated in the graded aerobic and maximal anaerobic exercise tests. Peak power, maximal oxygen uptake, and peak anaerobic power were measured during the tests. Blood samples were collected for assessment of baseline and post exercise hormones concentrations. **Results** The elite female and male athletes demonstrated high level of aerobic performance ( $VO_{2max}$ :  $43.2 \pm 4.8$  vs.  $54.8 \pm 3.7$  ml/kg/min;  $p < 0.001$ ). In male athletes the maximal exercise test induced an increase in post-exercise GH concentrations ( $p < 0.001$ ), IGF-1 ( $p < 0.05$ ), and GH/IGF-1 ratio ( $p < 0.05$ ). Graded exercise test had a significant effect on serum GH and GH/IGF-1 ratio in female athletes ( $p < 0.05$ ). The steroid hormones, IGF-1 levels and IGF-1/IGFBP-3 ratio were significantly higher after cessation of maximal exercise test in male athletes compared to female soccer players. High-intensity exercise elicited an increase of the norepinephrine level in female subjects ( $p < 0.05$ ). A positive correlation was found between the post-exercise GH and peak power and GH/IGF-1 ratio and maximal aerobic power ( $r = 0.68$ ;  $p < 0.01$ ). **Discussion** Hormonal status differentially affect physical performance in female and male soccer players. We conclude that growth hormone, GH/IGF-1 ratio, and free fraction of IGF-1 (IGF-1/IGFBP-3) measured during exercise as well as after its cessation might serve as predictors of maximal power and performance in female athletes.

### **DOES LOW-DOSE TRANSDERMAL TESTOSTERONE APPLICATION IN MALE UNDERCUT THE DETECTION LIMITS IN DOPING ANALYSIS?**

SCHÖNFELDER, M.1, HOFMANN, H.2, SCHULZ, T.2, ENGL, T.2, KEMPER, D.2, RAUTENBERG, C.3, OBERHOFFER, R.2, THIEME, D.3

1: NEUROPATH (TU Munich, GER), 2: LPP (TU Munich, GER), 3: IDAS (Kreisch, GER)

**Introduction** Anabolic androgenic steroids still represent the most frequently abused category of prohibited substances in sports. Especially, in the last years the trend for abuse shifted to low-dose applications to undercut detection limits of analysis. Thus, the aim was to test whether a low-dose testosterone (T) application is detectable in biofluids. **Methods** Circadian samples of saliva, blood and urine of 11 male volunteers were analyzed for transdermal T application and influence of exercise in comparison to time-matched controls. Participants received two T-patches for 24h, each releasing 2.4mg/day. Salivary samples (DRG, Marburg, GER) and blood serum samples (Greiner, Kremsmünster, AUT) were generated during (0h, 3h, 6h, 9h, 24h) and after application (48h, 72h) and analyzed by specific enzyme-linked immunosorbent assay (ELISA, DRG, Marburg, GER) for whole, free and salivary T. Saliva and urine data were validated by an accredited anti-doping laboratory using gas and liquid chromatography mass spectrometry (GCMS). Statistical analysis was performed by paired t-test and ANOVA for repeated measure followed Bonferroni post-hoc testing for multiple comparison. Correlations were calculated using the Spearman method. The project was approved by the Ethics Committee of the Medical Department of the TUM (Number: 1777/07), registered at ClinicalTrials.gov (NCT02134470), and financed by the "Bundesinstitut für Sportwissenschaft" (Bonn, Germany). **Results** Circadian controls with and without exercise did not provoke prominent alterations of whole, free, and salivary T. T application for 24h led to a significant (all  $p < 0.001$ ) mean increase above controls: total T (median: 5.2 vs. 8.0ng/ml), free T (median: 11.3 vs. 15.6pg/ml), and salivary T (median: 62.4 vs. 99.9 pg/ml). In addition, all three T measurements indicated significant correlations to each other (all  $r > .538$ , all  $p < .001$ ). Comparison with circadian-matched controls showed peaking T-values after 6h and 9h, reaching highest augmentation up to  $252.6 \pm 123.5\%$  in saliva after 9h. After removal of T patch, all T levels in blood, saliva, and urine returned to baseline within 24h. Different techniques of hormone detection (ELISA, GCMS) indicated significant correlations. **Conclusion** The results indicate that saliva, blood, and urine exhibit comparable hormone augmentation during low-dose T application, indicating a possible consideration in future doping analysis. However, detection window is restricted to the time of T application. The interindividual variability was high in all biofluids, requiring the use of individual biological passport rather than statistical values.

### **STRENGTH TRAINING ALTERS EXPRESSION OF GENES INVOLVED IN REGULATION OF STEROID HORMONE AVAILABILITY IN M. VASTUS LATERALIS OF UNTRAINED WOMEN**

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*Lillehammer University College*

**Introduction** Steroid hormones can substantially affect skeletal muscle morphology and function, as evident from hormone replacement studies (Finkelstein et al. 2013). However, the contribution of exercise-induced circulating steroid hormones in adaptive responses after strength training is debated, with studies showing contradicting results (Rønnestad et al. 2011; West et al. 2010). Recent studies have suggested that local hormone synthesis may play a central role (e.g. Sato et al. 2014). **Methods** Twenty previously untrained women completed a 12-week full-body strength training intervention. Training-induced strength gains in leg muscles was evaluated as changes in 1RM knee extension. Gene expression of 10 steroidogenic enzymes was measured using qPCR in biopsies sampled at rest from m. vastus lateralis prior to and after the training intervention. **Results** Strength training resulted in  $33 \pm 13\%$  increases in 1RM knee extension. Of the 10 steroidogenic genes investigated, strength training increased the expression of AKR1C2 (fold change  $\sim 1.3$ ,  $p = 0.007$ ) and

AKR1C3 (fold change  $\sim 1.4$ ,  $p = 0.003$ ) in m. vastus lateralis. Discussion Strength training increased the expression of the steroidogenic enzymes AKR1C2 and AKR1C3, which are both involved in interconversion of the androgen-receptor ligand testosterone. For example, AKR1C3 transforms androstenedione to testosterone, and increased activity of AKR1C3 in muscle tissue may thus lead to increased bioavailability of active androgens. References Finkelstein JS, Lee H, Burnett-Bowie S-AM, Pallais JC, Yu EW, Borges LF, Jones BF, Barry CV, Wulczyn KE, Thomas BJ, Leder BZ. (2013). NEJM, 369(11), 1011-1022. Rønnestad BR, Nygaard H, Raastad T. Eur J Appl Physiol, 111(9), 2249-2259. Sato K, Iemitsu M, Matsutani K, Kurihara T, Hamaoka T, Fujita S. FASEB, 28(4), 1891-1897. West DWD, Burd NA, Tang JE, Moore DR, Staples AW, Holwerda AM, Baker SK, Phillips SM. J Appl Physiol, 108(1), 60-67.

### CORTISOL RESPONSES AFTER A HIGH INTENSITY EXERCISE PROTOCOL IN ADOLESCENT SWIMMERS

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Introduction Steroid hormones play a key role in modulating the exercise training responses. In particular, cortisol can negatively affect athletic performance, potentially causing fatigue and inflammation, and high levels of this hormone have been associated with impaired performance in elite athletes (Crewther et al., 2011). However, little is known about the cortisol responses in adolescent swimmers after high intensity exercise. The purpose of this study was to determine the salivary cortisol levels in response to a high intensity exercise protocol in adolescent swimmers. Methods Twelve adolescent swimmers (5 female, 7 male, age:  $14.4 \pm 1.0$  Tanner stage 4) participated in the study. Participants performed a high intensity swimming protocol, i.e. 3X200m front crawl at 90% of their best time and the time needed to complete each of the three 200m swimming distance (S1, S2, S3) was recorded. Swimmers were provided with salivate swabs to collect unstimulated mixed saliva before and immediately after the exercise protocol. The swab was placed in the mouth for one minute, then it was transferred into plastic tubes, centrifuged and the resulted saliva sample was analysed. Saliva samples were assayed in duplicate using a commercially available ELISA kit. Differences between the cortisol levels before and after the exercise protocol were analyzed using student's T-test, while one-way ANOVA for repeated measures and Tukey's post hoc tests were used for analyzing swimming performance. Pearson correlation coefficient ( $r$ ) was used to reveal potential relationship between cortisol levels and swimming performance. Results are presented as mean  $\pm$  SD. Results Salivary cortisol was significantly higher ( $1407.4 \pm 740.2$  pg/ml vs.  $4435.9 \pm 3039.5$  pg/ml  $p=0.004$ ) after the high intensity protocol. Swimming performance, i.e. the time needed to complete the swimming distance, changed significantly from the first (S1) to the last 200m (S3) (S1:  $2.20 \pm 0.08$  vs. S2:  $2.22 \pm 0.08$  vs. S3:  $2.25 \pm 0.08$   $p<0.05$ ). A positive correlation was found between the S3 time and salivary cortisol levels, which marginally failed to reach statistical significance ( $p<0.05$ ). Conclusion The findings of the present study suggest a significant effect of the exercise protocol on the saliva cortisol levels in adolescents. The relationship found between the increased cortisol levels and decreased performance may imply a causative association of this hormone with the swimming performance that could moderate effectiveness and long term adaptations of training. References Blair T. Crewther, Christian Cook, Marco Cardinale, Robert P. Weatherby and Tim Low Sports Med 2011; 41 (2): 103-123.

### MINDFULNESS TRAINING PREVENTS CORTISOL CONCENTRATION ELEVATION IN WHEELCHAIR-BASKETBALL PLAYERS DURING AN INTENSE COMPETITION PERIOD

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Introduction There is growing interest in the efficacy of mindfulness training to enhance athletic performance (Bernier, 2009; De Petrillo, 2009). Nonetheless, several questions remain unanswered regarding the mechanisms by which mindfulness training may alter cognitive or physiological function. The present study compared changes in salivary cortisol concentration between wheelchair-basketball players undertaking an 8-wk mindfulness training intervention (Mindful group) and a group who did not (Control group). The mindfulness training intervention coincided with an intense 7-wk competition period. Methods Sixteen highly-trained wheelchair-basketball players (5 females) were randomly assigned to a Mindful group ( $n=8$ ) and a Control group ( $n=8$ ). The Mindful group completed an 8-wk mindfulness training intervention comprising: 2-wk Introductory period of 8-min meditations + 10 min of exercises, 5 times each wk; 6-wk Intensive period: 45-min meditations + 5 min of exercises, 5 times each wk in addition to regular basketball training and competition while the Control group performed training and competition only. The mindfulness training intervention commenced 3-d before, and finished 3-d after the 7-wk competition period. Salivary cortisol was measured at baseline (BL), every 2 wk during (beginning Wk3, Wk5, Wk7), at the end (End), and 2 wk after (2-Wk Post) the competition period. Results Salivary cortisol concentrations increased in the Control group from BL to Wk3 ( $p=0.01$ ) and remained elevated compared to BL at Wk5 ( $p=0.03$ ) and Wk7 ( $p=0.01$ ), and decreased at End and 2-Wk Post to concentrations no different to BL ( $p=0.18$ ;  $p=0.20$ , respectively). Conversely, salivary cortisol concentrations in the Mindful group did not change from BL when measured at Wk3 ( $p=0.55$ ), Wk5 ( $p=0.42$ ), Wk7 ( $p=0.73$ ), End ( $p=0.62$ ) and 2-Wk Post ( $p=0.30$ ). Discussion The present study demonstrates that an 8-wk mindfulness training intervention attenuates the increase in salivary cortisol in wheelchair-basketball players. It has been concluded that mindfulness training may be a beneficial tool for athletes to manage the onset of physiological stress during intense competition. References Bernier M, Thienot E, Cordon R, Fournier JF. (2009). J Clin Sport Psychol, 25(4), 320-333. De Petrillo LA, Kaufman KA, Glass CR, Arnkoff DB. (2009). J Clin Sport Psychol, 3(4), 357-376.

### PROLONGED ELECTRICAL MUSCLE STIMULATION INCREASES PLASMA BRAIN-DERIVED NEUROTROPHIC FACTOR IN TYPE 2 DIABETES

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Introduction Electrical muscle stimulation (EMS) is expected to be a candidate for new exercise method in the patients who have a difficulty in performing voluntary exercise. We provided the first evidence indicating that a single bout of EMS could effectively attenuate post-prandial hyperglycemia in type 2 diabetes (T. Miyamoto et al., 2012; T. Miyamoto, Fukuda, Watanabe, Hidaka, & Moritani, 2015) and prolonged EMS could increase muscle strength and cardiorespiratory fitness in healthy subjects (Toshiaki Miyamoto, Kamada, Tamaki, & Moritani). It has been considered that type 2 diabetes is closely related to the onset of nervous diseases such as cognitive impairment and diabetic neuropathy. Recently, brain-derived neurotrophic factor (BDNF) and insulin like growth factor-1 have been considered of exercise-induced neuroplasticity-related proteins. The purpose of this study was to evaluate the effect of prolonged EMS training on plasma BDNF and IGF-1 concentrations as well as metabolic parameters in type 2 diabetes. Methods Fourteen men outpatients with type 2 diabetes participated in this study (Age:  $63.4 \pm 11.0$  years, BMI:  $27.0 \pm 4.6$ , HbA1c:  $7.7 \pm 0.6\%$ ). In a randomized crossover trial, patients

were evaluated at baseline and after two 8-week periods (control and EMS training) for body composition, estimated energy intake, physical activity and blood measurements (glucose and fat metabolic parameters, IGF-1, BDNF). Each patients performed 40-min EMS training, 4 days per week, during 8-week EMS training period while maintaining daily lifestyle during 8-week control period. Student's t-test or Wilcoxon test were used to compare the absolute changes of measurements between periods. Results There were not significant differences in estimated energy intake and physical activity between periods. It was found that EMS training significantly attenuated body fat and fasting glucose level ( $P<0.05$ ). Also, EMS training induced significant higher plasma BDNF ( $P<0.05$ ). However, significant differences were not found in the other evaluations. Discussion Our present study showed that prolonged EMS training induced significant lower body fat and fasting glucose level and higher plasma BDNF. This study suggested that EMS can be an alternative exercise method to improve cognitive function as well as metabolism for the patients who cannot perform voluntary exercise. References Miyamoto, T., Fukuda, K., Kimura, T., Matsubara, Y., Tsuda, K., & Moritani, T. (2012). *Diabetes Res Clin Pract*, 96(3), 306-312. Miyamoto, T., Fukuda, K., Watanabe, K., Hidaka, M., & Moritani, T. (2015). *J Electromyogr Kinesiol*, 25(1), 136-142. Miyamoto, T., Kamada, H., Tamaki, A., & Moritani, T. (In press). *European Journal of Sport Science*. t-miyamoto@huhs.ac.jp

## THE INFLUENCE OF THE STATINS IN THE SKELETAL MUSCLE

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The influence of the statins in the skeletal muscle Introduction The skeletal muscle (SM) is a tissue that can adjust to different stimulus. Intake drugs can cause alterations and incapacity to do exercise. Statins interfere with the SM functions is the prescribed medications for prevention and treatment of the cholesterol more used in the world. The side effect is myotoxicity. Creatine Kinase (CK) is a biomarker to evaluate the muscle damage The aim of this study was verify the myotoxicity of the SM without invasive methods, evaluate how the CK change in different groups first that intake statins, second that intake statins and exercise and third a control group, no statins and no exercise. Methods A sample of patients ( $n=32$ ), with age between 40-65 years was divided into three groups, one that intake statins, second that intake statins plus exercise and third control group. the evaluation was performed in the third group using three different assessments exercise drugs and last exercise and drug. The evaluation started with an exercise prescription during 30 min, blood samples before and after exercise and 24 hours after exercise. An ultrasound was done to evaluate macroscopic and organizations of the fibers gastrocnemius muscle, using a 13 MHz probe. An questionnaire was done subjects. Results The mean CK results were (before exercise, after exercise and 24h after exercise) to the first group that intake drug were, (baseline  $95-100$  U/L)  $114,5\pm53,4$ ;  $117,0\pm52,3$  and  $127,2\pm47,7$  U/L (mean  $\pm$ SD) the cholesterol mean was  $203$  mg/dl (min  $143$ -max  $321$ ), the second group that intake drug and do exercise were,  $94,4\pm43,8$ ;  $98,6\pm43,9$  and  $111,9\pm61,9$  U/L. The cholesterol mean was  $189,4$  mg/dl (min  $123,8$ -max  $253$ ) The third group in the first evaluation were,  $113,7\pm67,0$ ;  $124,8\pm75,4$ , and  $156,7\pm86,7$  U/L in the second evaluation the results were  $86,79\pm24,6$ ;  $87,51\pm25,6$  and  $93,24\pm38,0$  U/L, and the last evaluation for the same group were  $85,32\pm24,8$ ;  $89,54\pm25,8$  and  $89,43\pm17,4$  U/L. The mean of the cholesterol of this group was  $194,74$  mg/dl (min  $157$ -max  $236$ ). In the Ultrasound evaluations the echogenicity of the GM muscle was similar in all groups Discussion Results demonstrated an increase in CK levels in patients that intake statins and 24h after exercise the CK increase, in the first and second group this referred muscle pain that is indicative of a middle myalgia. The third group in the second and third assessments with drug and with drug and exercise respectively the CK decrease related to the first evaluation, with a specific kind of statins have a pleiotropic effect in skeletal muscle with an anti-inflammatory effect (Pella, Rybar, & Mechirova, 2005), is not clear that exercise and statins therapy interact with muscle toxicity (P. Phillips, 2008). Pella, D., Rybar, R., & Mechirova, V. (2005). Pleiotropic effects of statins. *Acta Cardiologica Sinica*, 21(4), 190-198. P. Phillips, R. Haas, (2008) Statin myopathy as a metabolic muscle disease. *Expert Rev. Cardiovasc. Ther.* 6(7), 971-978

## Mini-Orals

### MO-PM45 Nutritional Strategies

#### FIVE DAY BUCHINGER FASTING AFFECTS ENDURANCE PERFORMANCE AND METABOLISM OF SPORT STUDENTS

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Introduction: The effects of fasting on physical performance have so far been explored primarily for the intermittent fasting while Ramadan. The idea that training while fasting is the best way to optimize metabolic control and body composition, causes also the risk of a lower performance while training. Aim of the present study was to investigate the effects of a 5-day Buchinger fasting period on endurance performance. Methods: 16 healthy sport students (4 female, 12 male, age:  $24.7\pm1.5$ y, height:  $175.6\pm6.7$ cm, body mass:  $74.9\pm9.8$ kg) participated in the study. Skipping tests and step testswere performed before (BF), while (WF) and after (AF) 5 days of fasting. Step tests were performed at 5 min stages (66, 84, 102, 114, 132, 144, 156 beats per minute) and 1 min break between stages till exhaustion. Lactate threshold, resting heart rate (rHR), total body fat, body weight and maximal reached step test level were determined BF, WF and AF. Results: Body weight decreased during fasting (BF  $77.9\pm7.5$  kg vs. AF  $74.3\pm8.9$  kg,  $p=0.001$ ). Subjects improved maximal reached step test stages (BF:  $6.3\pm1.2$  vs. AF:  $7.1\pm0.7$ ,  $p=0.005$ ) as well as lactate thresholds changed (BF:  $9.0\pm2.8$  mmol/l vs. WF  $8.1\pm2.9$  mmol/l vs. AF  $10.8\pm2.3$  mmol/l,  $p=0.008$ ). Furthermore subjects rHR decreased (BF  $83\pm10$  rHR vs. WF  $72\pm15$  rHR,  $p=0.028$ , BF  $83\pm10$  rHR vs. AF  $71\pm10$  rHR,  $p=0.005$ ) and bpm at 4mmol/l lactate performance for step test increased overall three measurements (BF  $98.6\pm7.7$  bpm vs. WF  $108.9\pm33.3$  bpm vs. AF  $121.7\pm3.2$  bpm,  $p=0.05$ ). Discussion: Through a 5-day Buchinger fasting there are temporary restrictions during fasting for the aerobic performance, whereas after fasting there are beneficial effects on the physical performance. The results suggest that a fasting period improves the lactic capacity while skipping tests and endurance performance while step tests. It was also shown that there are benefits on the HR after a fasting period. Furthermore we conclude though the fact that lactate threshold is higher in performance after fasting period, athletes can use specific fasting periods in training.



## PREVALENCE OF CLINICAL EATING DISORDERS AND RISK OF LOW ENERGY AVAILABILITY AMONGST RECREATIONAL EXERCISERS.

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Introduction Melin et al. (2014) observed only 28% of female athletes with reduced energy availability or Low Energy Availability (LEA) also had disordered eating or an eating disorder. This suggests that diagnosis of disordered eating or eating disorders is not sensitive enough to use as the sole clinical indicator of LEA amongst exercising populations (Melin et al., 2014). Although studies have reported the prevalence of either eating disorders or risk of LEA very few have investigated the prevalence rates of both. Therefore this study aimed to investigate the prevalence of eating disorders and LEA in recreational exercisers in New Zealand. Methods 109 females, and 61 males aged 18-56 years were recruited via gyms and fitness centres throughout New Zealand. Participants all reported that they undertook at least 2.5 hours of moderate physical activity on a weekly basis. Participants completed an anonymous online questionnaire comprising 98 questions from validated eating disorder (Eating Disorder Inventory-3) (Garner, 2004) and LEA questionnaires (Low Energy Availability in Females Questionnaire) (Melin et al. 2014). Results Only one male scored in the medium risk range for the Eating Disorder Inventory Risk Composite (EDIRC) whereas eight females (7.3%, CI, 3.2%, 14.0%) scored in this range. Overall 33.5% (CI 26.5,41.2%) of participants were classified as at risk of LEA. Females had approximately 5.4 times greater probability of being at risk of LEA when compared to males ( $p < 0.001$ ). In the present study the vast majority of participants (males 87.5%, 95% CI, 47.3%, 99.7%,  $n=7$ , females, 89.8%, 95% CI, 77.8%, 96.6%,  $n=44$ ) who were classified as at risk of LEA were not considered at risk of an eating disorder. Discussion An EDIRC score in the low risk (low clinical) range (1st-75th percentile) is common among non-clinical samples and does not indicate risk of an eating disorder (Garner, 2004). In line with the findings by Melin et al. 2014, there was a large discrepancy between the number of participants classed as at moderate or high risk of an eating disorder compared with the number classed as being at risk of LEA. This appears to show many participants at risk of LEA do not have a formal eating disorder or disordered eating behaviour. This is an important finding in terms of developing screening tools and education programmes for those at risk of LEA. Further this research also suggests that researchers and health professionals should target their intervention largely to reach the general population of recreational athletes not solely those with eating disorders. References Melin et al. 2014. *Br J Sports Med*, 48(7), 540-545. Garner, 2004. *Psychological medicine*, 12(04), 871-878. Contact katherine.black@otago.ac.nz

## A NOVEL METHOD FOR THE DEVELOPMENT OF A GENERAL AND SPORTS NUTRITION KNOWLEDGE QUESTIONNAIRE

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Nutrition can significantly impact athletic performance by increasing exercise capacity, promoting training adaptations, assisting recovery and protecting immune function (Rodríguez, DiMarco, & Langley, 2009). However, research indicates that many athletes fail to follow an appropriate diet (Heaney, O'Connor, Michael, Gifford, & Naughton, 2011). Accordingly, sports dietitians commonly provide education to improve awareness of expert dietary recommendations. Whilst several cross-sectional studies have reported that nutrition knowledge (NK) of athletes is average, with scores on NK questionnaires commonly sitting around 55%, nutrition education programs are rarely evaluated (Heaney, 2011). Furthermore, the correlation between NK and diet quality (DQ), whilst positive, appears moderate at best (Spronk, Kullen, Burdon, & O'Connor, 2014). Nevertheless, it is prudent to note that existing sport NK questionnaires are flawed, and, therefore, previous studies may have underestimated athletes' NK and its relationship with DQ (Spronk et al, 2014). Likewise, the use of inaccurate NK measures may have impaired the development and evaluation of education programs (Heaney et al, 2011). The predominant problems with current tools are that they fail to consider health literacy, are outdated with regards to existing guidelines and have undergone minimal or inappropriate validation (Heaney, 2011). An example of inappropriate validation is the assumption that NK is unidimensional, and subsequent use of Cronbach's alpha to measure reliability. To rectify these problems, we propose a novel eight step methodology. In contrast to previous efforts, the protocol includes (1) detailed conceptualisation of NK, (2) a broad approach to item development, (3) the use of factorial analysis to describe dimensionality and assess appropriateness of reporting NK as a total score, (4) the use of item response theory (IRT) techniques such as Rasch analysis to quantify the relationship between questionnaire items and the 'latent construct', and allow for a shorter questionnaire that includes items with a greater range of difficulty. The results obtained when using classical test theory (CTT) and IRT will be compared and contrasted to determine the best approach regarding which items should be retained. To our knowledge, such a rigorous protocol has not been performed within the discipline of nutrition and dietetics. References Heaney, S., O'Connor, H., Michael, S., Gifford, J., & Naughton, G (2011). Nutrition knowledge in athletes: a systematic review. *Int J Sport Nutr Exerc Metab*, 21(3), 248-261 Rodríguez, N. R., DiMarco, N. M., & Langley, S. (2009). Position of the American dietetic association, dietitians of Canada, and the American college of sports medicine: nutrition and athletic performance. *Journal of the American Dietetic Association*, 109(3), 509-527 Spronk, I., Kullen, C., Burdon, C., & O'Connor, H. (2014). Relationship between nutrition knowledge and dietary intake. *British journal of nutrition*, 111(10), 1713-1726

## NUTRITIONAL SUPPLEMENT HABITS AND PERCEPTIONS OF DRAGON BOATERS

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The consumption of nutritional supplements (NS) is common among athletes for increasing strength, performance, immunologic function, and nutritional resources (i). The purpose of this investigation was to examine prevalence of NS use by dragon boat paddlers; (ii) reasons for use/ non-use; (iii) sources of information regarding NS; and (iv) whether age, gender, performance level influence NS use. Data were collected using semi-structured questionnaires. The questionnaire was completed by 600 elite paddlers (350 M, 250 F) online or at a sporting event or training camp. Data were evaluated by using chi-square analyses. Overall, The large majority (69%;  $n=414$ ) of surveyed athletes reported using nutritional supplements, with no difference between female (31%;  $n=77.5$ ) and male (32%;  $n=112$ ) athletes. 52% ( $n=215.28$ ) of NS user were between 25 to 30 years old. As expected, the most popular NS were multivitamins and minerals (45%), protein-carbohydrate mix (31%), protein (27%), caffeine (22%), other (19%), creatine (15%) and glucosamine (8%). The most common reasons for NS user were to provide energy, support exercise recovery and the immune system. The majority of supplementing athletes (75%) did not have any information regarding their supplements active ingredient, side effects or mechanism of action. Only 21% of NS user knew the recommended supplement dosages and had an opportunity to consult dietary specialists. Despite 16% of the athletes believing that supplements are not required with a balanced diet and can give rise to positive doping violations. However 71 % of athletes

requested more information or education regarding NS. 1. Ziegler, P.J., Nelson, J.A., & Jonnalagadda, S.S. (2003). Use of dietary supplements by elite figure skaters. *International Journal of Sport Nutrition and Exercise Metabolism*, 13, 266-276.

## AN EXPLORATION OF PERSONAL TRAINER PRACTICES AND PERCEPTIONS FOR NUTRITION CARE

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**Introduction** Personal trainers are well placed to provide basic nutrition care, and national regulating bodies are being encouraged to develop guidelines for personal training practices (ICREPS, 2013). In Australia, Fitness Australia developed a scope of practice to support personal trainers to provide nutrition care in line with national dietary guidelines (FA, 2014). However, concerns have been raised about the capacity of personal trainers to provide safe and effective nutrition care (Sass et al., 2007). Therefore, the aim of this study was to explore the context in which personal trainers provide nutrition care, and personal trainers' perceptions of nutrition care in relation to their role and scope of practice in Australia. **Methods** Semi-structured telephone interviews with 15 personal trainers working in Australia. **Results** All personal trainers provided nutrition care, and felt that nutrition was an important component of their role. However, most personal trainers did not use national dietary guidelines to direct the nutrition care they provided, as they were seen as impractical or did not align with the trainers' personal nutritional beliefs. Many personal trainers were unaware of their recommended scope of practice. Some personal trainers felt a gap between the nutrition knowledge they received in their baseline fitness education, and the knowledge required to discuss nutrition with clients. **Discussion** The personal training context is conducive to the provision of nutrition care. The scope of practice limiting nutrition care to the translation of the national dietary guidelines does not appear to have had a substantial impact on personal training practices. **Conclusion** Personal trainers perceived the provision of nutrition care as an important part of their role. Refinement of the scope of practice, or extended nutrition education may be required to ensure that when personal trainers provide nutrition care, they do so in a safe and effective manner. 1 International Confederation of Registers for Exercise Professionals (ICREPS). (2013). *Global Standards for the Health and Fitness Industry*. From <http://www.icreps.org/wp-content/uploads/2013/12/2013-12-19-ICREPS-Global-Standards.pdf>. 2 Fitness Australia (FA). (2014). *Position Statement: Scope of practice for registered exercise professionals*. From [https://fitnessaustralia.s3.amazonaws.com/uploads/uploaded\\_file/file/224/Scope-of-Practice-for-Registered-Exercise-Professionals.pdf](https://fitnessaustralia.s3.amazonaws.com/uploads/uploaded_file/file/224/Scope-of-Practice-for-Registered-Exercise-Professionals.pdf) 3 Sass C, Eickhoff-Shemek J, Manore M, Kruskal L. (2007). *ACSM's Health & Fitness Journal*, 11(3), 12-19. Contact: k.barnes@griffith.edu.au

## EVALUATING RELATIVE HYDRATION WITH HYPOTONIC VS ISOTONIC SPORTS DRINKS: A TALE OF TWO MEASURES

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The recovery of plasma volume following exercise causing dehydration is an important factor for maintenance of cardiovascular capacity and thermoregulatory function in performance nutrition. The movement of water across a semipermeable membrane by osmosis, such as the luminal epithelium of the upper intestine, should be faster with an ingested hypotonic sports drink, relative isotonic equivalent. Empirical evidence on the matter is equivocal, however. To evaluate the question: does a hypotonic sports drink cause faster hydration than an isotonic?, a systematic literature review and mixed model random effects meta-regression was conducted. Included studies were randomised controlled trials in healthy adults (18-65 y). The studies included an orally ingested or stomach-perfused hypotonic (<275 mOsmol.kg<sup>-1</sup>) vs. isotonic contrast (275-300 mOsmol.kg<sup>-1</sup>) with drinks containing carbohydrate and minerals ([Na<sup>+</sup>] <40 mmol.L<sup>-1</sup>). Drinks were taken at rest, during exercise, or recovery (≥1 ml.min<sup>-1</sup>). The meta-analysis was the sample-size weighted within-contrast factor effect (hypotonic/isotonic), interacted with covariates measurement type and standardised isotonic osmolality. The search utilised Scopus (incl. Medline), Web of Science, and Sport Discus. From 785 retrieved abstracts, 12 publications containing 44 contrasts met the inclusion/exclusion criteria with plasma volume (23 contrasts), plasma D<sub>2</sub>O enrichment (1 contrast), and intestinal water absorption (gut triple-lumen segmental perfusion, 15 contrasts) as hydration outcomes. Hypotonic drinks caused a moderate to very large standardised increase in hydration rate, but statistical confidence rendered the overall outcome unclear (meta-regression percent effect on hydration outcome: per -50 mOsmol.kg<sup>-1</sup> x-axis change, 6%, 95%CL -4, 18%; per -150 mOsmol.kg<sup>-1</sup>, 20%, 95%CL -12, 63%). Subset analysis resolved the source of uncertainty as measurement differences. Intestinal water absorption was slower with hypotonic drinks (per -50 mOsmol.kg<sup>-1</sup>, -9%, 95%CL -19, 2%). In contrast, restoration of plasma volume was almost certainly faster with hypotonic drinks (per -50 mOsmol.kg<sup>-1</sup>, 17%, 95%CL 9, 25%; >very large). Most segmental perfusion studies were designed to increase fluid absorption with the isotonic by altering the carbohydrate concentration and type (multiple-transportable sugars) to favour jejunal solute drag; indeed, analysis of studies without carbohydrate covariates reduced the isotonic advantage to small (per -50 mOsmol.kg<sup>-1</sup>, -2.4%, 95%CL -2.3,-2.5%). Inference from segmental perfusion assessment of hydration is limited. Therefore, end-point plasma volume change suggests hydration rate is almost certainly likely to be greater with hypotonic vs. isotonic sport beverages. Funding from Frucor Beverages, NZ.

## HYDRATION STRATEGIES AND RISK OF HIPONATREMIA OF RUNNERS IN THE 2015 CURITIBA MARATHON

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**Introduction:** Recently, marathon running has evolved from a minority participation sport for elite to a mass participation activity with the expansion of amateur club runners (Williams et al, 2012). After that, reports have emerged of serious illness and death from hyponatremia and the excessive fluid intake is believed to be the primary risk factor (Almond et al, 2005; Siegel, 2015). The aim of this study was to explore the hydration strategies of marathon runners, their source of information, the knowledge about fluid intake and understanding of hyponatremia. **Methods:** Fifty-eight runners of the 2015 Curitiba Marathon (Curitiba, Brazil) answered a questionnaire adapted from Williams et al (2012). Mean temperature and humidity during the race was 18°C and 82%. The questionnaire was composed of questions about planned fluid consumption, volume to be consumed, volume of water and sports drinks (Gatorade) available in the race and the number of stations that volunteers planned to carry out the drink. Furthermore, it was asked for sources of information and understanding of hyponatremia. **Results:** In total, 41.4% had a fluid intake plan. However, 8% planned to ingest a large volume enough to put them at greater risk of hyponatremia (> 3500 mL). Only 4 (7.8%) knew the exact volumes of water and sports drink (Gatorade) available in the course; 58.6% wanted to drink water in all stations. Only 15.5% planned to drink according to thirst. While 52% of the runners had heard of hyponatremia or low sodium levels, only 4 (6.9%) was in fact a basic understanding of its cause and effects. There was no significant difference (p > 0.05) in the proportion of experienced runners and inexperienced runners or club runners and nonclub runners who planned to drink more than 3500 mL during the race. Runners with basic understanding of hyponatremia were

experienced runners. There was no significant difference in proportions of club runners and nonclub runners who understood hyponatremia. Discussion: There was a lack of understanding about the proper fluid intake to prevent hyponatremia and their associated risks. Approximately 10% of the runners planned to ingest a volume of fluid which would place them at an increased risk of developing hyponatremia during the marathon. Runners' knowledge of safe drinking strategies and exercise-associated hyponatremia was poorer than the London Marathon runners (Williams et al, 2012). Club runners, who have professional staff, may not be given proper information about fluid intake strategies and the importance of sports drink (Gatorade) for long distance races. Educational interventions are needed to prevent hyponatremia. References Almond, CS et al. (2005). N Engl J Med, 352(15), 1550-1556 Siegel, AJ (2015). Am J Med, 128(10), 1070-1075 Williams, JW et al. (2012). Clin J Sport Med, 22, 152-156

## FLUID CONSUMPTION HABITS OF ELITE ATHLETES

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**INTRODUCTION** Fluids are a vital requirement for athletes. All nutrients are important for performance, but has a more critical importance of water. Dehydration and hypohydration can lead to headaches, reduced blood volume, reduced endurance, altered thermoregulatory capability and impaired cognitive and physical performance 1-3. To our knowledge, no studies have examined water intake using the most recently available dietary data of Turkish athletes. Objective of present study was to examine fluid consumption habits of elite Turkish athletes and compared total fluid intake of training and non-training days. **METHODS** A total of 142 male (mean age  $24.5 \pm 4.2$  years, height  $177 \pm 11.7$  cm and weight  $79.1 \pm 6.9$  kg) and 103 female (mean age  $24.8 \pm 3.3$  year, height  $167.6 \pm 9.4$  cm and weight  $58.5 \pm 5.6$  kg) Turkish elite athletes living in Bursa participated in study. Written questions asked techniques were used for data collection. As data collection tool was administered a questionnaire consisting of two parts. The first part of the questionnaire assessed personal knowledge, the second part assesses water and fluid consumption of subjects. To compare the non-training and training days fluid consumption was used Independent Samples T Test. **RESULTS** Female athletes in non-training (NTD) and training days (TD) intake water 1066.4 ml/day (47.5%) and 1518.4 ml/day (51.4%), tea 386.1 ml/day (17.2%) and 534.7 ml/day (18.1%), fruit juice 175.1 ml/day (7.8%) and 239.3 ml/day (8.1%), energy drinks 40.4 ml/day (1.8%) and 85.7 ml/day (2.9%), respectively. Male athletes in NTD and TD intake water 1192.1 ml/day (48.4%) and 1653.7 ml/day (52.1%), tea 445.8 ml/day (18.1%) and 568.1 ml/day (17.9%), fruit juice 169.9 ml/day (6.9%) and 241.2 ml/day (7.6%), energy drinks 54.2 ml/day (2.2%) and 98.4 ml/day (3.1%), respectively. Statistically significant differences were observed between NTD and TD fluid intake in both gender ( $p < 0.05$ ). Male subjects consumed 28.9% more fluid in TD ( $3174 \pm 46.3$ ) than NTD ( $2463 \pm 32.1$  mL/day). Female subjects consumed 31.6% more fluid in TD ( $2954 \pm 35.4$ ) than NTD ( $2245 \pm 45.2$  mL/day). **DISCUSSION** Adequate fluid consumption, especially water intake is very important for athletes. Athletes have been increased fluid intake in training days. Water is the most increased fluid. This may be related to excessive sweating of athletes during exercise. Drinking sufficient volumes of fluid during physical activity to minimize dehydration is arguably the simplest and most effective means of sustaining physiological function and improving physical performance. **REFERENCES** 1.Popkin BM, D'anci KE, Rosenberg IH (2010). Nutr Rev, 68 (8), 439-58. 2.Sawka MN (1992). Med. Sci. Sports Exer. (1992). 24 (6), 657-670. 3.Dennis, EA, Dengo AL, Comber DL, Flack KD, Savla J, Davy KP, Davy BM (2010). Obesity (Silver Spring), 18 (2), 300-307 **CONTACT** e-mail: ramizar@uludag.edu.tr

## EXERCISE WITH NITRATE SUPPLEMENTATION – WHAT IS THE EFFECT ON FAT METABOLISM DURING REPEATED SPRINTS?

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1 Inst. f. Sport Science; Leibniz University, Hannover 2 Inst. f. Sport Medicine; Hannover Medical School, Hannover **Introduction** Recently the influence of a supplementation with inorganic nitrate ( $\text{NO}_3^-$ ) on physical performance and physiology has been of interest. Especially its beneficial effects on exercise tolerance and performance during submaximal exercise when taken before the exercise. Our aim was to investigate long term effects of  $\text{NO}_3^-$  on fat metabolism during a repeated sprint test when taken during a training period. **Methods** A group of 17 young ( $26.7 \pm 4.1$  y) healthy male athletes ( $\text{Wmax}$   $4.85 \pm 0.7$  W/kg bodyweight) performed an interval training on a cycling ergometer for 3 weeks, 3 times a week in addition to usual training agenda within a placebo controlled double blind trial. 9 (N) participants took a  $\text{NaNO}_3$  supplementation of 8.5 mg per kg bodyweight daily and 8 (P) a placebo ( $\text{NaCl}$ ). We tested for repeated sprints in a Double-Wingate-Test before and after training. Physiological parameters, concentrations of free fatty acids [FFA], free glycerol [FG] and total glycerol [GG] in plasma were measured. Triglyceride concentration [Tri] was calculated from [FG] and [GG]. **Results** There was no significant change in [FFA]. Although [FFA] follows a comparable course pattern, this is similar in both groups before and after training and changes in concentration over testing time are not significant. There is a significant change in the course of [FG] between P and N after training: in all cases [FG] increases towards the end of the test. However, in P there is a significant increase in [FG] during resting time 18 min and 30 min after repeated sprinting, in N a significant decrease in [FG] respectively. [GG], [Tri] and respiratory quotient (RQ) remained similar. **Discussion** The results suggest a decrease in fat metabolism after training with  $\text{NO}_3^-$ ; the increase in [FG] towards the end of the test is smaller for N than for P. But there is no corresponding result in RQ. Although, an interpretation of RQ in terms of substrate metabolism remains questionable under testing conditions due to hyperventilation. Possibly [FG] decreases faster in N than in P during resting time due to an increase in liver perfusion caused by vasodilatation resulting in an increase in transport of FG to hepatocytes and faster elimination of FG from plasma. **References** Clements, W.T.; Lee S.-R.; Bloomer, R. J. Nitrate Ingestion: A Review of the Health and Physical Performance Effects. *Nutrients* 2014, 6, 5224-5264 Thompson, C.; Wylie, L.J.; Fulford, J.; Kelly, J.; Black, M.I.; McDonagh, S.T.J.; Jeukendrup, A.E.; Vanhatalo, A.; Jones, A.M. Dietary nitrate improves sprint performance and cognitive function during prolonged intermittent exercise *Europ. J. Appl. Physiol.* 2015, 115, 1825-1834 **Contact** Magdalena.roehrich@web.de

## Mini-Orals

### MO-PM14 Ageing 3

#### PROCESS EVALUATION OF THE INTERVENTION 'EXERCISE ON PRESCRIPTION' PERFORMED IN PROFESSIONALS WITHIN PRIMARY CARE, PROFESSIONALS IN SPORTS, AND PARTICIPANTS

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**Introduction** Too little exercise leads to a variety of complaints and ultimately to an decrease in health. Promoting sport as an intervention in primary care seems promising to stimulate people to a more active lifestyle and improve their perceived health. 'Exercise on prescription' is one of these preventive interventions that is initiated in the primary care setting. The objective of 'Exercise on prescription' is to encourage inactive people to be physically active and thereby decrease complaints. General practitioners, practice nurses or physiotherapists offer patients a wide range of sport and physical activities. In the Netherlands 'Exercise on prescription' is conducted since 2012. The goal of the process evaluation is to gain insight into the process and the limitations experienced by professionals within primary care with redirecting patients to sport and physical activities (in stead of give them medication). In addition, the research provides insight into which patients are reached, which criteria are applied by professionals and which results are experienced. Also, success factors, limitations and experienced were registered by professionals in sports and participants. **Methods** To answer the research questions semi-structured interviews with professionals within primary care (n = 20) and providers of sport activities (n = 10) were held. In addition, participants (n = 40) (aged 18-74 years) filled out a questionnaire regarding characteristics, experiences, success factors, limitations and outcome perspectives. **Results** The results give insight in the criteria that professionals within primary care use to redirect patients. In addition success factors and limitations are described concerning stimulating patients to participate in sports in order to improve their health and decrease medical costs. Also, the results show what is needed according to the professionals in sports and participants to stimulate them to continue to participate in sport and to increase their perceived health. **Discussion** Based on the results conclusions about the reach, feasibility and the effects on sport behaviour and perceived health as a result of the intervention 'Exercise on Prescription' can be drawn and recommendations for further development can be made. Contact d.collard@mulierinstituut.nl

#### THE EFFECTS OF NINE MATRICES EXERCISE TRAINING ON PHYSICAL FITNESS AND HEALTH IN OLDER ADULTS

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Nine Matrices Exercise (NME) program is a new alternative exercise that combines aerobic exercise, resistance training and stretching to develop and maintain cardiorespiratory endurance, strength and flexibility in older adults. The purpose of this study was to examine the effectiveness of the NME program on cardiorespiratory endurance, muscular strength, flexibility, agility/ balance, heart rate, blood pressure and body mass index (BMI) among older adults. Thirty healthy Thai elderly volunteers in the age group of 60-75, are part of Kasetsart University aging club and undertook 8 weeks of NME program intervention 5 days per week and 30-60 minutes per session. All the volunteers were measured for resting heart rate, blood pressure, BMI and performed the senior fitness test which consists of the 6-Minute Walk, Chair Sit-&-Reach, Arm Curl, Back Scratch, Chair Stand and 8-Ft Up & Go before and after training. The data was analyzed by using mean, standard deviation and paired samples T-Test. The results revealed that there was significant reduction in heart rate ( $P<.01$ ) and BMI ( $P<.01$ ) before and after training, but no significant difference in blood pressure. There was significant improvement in their cardiovascular endurance ( $P<.01$ ), arm strength ( $P<.01$ ), leg strength ( $P<.01$ ), shoulder flexibility ( $P<.01$ ), lower back/ hamstring flexibility ( $P<.01$ ) and agility/balance ( $P<.01$ ) before and after training. In summary, the NME training protocol produced beneficial changes in cardiovascular and musculoskeletal fitness, resulting in better and more healthy ageing of the older people and they can take an active part in society and enjoy an independent and high quality of life. Also, we concluded this NME program as an alternative physical activity which practical and appropriate to improve and maintain health-physical fitness to older adults.

#### DANCING IN TIME: FEASIBILITY AND ACCEPTABILITY OF A CONTEMPORARY DANCE PROGRAMME TO IMPROVE HEALTH AND WELLBEING IN COMMUNITY DWELLING OLDER ADULTS.

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Many older adults do not engage in sufficient physical activity (PA), and are known to be at risk of depression and falls. This early-phase study examined the feasibility, and impact of a 10 week contemporary dance (CD) programme on older adults' PA, mobility, sedentary behaviour (SB), depressive state and fear of falling as part of the development of the intervention. An uncontrolled 'pre-post' intervention design was used. Three groups of older (60yrs+) adults were recruited from local community groups between January and December 2015 to participate in a 3 separate, 10 week dance programmes. Each programme comprised 2, 90 minute dance classes per week. Quantitative measures of physical activity (PA), sedentary behaviour (SB), depression, mobility and fear of falling were measured at baseline (session 4) and then at the end of the dance programme (session 20). Weekly attendance was noted, and post-study qualitative work was conducted with participants in 3 separate focus groups, and for all samples a combined thematic analysis of the content conducted. A total of 38 older adults (Mean Age=77.3±8.4yrs, 1M) completed the dance programme ( $F=37$ ) with the mean number of sessions attended being 12.2±3.5, and mean adherence rate 72.1±20.8%. Of these 38, only 22 (21F, 1M) older adults ( $M=74.8$ ,  $SD=8.44$ ) consented to be part of the study. The mean attendance was 14.6 (±2.6) sessions, and mean adherence was 84.3% (±17). Significant increases in moderate (243.2±175.2 vs 305.7±217.9 minutes/week,  $p<0.05$ ) and vigorous (34.5±60.2 vs 51.8±70.6,  $p<0.005$ ) PA were noted, with a significant decrease in sitting time over the weekdays (2299.5±1630.1 vs 2197.27±713.4 minutes/week,  $p<0.05$ ). Statistically significant decreases in the GDS (3.2±3.3 vs 2.1±2.8;  $p<0.05$ ) and FES-1 (27.6±9.9 vs 23.0±8.6,  $p<0.005$ ) scores and the time taken to complete the TUG test (10.1±4.2 vs 7.7±2.8,  $p<0.005$ ) were noted. Qualitative data indicated that all participants viewed the intervention positively, enjoyed dancing, and reported health and well-being gains. The recruitment of older adults, good adherence and favourability across all three sites indicate that a dance programme is feasible as an intervention. Furthermore, a CD programme has the potential to positively



affect the PA, SB, falls related efficacy, mobility and incidence of depression of the participants, but an adequately powered study with additional control groups are required to test this intervention approach further.

### **BONE MICROARCHITECTURE AND BONE STRENGTH FOLLOWING A 12-WEEK PROGRESSIVE HIGH-RESISTANCE POWER TRAINING IN MOBILITY LIMITED OLDER ADULTS**

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**Background** With increasing age bone health worsens, causing bone fragility and greater risk of osteoporotic fractures, representing a remarkable economic burden for the health care systems. Strength training is regarded as effective intervention to counteract age-related bone deterioration, however power training (high movement velocity and lifted weight) induces higher mechanical strain on bones and was shown to be particularly relevant for bone adaptation (von Stengel et al., 2007). The effects on bone health are generally assessed by dual-energy X-ray absorptiometry (DXA) derived bone mineral density (BMD). Recently, a new high-resolution peripheral quantitative computed tomography (HR-pQCT) technique was introduced. This allows to distinguish between cortical and trabecular bone and to assess bone geometry, densities, microarchitecture and strength, potentially in the early phase of bone formation. The aim of this study was to assess the effect of short-term progressive high-resistance power training in mobility-limited older adults on bone geometry, microarchitecture, densities and bone strength, at the tibia and the wrist anatomical locations. **Methods** 57 women and men, (75-93 years), were randomly allocated into a training (TRAIN, n = 28) and a control (CTRL, n = 29) group. A 12-week progressive high-resistance power training for upper and lower extremities was performed by the TRAIN group while the control group maintained current life-style. Both groups received pre-post intervention scans at the radius and tibia using HR-pQCT. **Results** Women increased significantly both failure load ( $p=0.028$ ) and stiffness ( $p=0.05$ ) at the radius, whereas men remained unchanged. When data were analyzed for the whole cohort together, a trend for increase in bone strength (stiffness, TRAIN +2.6%,  $p=0.063$ ), trabecular thickness (TRAIN +4.22%,  $p=0.081$ ), and trabecular separation (TRAIN +3.9%,  $p=0.067$ ) at the radius were observed. No significant changes were seen at the tibia for the whole cohort and after gender stratification. **Conclusion** 12-week progressive high-resistance power training shows significantly increased bone strength at the radius in women and tendencies regarding the whole cohort. Associations of reduced bone strength in postmenopausal women with previous wrist fractures (Melton III, et al., 2010) underline importance of the improvements following the exercise intervention. Results suggest progressive high-resistance power training to be effective in improving bone health in mobility limited old aged individuals. von Stengel, et al. (2007). *Br J Sports Med.*; 41(10) Melton III, et al. (2010). *Osteoporos Int.*; 21(7)

### **SIDE TO SIDE DIFFERENCES IN DOMINANT VERSUS NON-DOMINANT ARM IN BMD, T-SCORE AND Z-SCORE AND ISOMETRIC HANDGRIP STRENGTH MALES AND FEMALES AGED 40-65 YEARS OLD IN KOSOVA**

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**Introduction:** This observational, cross-sectional study, investigates and compares the differences of BMD, T-score, Z-score (DEXA scan) and isometric strength (handgrip) between dominant versus non-dominant arms of 162 subjects aged 40-65 in a developing, low income country such as Kosova. **Methodology:** Bone Mineral Density (BMD), T-score and Z-score at distal forearm regions of both arms, together with the isometric strength Handgrip were evaluated in a total of 162 subjects, out of which 53 Males (average age  $55.15 \pm 7.12$ ) and 109 Females ( $54.27 \pm 5.1$ ). Additionally, self-administered Nutritional Standard Questionnaire (NSQ) and International Physical Activity Questionnaire (IPAQ) were filled. **Results:** When comparing BMD, T-score and Z-score in dominant versus non-dominant arms in total subjects, results with significant differences were found in total subjects in BMD ( $0.379 \pm 0.09$  vs  $0.352 \pm 0.08$ ), T-score ( $0.02 \pm 1.51$  vs  $-0.52 \pm 1.16$ ), and Z-score ( $0.51 \pm 1.3$  vs  $-0.01 \pm 0.95$ ). Similar results ( $p < 0.05$ ) were evidenced in Females with BMD ( $0.343 \pm 0.07$  vs  $0.317 \pm 0.06$ ), T-score ( $-0.19 \pm 1.47$  vs  $-0.69 \pm 1.17$ ) and Z-score ( $0.75 \pm 1.37$  vs  $0.1 \pm 1.01$ ), whereas not significant differences were observed in Males BMD ( $0.450 \pm 0.09$  vs  $0.421 \pm 1.48$ ) comparing to significantly higher results ( $p < 0.05$ ) in T-score ( $0.44 \pm 1.48$  vs  $0.17 \pm 1.07$ ) and Z-score ( $0.751 \pm 1.37$  vs  $0.1 \pm 1.01$ ) between dominant and non-dominant arms. When comparing the Handgrip isometric strength test in dominant vs non-dominant arms, significantly higher results ( $p < 0.05$ ) were observed in the dominant side in total subjects ( $30.64 \pm 9.32$  vs  $28.24 \pm 8.81$ ), which was the same case ( $p < 0.05$ ) in Females ( $26.75 \pm 5.92$  vs  $24.59 \pm 1.47$ ), and also in Males ( $38.49 \pm 9.95$  vs  $35.74 \pm 9.56$ ). When comparing the total subject's BMD, T-score, Z-score and Handgrip based on the PA levels (1, 2, 3) between dominant and non-dominant sides, no significant differences were found between PA1, as well as PA3 ( $p > 0.05$ ), whereas significant differences were found in dominant arms of PA2 level (comparing to the non-dominant ones). **Conclusion:** This study analyses and compares the side to side differences in bone density and muscular force between dominant and non-dominant arms amongst a population which is frequently exposed to diagnostic screenings for age related conditions (aged 40-60). This study helps to understand the background factors that might play a crucial role on diagnostic process.

### **ACTIVE LIFE STYLE HAS A POSITIVE IMPACT ON MUSCLE AND FAT MASS DISTRIBUTION AS WELL AS ON FUNCTIONAL FITNESS IN OLDER ADULTS**

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**Introduction:** Muscle mass (MM) and strength decrease with age in older adult population and may even accelerated after the age of 65 years. Mankowski, Anton & Aubertin-Leheudre (2015) noted that high levels of adipose tissue and low muscle mass and strength could contribute to a decline in motor function and significantly increase the risk for disability. This study aimed to investigate the influence of the level of physical activity (PA) in both, extremely active (ExA) and extremely inactive (ExInA) elderly subjects on body composition parameters and performance output, with special emphasis on the relationship of MM and fat mass (FM) distribution. **Methods:** The quantity of PA was measured with General Physical Activity Questionnaire (GPAQ) in 3 Slovenian towns on a sample of 443 subjects (EU project PANGeA: Physical Activity and Nutrition for Quality Ageing) from which 36.3 % were men ( $68 \pm 6$  years;  $174 \pm 6$  cm;  $84 \pm 10$  kg) and 64.7% were women ( $67 \pm 5$  years;  $161 \pm 6$  cm;  $70 \pm 12$  kg). Subjects were further divided in 3 groups by METs (ExInA, Moderate Active and ExA), and age ( $\leq 64$ , 65-70 and 71+ years). Fat free mass (FFM; %), FM (%), MM (kg) and mineral mass (MiM; kg) were assessed by Maltron BioScan 916S bioimpedance analyzer. Gait velocity (Gv; m/s), grip strength (GS; kg) and flexibility were measured by OptoGait system, Jamar dynamometer, and Sit and Reach test (SoR; cm), respectively. **Results:** Two-way ANOVA showed no significant interactions between AGE and METs on body composition (BC) and performance parameters ( $p > 0.05$ ). However, there was a significant main effect ( $P < 0.001$ ) of

AGE for MiM, Gv and SaR, as well as of METs for FFM ( $P<0.001$ ), FM ( $P<0.001$ ), MM ( $P=0.019$ ), MiM ( $P=0.006$ ), GS ( $P=0.019$ ), Gv ( $P=0.001$ ) parameters. Subsequent comparisons revealed that <64 group had higher values ( $P<0.001$ ) of MiM, SaR and Gv as compared with 71+ group. Furthermore, ExA group had higher values of FFM ( $P<0.001$ ), Gv ( $P<0.001$ ), MiM ( $P=0.002$ ) and MM ( $P=0.01$ ) as compared with ExInA. Finally, FM values were on average 9.7% higher in ExInA as compared with ExA ( $P<0.001$ ). Discussion: The level of PA is correlated with BC and functional abilities, which represent an important indicator of general health. These results suggest that higher level of PA has a preventive role in preserving MM and functional abilities with age. In addition, it contributes to a reduction of total FM, which is related to higher levels of disability and mobility impairments in older adults population (Koster et al., 2011). The detrimental effect of physical inactivity on MM in older adults, as it emerges from the present work, emphasizes the importance of continuation active life style in the third age, with a special attention on maintaining/improving muscular strength. References: Mankowski RT, Anton SD, Aubertin-Leheudre M. (2015). *Curr Geriatr Rep*, 4(3), 221-228. Koster A, Ding J, Stenholm S, et al. (2011). *J Gerontol A Biol Sci Med Sci*, 66(8), 888-895. armin.paravlic@zrs.upr.si

## IS THERE A DIFFERENCE IN BONE HEALTH BETWEEN MEN AND WOMEN WITH MCARDLE DISEASE?

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Introduction McArdle is a genetic disease characterized by an inability to break down muscle glycogen. Hyperkalemia is one common symptom of this pathology, which could potentially influence bone health due to the fact that potassium have opposing actions on calcium excretion (Weaver, 2013). The aim of this study was to evaluate the bone mineral content (BMC) and the bone mineral density (BMD) of men and women with McArdle disease. Methods 18 patients ( $31.6\pm7.1$  years), 8 men and 10 women of similar age, height and body mass took part in the study. Body composition was assessed using DXA (Hologic QDR Discovery), while physical activity (PA) and quality of life (QL) levels were evaluated by IPAQ and SF-36 questionnaires, respectively. Covariance analysis was performed in order to determine bone differences between genders including body mass, height and age as covariates and T-student test was applied in order to assess PA and QL differences. Results Men showed significantly higher values than women in most of the BMC variables, both at the whole body level ( $1637\pm64$  vs  $1615\pm57$ g) and in several regional levels: legs ( $402\pm12$  vs  $389\pm11$ g), arms ( $149\pm5$  vs  $132\pm4$ g), and trochanter ( $8\pm1$  vs  $7\pm1$ g) (all  $p<0.001$ ). BMD values were also higher in men at legs ( $1.16\pm0.02$  vs  $1.08\pm0.02$  g•cm<sup>-2</sup>) and arms sites ( $0.74\pm0.01$  vs  $0.70\pm0.01$ g•cm<sup>-2</sup>, both  $p<0.001$ ). Men showed 4.5% lower BMD values at femoral neck while women had 3.6% greater levels when compared to reference values (RV) for subjects with similar age without pathologies. Moreover, lumbar spine BMD was 8.2% lower and 2.0% greater (in men and women respectively) (Yang and Shen, 2015). Similar results of PA and QL were found between genders, being regular PA levels within the range considered healthy ( $>600$  MET.min.wk<sup>-1</sup>), and QL scores below the corresponding RV (Alonso et al., 1998; Brown and Bauman, 2000). Discussion Although men showed higher values than women in BMC at most of the studied sites and BMD at the arm and legs, bone health in men with McArdle disease seems to be reduced compared to their healthy counterparts while women with McArdle disease showed similar values than gender adjusted RV. Although no differences in the PA and QL among genders were present, more studies in this field are warranted in order to adequately interpret these findings and to better understand the possible mechanisms that could explain these gender differences. References Alonso J, Regidor E, Barrio G, Prieto L, Rodríguez C, Fuente L (1998). *Med Clin*, 111: 410-416 Brown WJ, Bauman AE (2000). *Aust N Z J Public Health*, 24:520-5 Yang S, Shen X (2015). *Arch Osteoporos*, 10:1-8 Weaver CM (2013). *Adv Nutr*, 4:368S-377S Contact Irene.rodriquez@uclm.es

## Mini-Orals

### MO-PM26 Fitness & Energy Expenditure

#### QUALITY OF LIFE, CARDIORESPIRATORY FITNESS AND PHYSICAL ACTIVITY LEVELS IN BLACK AFRICAN WOMEN

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Introduction: Regular physical activity (PA) is associated with health protective effects, higher physical fitness and a better quality of life<sup>1,2</sup>. It is however unclear whether PA interventions could promote significant changes in Health Related Quality of Life (HRQoL) and whether changes in HRQoL are related to changes in cardiorespiratory fitness (CRF) and physical activity levels (PAL) in black African women from South Africa's low socioeconomic communities. Purpose: To assess the changes in HRQoL, CRF and PAL during a PA intervention in black African women from low socioeconomic communities in South Africa and to investigate the relations between these changes. Methods: A group of black African women ( $n=55$ ; age= $59\pm11$ y) participated in this study and followed an aerobic and strength training program for 12-weeks, 1 h, once a week. Before and after the PA program the SF-8 Health Survey was used to assess the HRQoL. CRF was obtained during a metabolic step test and activity energy expenditure (AEE), total PA (TPA), time spent in sleep/sedentary activities (SST), light PA (LPA) and moderate to vigorous PA (MVPA) were assessed using a combined accelerometry and heart rate monitor (ActiHeart). Paired t-test was used to compare pre-post results. A multiple linear regression was developed using the changes in HRQoL as response variable, while the explanatory variables were those found to be significant correlated ( $p<0.20$ ) with changes in HRQoL using a linear relationship. Results: After the PA intervention significant changes in CRF ( $p<0.01$ ) and HRQoL ( $p<0.01$ ) were observed. VO<sub>2</sub> peak increased from  $17.3\pm4.6$  to  $23.2\pm5.5$  ml/kg/min ( $p<0.01$ ), while non-significant increases were found for TPA, LPA and MVPA. A non-significant decrease on SST was also found. Change in BMI was associated with change in physical and mental health component ( $p<0.05$ ). Multiple linear regression showed that changes in BMI, AEE, PAL, LPA and MVPA are affecting the change in physical health while change in mental health was related to change in body weight. Discussions: This study showed the beneficial effects of a combined PA intervention in black African women from South Africa's low socioeconomic communities on both CRF and HRQoL. Despite of training once a week increases on PALs and reductions on sedentary behaviours were observed. These changes may lead to prevent cardiovascular diseases and increase HRQoL. References 1. Haskell WL, Lee I-M, Pate RR, et al. *Med Sci Sports Exerc*. 2007;39(8):1423-1434. 2. Gill DL, Hammond CC, Reifsteck EJ, et al. *J Prev Med Public Health*. 2013;46 Suppl 1:S28-S34.

## RELATIONSHIP BETWEEN ESTIMATED MAXIMUM OXYGEN INTAKE, PAST SPORTS EXPERIENCE AND PHYSICAL ACTIVITY IN FEMALE UNIVERSITY STUDENTS

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**Introduction** Physical inactivity is associated with an increased incidence of obesity, diabetes, cardiovascular disease, osteoporosis, and cancer. Both recent physical activity and past exercise experience are thought to be affect the current fitness level. In this study to clarify the effects of recent physical activity and past sports activities experience on the estimated maximum oxygen intake in female college students. **Methods** Two hundred eighteen healthy subjects (female,  $20.9 \pm 1.1$  years) participated in this study. The maximum oxygen uptake ( $50\%VO_{2max}$ ) was calculated by running stamina test. An accelerometer (Suzuken, Aichi, Japan, life-corder Ex) were attached to an elastic belt and worn at the back of the waist for a week to calculate the average number of steps and the average activity energy expenditure per day. The evaluation of the physical activity self-reported, using the Japanese version of the (GPAQ: Global Physical Activity Questionnaire). Physical activity environment measure, using the Japanese version of the (IPAQ-E International Physical Activity Questionnaire Environmental Module). Exercise self-efficacy was using the five items that made the Marcus et al (1992). From elementary school up to the present, for the sports activities that have been carried out continuously, sports events, the number of practice per week, once of practice time (minutes), and the duration (in years) was described using a questionnaire. **Results** The average value of the estimated  $50\%VO_{2max}$  was  $19.5 \pm 3.9$  ml/kg/min. The third period to continue the exercise experienced groups Elementary school, junior high and high school students of the estimated  $50\%VO_{2max}$  ( $n=56$ ,  $21.2 \pm 4.2$  ml/kg/min) was significantly higher than None exercise experience group ( $n=33$ ,  $18.4 \pm 2.9$  ml/kg/min), and one period to the exercise experience group ( $n=60$ ,  $18.6 \pm 3.8$  ml/kg/min) ( $p<0.05$ ). The results of multiple regression analysis for the estimated  $50\%VO_{2max}$ , sports activities time at the time of junior high school students, sports activities time at the time of high school students, recent sitting time, the number of steps and self-efficacy were significant contribution rate 17.3% ( $F=8.86$ ,  $p<0.001$ ). Standard partial regression coefficient was, sports activities time  $\beta=0.223$  ( $p<0.01$ ) at the time of high school students, exercise self-efficacy  $\beta=0.222$  ( $p<0.01$ ), and sitting time  $\beta=-0.148$  ( $p<0.05$ ). **Discussion** Dose-response relationship between the estimated maximum oxygen uptake greater the sports activities becomes higher were observed. Sports activities time at the time of high school students, exercise self-efficacy, following the sitting time have shown that had been affected by the estimated maximum oxygen uptake. Exercise self-efficacy is a recent physical activity from that association was observed, it was considered that it is important to increase the physical activity by environmental improvement such as physical education classes and sports club activities. **References** Namba H, et al. J Med Internet Res 2015;17(3):e74

## A STUDY ON THE RESTING ENERGY EXPENDITURE OF CHINESE ADOLESCENTS IN DIFFERENT PUBERTY STAGE

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**Introduction:** Resting Energy Expenditure (REE) accounts for the biggest proportion of the total energy consumption. Accurately grasping the information of REE plays an important role in keeping energy balance, maintaining normal body quality, scientifically arranging diet and exercise as well as promoting the growth and development of adolescents. At present, the studies on REE mainly focus on some specific population like adults, metabolic disease patients, critically ill patients or obese children and the main research methods used are actual measurements or estimations based on formula. Although REE conformed through actual measurement can be accurate, it cannot be popularized since the measuring instruments are expensive and the operations are too complicated. REE is calculated on the base of formula or directly estimated through the recommended value of 3.5 ml/kg/min for adults by most scholars. **Methods:** 120 Chinese teenagers aged 11 to 14 years old (62 males, 58 females) voluntarily participated in the experiment. The portable gas analyzer (925g), Cosmed K4b2 (Cosmed, Rome, Italy) can measure the energy consumption in the laboratory and non-laboratory environment, which has been widely employed in the experiment study of energy consumption, including that of the children and adolescents. With a room temperature of  $25 \sim 27^\circ\text{C}$ , all the subjects fasted for more than 2 hours after the meal and wearied K4b2 for few minutes to adapt instrument. After being adapted, they were asked to lay down quietly on the mat for a 20-30 min testing. The 16th to 20th minute of the testing data was selected to calculate REE by the Weir formula. The subjects were divided into five stages by means of the Self-administered Pubertal Development Scale (Chinese version), that is, pre-puberty, early puberty, middle puberty, late puberty and post-puberty. **Results:** As to the puberty stage, 33 male subjects were at their middle puberty, accounting for the highest proportion. 20 people (32.3%) were at their early puberty, 8 (12.9%) at pre-puberty and 1 (1.6%) for late puberty. 58 female subjects were at puberty, 41 of whom were at late puberty (70.7%), and 11 (19.0%) at middle puberty, 6 (10.3%) at early puberty. With the continuous development of puberty, REE of the male and female were decreasing. For the male, pre-puberty ( $7.33 \pm 1.62$  ml/kg/min,  $35.26 \pm 7.39$  cal/kg/min) > early puberty ( $6.77 \pm 1.22$  ml/kg/min,  $32.37 \pm 5.45$  cal/kg/min) > middle puberty ( $6.12 \pm 1.15$  ml/kg/min,  $29.19 \pm 5.44$  cal/kg/min) (early puberty VS middle puberty,  $P<0.05$ ); while for the female, early puberty ( $6.89 \pm 1.44$  ml/kg/min,  $32.42 \pm 6.42$  cal/kg/min) > middle puberty ( $6.57 \pm 1.25$  ml/kg/min,  $31.44 \pm 5.83$  cal/kg/min) > late puberty ( $6.18 \pm 1.28$  ml/kg/min,  $29.30 \pm 5.97$  cal/kg/min) (middle puberty VS early puberty,  $P>0.05$ ; middle puberty VS late puberty,  $P>0.05$ ). **Conclusions:** REE of the adolescents with different puberty stage are higher than the 3.5ml/kg/min recommended standard of adults without exception.

## ENERGY EXPENDITURES FOR FIVE OUTDOOR FITNESS EQUIPMENTS

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Outdoor fitness equipment (OFE) has gain popularity in many regions globally. However, the energy expenditures and intensities of operating these equipment are unknown. Thus, this study employed K4b2, a portable device for pulmonary gas exchange measurement, to objectively estimate the energy expenditures and intensities of operating five OFE. Five males and five females were recruited to operate the following OFE: air walker, ski machine, twister, upper limb traction, and rowing machine. The subjects followed the same protocols of operating the machine with random order. The average age of the subjects were  $23.7 \pm 1.8$  and BMI of  $23.8 \pm 3.8$  kg/m<sup>2</sup>. We use METs as indicator for intensity of physical activity, and cal/kg/min for energy expenditure. The average energy expenditure and METs for Air walker is  $62.41 \pm 10.97$  cal/kg/min and  $3.55 \pm 0.73$  METs, Ski machine is  $67.19 \pm 17.14$  cal/kg/min and  $3.79 \pm 0.99$  METs, Twister is  $13.02 \pm 3.33$  cal/kg/min and  $2.25 \pm 0.62$  METs, Upper limb traction is  $12.90 \pm 3.14$  cal/kg/min and  $2.24 \pm 0.64$  METs, Rowing machine is  $22.03 \pm 4.61$  cal/kg/min and  $3.72 \pm 0.79$  METs. These data provides objective assessment of operating OFE in evaluating its goal of achieving public health.

### CHANGES IN URINE VOLUME AND SUBJECTIVE MICTURITION DURING WATER EXERCISE IN MEN

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**Purpose:** The purpose of this study was to investigate the relationship of in water exercise to urine volume, subjective micturition, oxygen uptake, heart rate, rating of perceived exertion (RPE), blood pressure and rectal temperature during water exercise. **Methods:** Eight healthy males (age:  $22.3 \pm 2.1$  years, weight:  $66.2 \pm 10.3$  kg, height:  $169.5 \pm 4.7$  cm) subjects volunteered for this study. Each subject signed an informed consent form. The study was conducted in an indoor pool facility at K University, in 2015. This study consisted of two experimental conditions: the land trial and the water trial. The water level was set to the xiphoid. Subjects participated in both conditions on different days. Measurement items were urine volume, subjective micturition, oxygen uptake, heart rate, RPE, blood pressure (SBP: Systolic Blood Pressure / DBP: Diastolic Blood Pressure) and rectal temperature. The water temperature was 30 degrees Celsius. Both conditions began with 30 minutes in a sitting posture on land. Then, for the next 30 minutes, the water trial performed water exercise while the land trial performed exercise. Finally, for the last 30 minutes, both conditions were back on land in a sitting posture. **Results:** Urine volume after immersion in the water trial was higher than that of land trial ( $p < 0.05$ ). Subjective micturition after immersion and recovery at 30 minutes in the water trial were higher than that of land trial ( $p < 0.05$ ). No significant differences were found in oxygen uptake, heart rate, RPE, blood pressure and rectal temperature between the water trial and the land trial. **Discussion:** Venous return increases in water and urine formation rises and then the diuretic effect increases. Previous studies demonstrated that responses to the physical characterizations in water differed from those on land. Compared with in land exercise, the loss of body fluid is increasing by urine in water exercise. These things suggest increased urine volume and subjective micturition. **Conclusion:** 1) Urine volume and subjective micturition increase through immersion in water. 2) Urine volume increases athletic strength during exercise more in water than on land. **References:** Onodera S, Yoshioka A, Nishimura K, Kawano H, Ono K, Matsui T, Ogita F, Hara H : Water exercise and health promotion, The Journal of Physical Fitness and Sports Medicine, 2(4), 393-399, 2013. Greenleaf LE : Physiological responses to prolonged bed rest and fluid immersion in humans. Journal of Applied physiology, 7, 619-633, 1984.

### COMPARISON OF HEAT RATE AND OXYGEN UPTAKE OF TURNER DURING A PERSON TURNING THE LONG JUMP ROPE DURING THE EXISTENCE AND NON-EXISTENCE OF A JUMPER

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**Purpose:** Elementary schools in Japan undertake physical education classes. However, no reports have investigated the physiological responses of a person turning the long jump rope during long jump rope exercises. The purpose of this study was to clarify the effect on the heart rate and oxygen uptake of the person turning the rope during the existence and non-existence of a jumper. **Methods:** Subjects were six healthy Japanese males volunteered to participate in this study. Their age, heights and body weights were  $22 \pm 1$  years,  $171.7 \pm 9.3$  cm and  $65.8 \pm 6.4$  kg, respectively (mean  $\pm$  SD). All subjects signed informed consent forms prior to participation in this study. Measurement conditions were set for the existence and non-existence of a jumper. The rotational speed of the rope was 90 rpm. The experimental protocol called for sitting on a chair to rest for five minutes followed by three minutes of exercise and five minutes of again sitting on a chair to rest for recovery. The exercise chosen was to turn a jump rope for three minutes under both the aforementioned conditions. The long jump rope used was certified by the NRAJ (National Recreation Association of Japan, length of rope: 10 m). Measurement indexes were heart rate, oxygen uptake, blood pressure and Rating of Perceived Exertion. **Results and Discussion:** The heart rate of the person turning the rope under the jumper existence condition was significantly higher than that under the jumper not-existence condition at one minute and three minutes after the exercise ( $p < 0.05$ ). The oxygen uptake of the person under the former condition was significantly higher than that under latter condition at one minute, two minutes and five minutes after the exercise ( $p < 0.05$ ). The Rating of Perceived Exertion of the person under the former condition was significantly higher than that under latter condition at two minutes and three minutes after the exercise ( $p < 0.05$ ). Based on these results, the workload of the person turning rope was significantly higher during the existence of a jumper; therefor, turning the rope is a form of anaerobic exercise. These results suggest that the reason for the higher workload was the expanse of the rope. **Conclusion:** The workload of a person turning the long jump rope was significantly higher during the existence of a jumper.

### VALIDITY OF THE MIO FUSE AND ACTIHEART TO MEASURE STEPS AND ENERGY EXPENDITURE IN HEALTHY ADULTS

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**Introduction.** In recent years, the consumer marketplace has been flooded with an array of physical activity monitors. However, to date, little research exists about the validity of these commercially available physical activity monitors. Hence, the purpose of this study was to evaluate the validity of a consumer-based physical activity monitor (MIO Fuse) and a research physical activity monitor (Actiheart) for estimating energy expenditure (EE) and step counts in healthy adults. **Methods.** Eighteen healthy adults ( $n=5$  males), aged 21 to 36 years (mean BMI  $21.7 \text{ kg/m}^2 \pm 3.1$ ) completed two trials of 50-minutes of standardized structured activity (one familiarization session, one validation session). The participants wore a MIO Fuse on their right wrist, an Actiheart on their chest as well as a portable metabolic system (Oxycon Mobile, Jaeger). Steps were recorded through video-recording. Both sessions started with 10 minutes of rest, followed by walking on a treadmill at low ( $< 3$  METs), moderate (4-6 METs) and high intensity ( $> 7$  METs) for 10 minutes each, interspersed with set times for rest. Total volume of EE and total estimated-steps were obtained at the end of the session. EE from MIO Fuse and Actiheart were compared with the gold standard, indirect calorimetry. Estimated steps were compared with manual counting of the video recording. Validity was assessed by means of paired T-tests and Bland-Altman plots comparing each device to the criterion method. **Results.** Total estimated EE from the MIO fuse ( $211 \pm 84$  kcal) was not different from the criterion method, indirect calorimetry ( $206 \pm 35$  kcal) whereas the estimated number of steps from MIO fuse ( $3221 \pm 31$  steps) was statistically different from the video recording ( $3337 \pm 37$ ) ( $p = 0.01$ ). EE estimation from the Actiheart ( $157 \pm 34$  kcal) was significantly lower ( $p < 0.01$ ) compared to the criterion method. Bias for EE for MIO fuse was -5.6 kcal (limits: -150.9; 162.2) and 49.4 kcal (limits: -25.4 to 124.2) for Actiheart. Bias for steps for MIO fuse was -111.0 (-315.65 to 93.52). **Conclusion.** The present study showed that MIO fuse can accurately measure EE compared to indirect calorimetry but underestimates the number of steps one is taking. In line with previous studies[1], we confirm the low accuracy of the Actiheart to measure EE. **Reference** [1] Koehler K, et al. European Journal of Sport Science 2013;13(1):31-41



## Mini-Orals

### MO-BN13 Neural Responses

#### INTERMANUAL INTERFERENCE IN MOTOR ADAPTATION

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**Introduction:** Bilateral practice is a profitable method in motor learning which bases on the motor system's capacity to transfer motor memory (Magill, 2007). For instance, adapted motor behavior of arm movements can be transferred from the trained to the untrained arm (Joiner et al., 2013). Contrary, motor memory interference can occur as the retention of a learned motor task A was shown to be degraded when a second task B is learned in-between (Shadmehr & Brashers-Krug, 1997). Yet, it is unclear if both intermanual transfer and interference effects may occur in connection with each other. Thus, the aim of this study was to investigate intermanual interference, i.e., if consecutive learning of two tasks A and B using different arms degrades retention of task A. **Methods:** 36 right-handed subjects (18-30 yrs) performed 2d point-to-point arm reaching movements handling a robotic device (Shadmehr & Brashers-Krug, 1997). Subjects were equally assigned to three groups (C,T1,T2). Following familiarization and baseline measurement of both arms, all groups performed a practice block adapting their right arm movements to a robot-induced force field (task A). Subsequently, test group subjects adapted their left arm movements either to the same force field A (T1) or to force field B of similar structure but reversed direction (B=-A; T2). Control subjects (C) had a break. Finally, all groups were tested for retention of task A with the right arm. To gauge motor performance, error clamp trials were used. This allowed measurement of forces that subjects predictively generated to counteract the expected force field (Joiner et al., 2013). Intermanual interference was assessed using an ANOVA (factors: time [end of practice, retention], group [C,T1,T2]) comparing right hand practice performance and retention of task A. **Results:** Only group T2 showed a significantly degraded retention of task A ( $p < .001$ ,  $d = 2.15$ ). The ANOVA revealed a significant time\*group interaction ( $p < .001$ ,  $p\eta^2 = .47$ ). Post-hoc tests indicated significant time\*group interactions between T2 and C ( $p < .001$ ,  $p\eta^2 = .44$ ) as well as between T2 and T1 ( $p < .001$ ,  $p\eta^2 = .48$ ). There was no significant time\*group interaction between C and T1 ( $p = .862$ ,  $p\eta^2 < .01$ ). **Discussion:** Our results demonstrate intermanual interference effects. Thus, switching arms when learning competing tasks does not prevent interference effects. Contrary, consecutive learning of task A with both arms did not lead to enhanced retention performance compared to control subjects. This might be due to ceiling effects of learning this comparably simple task. Altogether, the findings contribute to an enhanced understanding of motor learning, thus serving as a basis for rehabilitation and sports settings. **References:** Joiner WM, Brayanov JB, Smith MA (2013). *J Neurophysiol*, 110, 984-998. Magill R (2007). *Motor learning and Control*. McGraw-Hill, New York. Shadmehr R, Brashers-Krug T (1997). *J Neurosci*, 17, 409-419. Contact: stocking-er@kit.edu

#### MUSCLE FIBER CONDUCTION VELOCITY AND POWER PERFORMANCE: THE INFLUENCE OF FIBER COMPOSITION AND TRAINING BACKGROUND

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**Introduction** Explosive performance depends upon the rate of force development (RFD) and muscle power, which depend upon a number of neuromuscular variables as well as the type of chronic exercise performed (Cormie et al. 2011). An essential part of the neuromuscular structure is the system which propagates the action potentials along the muscle fibers. However, the velocity of this propagation, muscle fiber conduction velocity (MFCV), has received very little attention as a determinant of muscle power and RFD. Aim of the study was to explore the relationship between MFCV, fiber type composition and power/RFD in participants with different training background. **Methods** Thirty-eight young males participated (Power analysis: 0.923) according to their training background: sedentary (n=10), endurance (n=9), power (n=10), strength (n=9). They performed countermovement jumps (CMJ) and maximum isometric leg press on force-platforms. Resting MFCV (with intramuscular microelectrodes) and muscle fiber composition (with muscle biopsies) were obtained from vastus lateralis of the dominant leg. Statistics included one-way ANOVA, Pearson's r, partial correlations, stepwise multiple regression and reliability analysis ( $p < 0.05$ ). **Results** The power group had that highest CMJ power, RFD, MFCV, %CSA of type II and IIX fibers, while the strength group performed better than the sedentary and endurance groups in these parameters. Significant correlations were found between MFCV and type II, IIX muscle fibers CSA and %CSA, RFD and CMJ power ( $r = -0.358-0.943$ ;  $p < 0.001$ ). These correlations were higher for the power group and lower or non-significant for the sedentary and endurance groups. Partial correlations revealed that the %CSA of IIX muscle fibers dictates the correlation between MFCV, RFD and CMJ performance. Significant and reliable models for the prediction of CSA and %CSA of type II and IIX muscle fibers, based upon MFCV, RFD and CMJ were revealed ( $R = 0.707-0.935$ ;  $p = 0.000$ ). **Discussion** The present results suggest that MFCV is related to performance in explosive activities; i.e. higher MFCV leads to higher RFD performance. This relationship depends upon type IIX and II muscle fiber %CSA, as well as the type of chronic exercise training. The combination of MFCV, RFD and CMJ may provide reliable information about the muscle fiber composition. **References** Cormie et al. (2011). *Sports Med*, 41(1):17-38. Contact: smetheni@phed.uoa.gr

#### MODULATION OF SPINAL REFLEX EXCITABILITY IN THE CALF DURING HORIZONTAL JUMP-LANDINGS

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**Introduction** Spinal reflex responses are thought to be important for successful performance of landing tasks and stiffness regulation. The pathway of the simple stretch reflex is commonly probed using an electrically induced Ia-afferent response, or H-reflex. Previous research has examined Ia-afferent control during drop-jumps however; it is unknown how/if at all spinal reflexes functionally contribute to common landing tasks associated with injury in the sporting context. The aim of this study was to analyse Ia-afferent control during a horizontal jump-landing task. **Method** Eight healthy individuals participated. H-reflex recruitment curves of the left limb were attained during stance. The ascending portion of the H-reflex recruitment curve was fit with a least-squares sigmoidal function, using Klimstra's model. Stimulus intensity during landing was controlled at 50% of the maximal H-reflex response on the ascending portion of the curve.

H-reflex stimulation was elicited at the short latency response (SLR) of two landing distances: 25 and 50% of maximal broad jump distance. H-reflex amplitude was expressed relative to background EMG (bEMG) at the SLR and M-max [(H-reflex-bEMG)/M-max, %]. Intra-class correlation coefficient values of stimulation during landing were calculated for 3, 5, 10 and 15 trials. Results Soleus H-reflex amplitude was significantly inhibited during landings compared to stance, and during landings from greater distances. No change in H-reflex amplitude was observed in medial gastrocnemius. bEMG increased during landings from greater distances. Strong reliability of stimulation at H50 during landing was observed in 10 and 15 trials. Discussion Reduced soleus H-reflexes in the 50% condition likely indicates inhibition of Ia-afferents via pre-synaptic mechanisms (descending cortical drive, anticipatory activation of other afferents), or post-synaptic reciprocal inhibition. Based on previous research demonstrating an inverse relationship between bEMG and stiffness, our findings suggest that Ia-afferents may directly contribute to stiffness regulation during landings. Unaltered H-reflex excitability of medial gastrocnemius is most likely attributed to its functional role during the landing task. To better understand how spinal reflexes contribute to successful landing performance, future research should examine the mechanism of Ia-afferent inhibition and its relationship to stiffness regulation in subjects with ankle instability during landing. References Cronin N, Carty C, Barret R. (2011). PlosOne, 6, 1-6. Klimstra M, Zehr E. (2008). Exp. Brain Res, 186, 93-105. Taube W, Leukel C, Gruber M, Rantalainen T, Gollhofer A. (2008). J Neurophysiol, 99, 1243-1252. Contact c.thompson2@westernsydney.edu.au

## MODULATION OF CORTICOSPINAL EXCITABILITY FOLLOWING UPHILL VERSUS DOWNHILL LOCOMOTION

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Introduction Physical activity is widely recommended for health through its cardiovascular, muscular and cognitive improvements (1). It has been shown that neural plasticity in primary motor cortex could be enhanced after a single bout of aerobic exercise (2). The effect of contraction mode (concentric versus eccentric) on corticospinal excitability (CSE) changes has been investigated for single joint movement (3), but not for a global movement such as locomotion. The aim of this study was to investigate the effect of uphill versus downhill running exercise on CSE. We hypothesized that downhill running would lead to greater corticospinal changes compared to uphill running because of a greater amount of muscular afferents inputs. Methods Twelve healthy moderately active volunteers (female = 2,  $24.7 \pm 4.4$  years) participated in three experimental sessions. The first session consisted in an incremental running test (0% slope) to determine maximal heart rate (HRmax) of subjects. Two following sessions consisted in 30-min walking/ running treadmill exercise with a +10% slope or a -10% slope at the same intensity corresponding to 60% HRmax. CSE changes were assessed in an upper limb muscle (abductor pollicis brevis) with motor evoked potential (MEP) by transcranial magnetic stimulation before (PRE), immediately after (POST) and 30 min after exercise (POST30). Results Locomotion velocity was greater during downhill (2.4 m.s<sup>-1</sup>) than uphill (1.3 m.s<sup>-1</sup>) exercise despite the same rate of perceived exhaustion at the end of both exercises (11 on Borg scale from 6 to 20). No MEP changes were observed at POST in both conditions. ANOVA showed a main time effect with a significant ( $p < 0.05$ ) MEP amplitude increase at POST30 ( $156 \pm 71\%$ ) compared to PRE values. In addition, a significant ( $p < 0.05$ ) condition effect was shown with greater MEP amplitude increase at POST30 after +10% compared to -10% grade exercise. Discussion Consistently with previous findings, the present data showed that CSE is enhanced for a non-exercise muscle, 30 min after a running exercise but not immediately after (2, 4). Interestingly, uphill locomotion (which implies mostly concentric muscular contractions) induced greater changes in CSE than downhill exercise (which implies mostly eccentric muscular contraction) despite the same exercise intensity. Most predominant mode of contraction during locomotion should be considered in exercise-induced neural plasticity. However, precise mechanisms underlying these changes remain to be elucidated. References 1. Petzinger et al. The Lancet. Neurology 2013 ; 7 : 716 -26 2. Singh et al. Exp Brain Research 2014 ; 11 ; 3675-85 3. Duclay et al. J Physiol 2011 ; 11 : 2901-16. 4. Takahashi et al. Brain Stim. 2011 ; 4 : 90-96.

## NEURAL RESPONSES FROM ACUTE RESISTANCE TRAINING DIFFER FROM PREVIOUS SUPER COMPENSATION THEORY.

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1 Centre for Physical Activity and Nutrition Research (C-PAN), School of Exercise and Nutrition Sciences, Deakin University 2 Cognitive Neuroscience Unit (CNU), Deakin University 3 Institute of Sport, Exercise and Active Living (ISEAL), Victoria University Introduction Neural adaptations following resistance training are crucial for optimal performance enhancement. The primary aim of this study was to investigate the time-course of neurophysiological adaptations following acute bouts of strength and hypertrophy training for comparison with the conceptual super compensation model (Bompa and Haff 2009). Methods Participants (N=14) completed a randomised, counterbalanced crossover study comparing; control, strength and hypertrophy conditions. The strength condition involved 3 x 5RM leg extensions with 3 min recovery, while the hypertrophy condition involved 3 x 12 RM with 60s recovery. Transcranial magnetic stimulation (TMS) and peripheral nerve stimulation were used to measure excitability of the central and peripheral neural pathways, and maximal voluntary contraction (MVC) to quantify strength changes. Measures were taken pre, immediately post, 10, 20 and 30 mins and 1, 2, 6, 24, 48, 72 and 96 hours following training. Results Significant differences were observed at post, 10, 20, 30 min, 1 and 2 hours for both training groups compared to control group for force, ( $p < .05$ ), maximal compound wave; ( $p < .005$ ), silent period; ( $p < .05$ ) and corticospinal excitability; ( $p < .005$ ). Corticospinal excitability between strength and hypertrophy groups was near significance ( $p = .05$ ), with a large effect ( $n^2 = .202$ ). All measures returned to baseline within 6 hours post training. Discussion To our knowledge this is the first time neurophysiological responses following resistance have been directly measured. Interestingly, strength and hypertrophy training were found to have a similar neurophysiological profile in the acute stages post-training, contradictory to theory that strength training has a larger neural effect and requires longer recovery (Bompa and Haff 2009). Both acute resistance training paradigms caused an increase in MEP amplitude and a subsequent decrease in corticospinal inhibition, rather than neural fatigue as previously proposed (Bompa and Haff 2009). These responses are indicative of neural adaptations observed following longer-term resistance training programs (Kidgell et al. 2010; Weir et al. 2012). References Bompa, TO, Haff, GG (2009). Periodization: Theory and Methodology of Training, 16-19. Sheridan Books, USA. Kidgell, DJ, Stokes, MA, Castricum, TJ, Pearce, AJ. (2010). JSCR, 24(11)/3123-3132 Weir AT, Pearce AJ, and Kidgell DJ. (2012). Acta Physiol, 206, 109-119. 24(11)/3123-3132 Contact clatella@deakin.edu.au

## CHANGES IN CORTICOSPINAL EXCITABILITY PRIOR TO RAMP AND BALLISTIC ISOMETRIC CONTRACTIONS

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**Introduction** Previous work indicates that, in leg muscles, the increase in spinal motor neurone excitability prior to ballistic (BAL) contractions (high rate of force development) was delayed compared with ramp contractions (low rate of force development) (1), and that the excitability of the corticomotoneuronal cells was greater at the onset of BAL than ramp contractions (2). This suggests that corticospinal excitability during the preparatory period of a contraction may be specifically tuned depending on the rate at which force is developed during the subsequent contraction. This study investigated the modulation of corticospinal excitability during the preparatory period of BAL and ramp contractions. **Methods** Twelve young adults performed isometric contractions with the right ankle dorsal flexor muscles. Subjects had to match a template displayed on a monitor with the force of the ankle dorsiflexor muscles. The template represented a ramp (1500-ms duration) or a BAL (150-ms duration) contraction developing the same level of force (force associated with the maximal rate of force development during BAL contraction). Transcranial magnetic stimulation applied over the left motor cortex was used to evoke stimuli at 95% and 120% of the passive motor threshold (MT) in the tibialis anterior, in a 500-ms window preceding the onset of the contractions. Motor evoked potential (MEP) occurrence and amplitude were measured in response to the 95% and 120% MT stimulation, respectively. MEP amplitude was expressed relative to the corresponding Mmax evoked by electrical stimulation of the fibular nerve. **Results** MEP occurrence in response to 95% MT stimulation increased significantly ( $p < 0.05$ ) between each 100-ms window from 500ms (47% of occurrence) to the onset of the ramp contraction (100% of occurrence) whereas it increased only in the last 100-ms prior to BAL contractions compared with preceding 100-ms windows ( $p < 0.05$ ). Similarly, MEP amplitude in response to 120% MT stimulation increased significantly ( $p < 0.05$ ) between each 100-ms window from 500ms to the onset of the ramp contraction, whereas it increased ( $+220.1 \pm 160.6\%$ ) only in the last 200-ms prior to BAL contractions compared with preceding 100-ms windows ( $p < 0.05$ ). **Discussion** Data indicate that the descending drive differs between ramp and BAL contractions, with a delayed and more sudden increase in corticospinal excitability before BAL contractions. This indicates that adjustments within the corticospinal pathway prior to muscle activation differ between ramp and BAL contractions. **References** 1. Kagamihara et al. (1992) *Neurosci Res* 14:1-11 2. Nielsen and Petersen (1995) *J Physiol* 484:777-89 **Contact** Yannick.Gouverneur@ulb.ac.be

## MUSCLE RECRUITMENT PATTERN BY ELECTROMYOGRAPHY IN RESISTIVE EXERCISE IN DIFFERENT POPULATIONS

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**Introduction** The surface electromyography (sEMG) is useful for the knowledge of the motor pattern during exercise in healthy individuals and in different conditions; changes of sEMG, can be expressed by the value of the Root Mean Square (RMS), and assist in the diagnosis of changes in neuromuscular degenerative chronic diseases. So the goal was to analyze the participation of lung disease group (PG) with Chronic Obstructive Pulmonary Disease; of heart disease (CG) with heart failure; Type II Diabetics (DG); compared to a healthy group (HG) for resistive exercise of the 'Leg Press' 45°. **Methods** The study included 10 volunteers in each experimental group (PG, CG, DG and HG), aged 50-65 years, who underwent resistance training type 'leg press' instructed to perform a Maximum Voluntary Isometric Contraction (MVIC) for 10 seconds, and after 5 minutes of rest perform repetitions to fatigue in 60% of 1 RM determined in advance. Was recorded during the exercise the electromyographic activity of the muscles Rectus Femoris (RF), Vastus Lateralis (VL), Vastus Medialis (VM) and Biceps Femoris (BF). Was used for the analysis of the electromyographic signal RMS values throughout the movement, and after the signal standard in single percentage for comparison between groups. There were no differences statistics between the groups for age and height, but there was as the body mass. **Results** Regarding the analysis of Surface Electromyographic Signal differences were observed for muscle recruitment during the movement of 'leg press' highlighting that for the PG the most active muscle was the RF (36,5%) followed by the VL (35,8%), VM (20,7%), and BF (17,1%), for CG was BF (30,6%) followed by RF (24,9%), VM (23,5%) and VL (21,1%) for DG was VL (36,5%) followed RF (35,8%), VM (20,7%), and BF (17,1%), while for HG was VL (40,0%), followed by the VM (32,7%), RF (15,9%) and BF (11,4%). **Discussion** There is a different motor recruitment tendency for groups: PG, CG and DG when purchased in HG, since the fatigue process is observed when there is an increase in RMS values, (Mc Hugh et al, 2002) so decrease in excitation-contraction coupling, promoting a gradual reduction of contraction force suggesting bankruptcy in synaptic transmission (Barrama et al., 2014) probably by the presence of peripheral neuropathy in patients with chronic diseases degenerative. **References** Barrama PJ; Williams EN; Snyder ML; Buchaman TS. *MSSE*. 2014; 1089-97. Mc Hugh MP; Tyler TF; Browne MG; Gleim GW; Nicholas SJ. *AJSM*, 2002; 30 (3): 334-39. **Contact** Gabriella Soares de Souza: gacijo@hotmail.com

## EFFECTS OF DROPPING HEIGHT AND SURFACE INSTABILITY ON NEUROMUSCULAR PERFORMANCE DURING DROP JUMPS

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**Introduction** It has previously been shown that both, dropping height (Leukel et al., 2008) as well as surface condition (Prieske et al., 2013) have an impact on lower limb muscle activation during stretch-shortening cycle movements such as drop jumps (DJ). However, the combination thereof has not been examined yet. Thus, the purpose of this study was to investigate whether dropping height-induced changes in lower leg muscle activity during DJs are additionally modulated by surface condition. **Methods** Twenty four healthy and physically active participants ( $23.7 \pm 1.8$  years) performed DJs on a force plate on stable, unstable, and highly unstable surfaces (i.e., one and two balance pads on top of force plate, respectively) using different dropping heights (i.e., 20 cm, 40 cm, 60 cm). Electromyographic activity of soleus (SOL), gastrocnemius (GM) and tibialis anterior muscles (TA) was recorded and analyzed for time intervals -100 ms to ground contact (i.e., preactivation) and between 30-60 ms after ground contact which corresponds to spinal stretch reflex induced muscle activity (i.e., short latency response [SLR]). **Results** Repeated measures ANOVA revealed that the increase in dropping height produced significantly higher activities during preactivation in SOL and GM as well as during SLR in SOL, GM, and TA ( $p < 0.05$ ;  $1.72 \leq d \leq 3.90$ ). Further, the increase in surface instability resulted in significantly lower activities during preactivation in GM as well as during SLR in SOL and GM ( $p < 0.05$ ;  $1.12 \leq d \leq 3.63$ ). Moreover, a statistically significant dropping height  $\times$  surface interaction was observed for SOL during the SLR time interval. Post-hoc tests indicated lower SOL activity with increasing surface instability for moderate (i.e., 40 cm) and high

dropping heights (i.e., 60 cm) only ( $p < 0.05$ ;  $1.25 \leq d \leq 2.12$ ). Discussion Our findings indicate that surface instability modulates activity of selected lower leg muscles in moderate and high, but not in low dropping heights. This result implies that the implementation of unstable surfaces in plyometric training may impair activity of selected muscles at moderate to high dropping heights. References Leukel C, Taube W, Gruber M, Hodapp M, Gollhofer A (2008). *Acta Physiol*; 192(4):569–76. Prieske O, Muehlbauer T, Mueller S, Krueger T, Kibele A, Behm DG, Granacher U (2013). *Eur J Appl Physiol*; 113(12):2943–51.

### THE COMPARISON OF BIOMECHANIC DIFFERENCES IN EMG ACTIVITY OF CALF MUSCLES AT DIFFERENT TYPES OF WALKING

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**INTRODUCTION** Walking, as the most frequent type of human motion, does not only involve flat terrains, but also uneven surfaces, where there is an occurrence of constant loss and establishment of balance. The calf muscles control the ankle joint function. If they are weak, various injuries to the ankle joint may occur as a result. One of the way to improve neuro-muscular function of the ankle joint is walking with different variations of the foot position. The purpose of the study was to analyse differences in biomechanics and calf muscle activity during walking on a flat surface, at an inclination of 30° inversion, and at an inclination of 30° inversion at which the subjects tried to keep the lateral part of the foot in the air. **METHODS** The study included 16 participants walking on a flat surface (Walk), walking at an inclination of 30° to foot inversion (Walk A), and walking at an inclination of 30° to foot inversion with an ankle eversion (Walk A2). We monitored the changes in biomechanical parameters (walking speed, stride length – SL, contact time – CT) and EMG values at m. TA, m. PL, m. PB, m. SOL, m. GM and m. GL, according to SENIAM recommendations. EMG signal was analysed for the preactivation phase (interval 100ms before the foot touching the surface) and during the contact phase. EMG signals during walking were normalised to corresponding isometric MVC. **RESULTS** Statistically significant differences in walking were observed in stride lengths (the longest SL at Walk:  $130,6 \pm 2,73$  cm) and contact times (longest CT at Walk A:  $0,74 \pm 0,17$  s), but not in walking speed. PL was more active at walking at an inclination than on flat surfaces. This was true in the preactivation phase ( $p < 0.001$ , Walk A2 36,7 %MVC, Walk A 15,9%MVC, and at Walk 8,1 %MVC), as well as in the contact phase ( $p < 0.001$ , Walk A2 77,2 %MVC, Walk A 57,6 %MVC, Walk 14,2 %MVC). PB was also the most active in the preactivation phase at Walk A2, and the least at Walk ( $p < 0.05$ , Walk A2 26,9 %MVC, Walk A 17,3%MVC, and at Walk 9,24 %MVC). However, during the contact phase PB was more active at Walk A than at Walk A2 ( $p < 0.001$ , Walk A2 45,3 %MVC, Walk A 53,4%MVC, and at Walk 15,1 %MVC). **CONCLUSION** The study showed, that the length of a stride and the contact time changed during different types of walking, which had also been argued by Voloshina (2013). Our findings showed the increased activity of calf muscles in walking at an inclination than on flat surfaces. This is consistent with the study by Konradsen and Højsgaard (2007). I therefore conclude, that walking at an inclination could be appropriate way of exercise for people with unstable ankles. **SOURCES** Voloshina, S. A., Kuo, D. A., Daley, A. M. in Ferris, P. D. (2013). *JEB*, 215, 3963–3970. Konradsen, L. in Højsgaard, C. (2007). *SJMS*, 3(2), 99–103.

### THE EFFECT OF A FAILURE- AND SUBMAXIMAL PROTOCOL ON MUSCLE ACTIVATION DURING BLOOD FLOW RESTRICTION RESISTANCE EXERCISE.

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**Introduction** Blood flow restriction resistance exercise (BFRRE) is a field with growing popularity. Little is known about how effort during BFRRE influences muscle activity. Therefore, the present study aims to compare the effects of a submaximal- (SU) vs. a failure (FA) BFRRE protocol on muscle activity and changes in muscle size and strength. **Methods** 17 untrained (<2 leg-strength sessions per week, last 6 months) men (18–45 yrs.) completed fourteen BFRRE sessions with unilateral knee-extension divided into two blocks of seven sessions (within five days), separated by a 10-day rest period. Their legs were randomly assigned to either FA or SU protocol. The FA protocol consisted of four sets to voluntary failure while SU-protocol consisted of four sets aiming for 30-, 15-, 15- and 15 repetitions. Both protocols were conducted at 20% of one repetition maximum (1RM), and had 30 seconds rest between sets. The pressure cuff (13.5 cm pressure zone) was inflated to 100 mmHg, and stayed inflated throughout the four sets. Wireless Electromyography (EMG) sensors were positioned on m. vastus lateralis (VL) and m. rectus femoris (RF). Muscle activity (root mean square (RMS) and mean frequency (MNF)) was measured during the first BFRRE session in each training week, and during a maximal voluntary contraction (MVC) test (90° knee angle) prior to each of the BFRRE sessions. All RMS data is normalized to MVC. Muscle thickness was measured using ultrasound imaging. **Results** In the first session, the Fa group had significantly higher activation of RF during the first set, compared to SU (Fa;  $35.5\% \pm 9.5$  RMS normalized to MVC vs. SU  $28.3\% \pm 5.9$ ;  $p < 0.01$ ). Furthermore, there was a tendency to higher activation of VL during the second set in Fa ( $43.6\% \pm 12.4$ ) compared to Su ( $36.0\% \pm 9.5$ ;  $p < 0.052$ ). In the second session, the average activation of all four sets for VL was significantly higher in the Fa group ( $43.3\% \pm 8.7$ ) compared to the SU group ( $34.6\% \pm 10.5$ ),  $p = 0.014$ ). Average MNF in VL of all 4 sets were significantly higher in the SU group in both the first- (SU:  $90.7 \pm 17.1$  Hz vs. FA  $75.2 \pm 15.1$  Hz;  $p < 0.007$ ) and second (SU;  $90.5 \pm 16.8$  Hz vs. FA;  $75.7 \pm 12.2$  Hz;  $p < 0.006$ ) week of BFRRE. Both FA and SU increased their muscle thickness of VL and MVC significantly during the intervention ( $p < 0.001$ ), with no group differences. **Discussion** We observed a higher activation of RF and a tendency toward higher activation of VL during the FA protocol in the first BFRRE bout. In the first BFRRE bout of the second week, there was a significantly higher activation of VL in FA during the first three sets, compared to the SU protocol. Combined with the downward shift in MNF in the VL FA group, which indicate muscle fatigue; this shows that the failure protocol provides a greater impact on muscle activity. In spite of the higher activation during the FA protocol, we did not find any group differences in changes of strength or muscle thickness. Contact: haakon.stalesen@gmail.com



## Mini-Orals

## MO-PM09 Health &amp; Exercise

**RESPONSE OF THE UBIQUITIN-PROTEASOME PATHWAY TO HIGH-FREQUENCY BLOOD FLOW RESTRICTED RESISTANCE EXERCISE**

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**INTRODUCTION** High frequency blood flow restricted resistance exercise (BFRRE) has been shown to induce a robust increase in muscle size (1). However, how high-frequency training blocks affects protein degradation systems is still largely unknown. The aim of the present study was to investigate changes in ubiquitin-proteasome pathway markers, muscle size and strength during two weeks of high frequency BFRRE interspersed by 10 days of rest. **METHODS** Thirteen participants (9 men) completed four sets (30 s rest) of unilateral knee-extensions to failure at 20 % of 1 repetition maximum (1RM). Partial blood flow restriction (90-100 mmHg) was induced using a 15 cm wide pressure cuff. Biopsies were obtained from m. vastus lateralis at baseline, four times during and two times post intervention. Muscle tissue was homogenized and fractionated into a cytosolic, membrane, cytoskeletal and nuclear fractions. Muscle ring-finger protein-1 (MuRF1), FOXO3a, free ubiquitin (UbF), and ubiquitinated proteins (UbP) were assessed by western blotting. Muscle growth was assessed as changes in muscle fiber area (MFA) using immunohistochemistry and thickness of m. vastus lateralis by ultrasound imaging. Strength was measured as 1RM in knee extension. **RESULTS** Total UbP levels and UbP levels of the cytoskeletal fraction were reduced 1 hour after the first BFR session in both training weeks (total UbP: 1 week  $-24 \pm 17\%$ ,  $p < 0.01$ ; 2 week  $-37 \pm 17\%$ ,  $p < 0.01$ ; UbP-cytoskeleton: 1 week  $-24 \pm 17\%$ ,  $p < 0.01$ ; 2 week  $-37 \pm 17\%$ ,  $p = 0.01$ ), compared to baseline. Total UbP levels were reduced also 3 days post exercise ( $-16 \pm 16\%$ ;  $p < 0.01$ ). We did not observe any changes in UbF. Cytoskeletal levels of MuRF1 increased 1 hour after BFR in both training weeks (1 week  $87 \pm 62\%$ ,  $p < 0.01$ ; 2 week  $84 \pm 67\%$ ,  $p < 0.01$ ), but did not change in other fractions. FOXO3a levels were reduced in the nuclear fraction on the fourth day of BFR ( $-36 \pm 18\%$ ,  $p < 0.01$ ) and in the rest week ( $-25 \pm 30\%$ ,  $p = 0.01$ ). MFA of type I fibers was significantly increased post intervention ( $19 \pm 20\%$ ,  $p < 0.01$ ), and it was significantly higher than in type II fibers where only a tendency towards an increase was observed ( $12 \pm 20\%$ ,  $p = 0.051$ ). Muscle thickness of m. vastus lateralis was significantly increased after the intervention ( $5.1 \pm 5.5\%$ ,  $p < 0.01$ ) and 1RM in knee extension increased with  $6 \pm 2\%$  ( $p < 0.01$ ). **DISCUSSION** Two blocks of high frequency BFRRE affected several markers of the ubiquitin-proteasome pathway. Reduced ubiquitination of proteins could indicate either reduced protein breakdown or an increased efficiency of the proteasome system to degrade ubiquitinated proteins. The translocation of MuRF1 to the cytoskeleton 1 hour after BFR, may suggest an interaction with titin. Furthermore, reduced FOXO3a levels in the nuclear fraction indicates dampened activity during the BFRRE intervention. Interestingly, the muscle growth was more pronounced in type I than type II fibers. **REFERENCES** 1Nielsen JL et al. J Physiol 590: 4351-4361, 2012 **CONTACT** thomas.bjornsen@uia.no

**DETRAINING-INDUCED ALTERATIONS IN ADIPOKINES AND CARDIOMETABOLIC RISK FACTORS AFTER RESISTANCE AND AEROBIC INTERVAL TRAINING IN MEN WITH OBESITY**

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**Introduction** Evidence supports that exercise training reduces cardiometabolic risk factors especially in obese men (Beavers et al. 2010; Nikseresht et al. 2014b; Nikseresht et al. 2014a), but there is limited research directly comparing different kinds of exercise training. The study aimed to investigate responses of selected markers of adipokines and cardiometabolic risk in obese men during exercise training and detraining. **Methods** Age- and fitness-matched obese men were allocated to nonlinear resistance training (NRT,  $n=12$ , 55-minute of weight training with flexible periodization), aerobic interval training (AIT,  $n=10$ , treadmill working with 4 sets 4-minute at 80-90% HRmax) and control (CON,  $n=11$ ) groups. The training groups performed 3 sessions per week for 12-week followed by a 4-week detraining period. **Results** Serum retinol-binding protein-4 (RBP-4), interleukin-18 and omentin-1 levels did not significantly change after training compared with CON. No significant changes in RBP-4 occurred in training groups after detraining, but omentin-1 only with AIT ( $-64\%$ ,  $P=0.002$ ) and IL-18 only with NRT ( $+53\%$ ,  $P=0.04$ ) worsened significantly. High-density lipoprotein cholesterol (HDL-C) improved significantly after AIT ( $+10\%$ ,  $P=0.014$ ) compared with CON, and returned to the pre-training values after detraining. Apelin-13 increased significantly after training (AIT= $+10\%$ , NRT= $+11\%$ ;  $P < 0.02$ ) when compared to baseline levels, but this variable remained significantly above pre-training values after detraining. **Discussion** It seems that the 2 exercise programs are beneficial overall (e.g. all improvements listed above) but AIT is the only one that had some effects on one (HDL-C) of the lipid profiles, which has been shown to reduce coronary heart diseases risk. Also, detraining in both training programs had comparable results (except for IL-18). Thus, it is suggested that the training programs (especially with NRT) should not be discontinued to prevent future cardiovascular events.

**HIGH INTENSITY INTERVAL TRAINING (HIIT) IMPROVES BIOLOGICALLY ACTIVE TESTOSTERONE COMPARED WITH MODERATE CONDITIONING EXERCISE IN LIFELONG SEDENTARY AGING MEN.**

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**Introduction** Testosterone is an important biological hormone which displays a precipitous decline with advancing age. There is a pervasive belief that serum testosterone is favorably affected following short-term (Hayes et al., 2015) and lifetime exercise (Ari et al., 2004) in aging cohorts. The present study examined whether serum testosterone was altered following six weeks of high intensity interval training (HIIT) in a group of 22 lifelong sedentary (SED;  $62 \pm 2$  years) compared with 17 lifetime exercising (LEX;  $60 \pm 5$  years) aging men. We further examined the incidence of androgen deficiency in SED and LEX during the intervention. **Methods** Total testosterone (TT), sex hormone binding globulin (SHBG), bioavailable testosterone (bio-T), and free testosterone (free-T) were sampled at phase A (baseline), phase B (following low/moderate intensity conditioning exercise), and phase C (following HIIT). Blood was sampled by venepuncture from an antecubital forearm vein and subsequently analysed by electrochemiluminescent immunoassay. **Results** No difference between groups were observed for TT, SHBG, bio-T, or free-T at phase A, B, or C ( $P > 0.05$ ). TT increased in SED from phase A to B ( $P=0.007$ ), and remained elevated at phase C compared to phase A ( $P < 0.001$ ). No difference in TT existed between phase B and C ( $P=0.135$ ). TT in LEX was un-

changed from phase A to B ( $P=1.000$ ), but greater at phase C compared to phase A ( $P=0.01$ ). Free-T in SED remained unchanged from phase A to B ( $P=0.102$ ), and B and C ( $P=0.185$ ). However, free-T was elevated at phase C compared to phase A ( $P=0.023$ ). There was no change in free-T from phase A to B ( $P=0.874$ ), B to C ( $P=0.099$ ), or A to C ( $P=0.063$ ) in LEX. Incidence of androgen deficiency ( $TT < 11.3 \text{ nmol/L}$ ) was greater in SED than LEX at phase A ( $P=0.043$ ). There was no alteration in androgen status from phase A, to B, to C in either group. Discussion Present data indicate significant changes to TT following moderate intensity exercise in SED, and following HIIT in LEX. However, the biological significance of these changes were largely negated since concomitant increases in SHBG contrived to abrogate change to free-T, leaving only a small increase in free-T following HIIT. In conclusion, moderate conditioning exercise does not alter biologically active free-T concentrations whereas subsequent HIIT improves free-T in lifelong sedentary aging men. As such, SHBG should be measured as an adjunct to TT related research in similar aging cohorts. References Ari Z, Kutlu N, Uyanik BS, Taneli F, Buyukyazi G, Tavli T. Serum testosterone, growth hormone, and insulin-like growth factor-1 levels, mental reaction time, and maximal aerobic exercise in sedentary and long-term physically trained elderly males. *International Journal of Neuroscience*. 2004;114(5):623-37. Hayes LD, Sculthorpe N, Herbert P, Baker JS, Spagna R, Grace FM. Six weeks of conditioning exercise increases total, but not free testosterone in lifelong sedentary aging men. *Aging Male*. 2015;18(3):195-200.

## CHARACTERISATION OF PHYSICAL ACTIVITY, FUNCTIONAL FITNESS AND BODY COMPOSITION IN YOUNG SURVIVORS OF CHILDHOOD BRAIN CANCER AND CRANIAL RADIOTHERAPY.

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Recent studies indicate that within 17 years of diagnosis 62% of childhood brain cancer and cranial radiotherapy (CRT) survivors will develop at least one chronic health condition (Oeffinger et al., 2006). Regular exercise improves body composition, musculoskeletal, cardiopulmonary and cardiovascular function, hence decreasing overall likelihood of developing chronic disease. Therefore, this study aimed to characterise physical activity levels, anthropometry, body composition and cardiovascular, musculoskeletal and vascular function in young survivors. Nineteen survivors (9 male, 10 female; age: males  $19 \pm 3$  y, females  $20 \pm 2$  y) were compared with matched controls. Physical activity levels were assessed using Actical accelerometers worn for seven days. Muscular strength, muscular endurance, aerobic capacity ( $\text{VO}_{2\text{peak}}$ ) and anthropometry were assessed according to standard guidelines. Blood pressure and heart rate (HR) measurements were taken at the conclusion of a 20 minute rest period. Body composition was determined using dual x-ray absorptiometry. Cancer survivors were significantly less active than controls, spending an average of 76.8% of the day being sedentary and 15.8 min participating in moderate intensity physical activity. Further, survivors recorded lower muscular strength (lateral pull-downs,  $p=0.026$ ; bicep curls right-arm,  $p=0.006$ , left-arm,  $p=0.012$ ), muscular endurance (squats,  $p=0.007$ ; sit-ups,  $p=0.011$ ; push-ups,  $p=0.008$ ) and  $\text{VO}_{2\text{peak}}$  values ( $\text{L}\cdot\text{min}^{-1}$ ,  $p=0.002$ ;  $\text{ml}\cdot\text{kg}^{-1}\cdot\text{min}^{-1}$ ,  $p=0.009$ ). Survivors had higher resting HR ( $p=0.030$ ) and were shorter ( $p=0.002$ ) than controls. They also had higher percentages of total body fat ( $p=0.013$ ), android fat ( $p=0.003$ ) and gynoid fat ( $p=0.023$ ), and experienced deficits in total lean body mass ( $p=0.006$ ), total bone mineral content ( $p=0.000$ ) and total bone mineral density ( $p=0.007$ ). This study demonstrates that survivors of childhood brain cancer and CRT engage in less physical activity, have altered body composition and experience muscular weakness and aerobic deficiency. This is important as long-term inactivity not only exacerbates physical performance limitations but can induce the development of risk-factors that predispose survivors to chronic health conditions (Florin et al., 2007). Florin, T. A. et al., 2007. *Cancer Epidemiology Biomarkers & Prevention*, 16, 1356-63. Oeffinger, K. C. et al., 2006. *The New England Journal of Medicine*, 355, 1572-82.

## VERIFICATION OF THE LACTATE-TURN-POINT DETERMINATION BY MEANS OF CONSTANT-LOAD BICEPS CURL EXERCISE

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Introduction Resistance training is regulated by %1-repetition max (1RM) weight, number of reps and sets. In endurance sports, turn points (TPs) are a "gold standard" for exercise prescription (Tschakert & Hofmann, 2013) also described for resistance exercise (Maté-Muñoz et al., 2015). Aim of our study was to determine the first (LTP1) and the second (LTP2) lactate TPs during an incremental resistance exercise test (IET) and to verify these TPs by constant-load tests (CLT). Methods 12 subjects (age:  $24.8 \pm 3.1$  yrs.; height:  $181.4 \pm 7.3$ ; body mass:  $76.0 \pm 8.1$  kg) performed a one-arm biceps curl IET after a 1RM test to calculate the step rate for the IET ( $1\text{RM}/45$ ). After warm-up (3 min) workload was increased every min (30 reps/min) until maximum. LTP1 and LTP2 were determined by linear regression break point analysis. To verify the TPs CLTs were performed 5% Pmax IET below and above each TP. These tests were performed in the same way than the IET until the target load was reached and then kept constant for 30 min. Heart rate (HR), blood lactate concentration (La) and gas exchange variables were measured. Results Peak load in the IET was  $5.3 \pm 0.9$  kg ( $\text{Lamax}$ :  $2.20 \pm 0.40$  mmol/l;  $\text{HRmax}$ :  $135 \pm 15$  b/min;  $\text{VO}_{2\text{max}}$ :  $1.15 \pm 0.30$  l/min). LTP1 was detected at  $1.9 \pm 0.6$  kg ( $\text{La}$ :  $0.86 \pm 0.36$  mmol/l;  $\text{HR}$   $90 \pm 13$  b/min;  $\text{VO}_2$ :  $0.50 \pm 0.05$  l/min) and LTP2 at  $3.8 \pm 0.7$  kg ( $\text{La}$ :  $1.38 \pm 0.37$  mmol/l;  $106 \pm 10$  b/min;  $\text{VO}_2$ :  $0.62 \pm 0.11$  l/min). CLT showed La steady state in all tests except CLE above LTP2. Delta-La (rest-30min) were found at  $-0.17 \pm 0.27$  mmol/l below LTP1, at  $0.13 \pm 0.41$  mmol/l above LTP1, at  $0.79 \pm 0.72$  mmol/l below LTP2, and  $1.36 \pm 0.63$  mmol/l above LTP2 with an early termination of the test at  $16.5 \pm 9.1$  min. Discussion It was possible to determine LTP1 and LTP2 during a one-arm biceps curl IET similar to cycle ergometer IET (Tschakert & Hofmann, 2013). The CLE around the TPs validated the three phase concept for cardiorespiratory and metabolic variables and a steady state was found in all tests except above LTP2. Subjects had to stop exercise because of muscular fatigue and/or non steady state La. These results showed that the tree-phase model (Tschakert & Hofmann, 2013) is also applicable for resistance training. References Maté-Muñoz, J. L., Domínguez, R., Barba, M., Monroy, A. J., Rodríguez, B., Ruiz-Solano, P., & Garnacho-Castaño, M. V. (2015). *J Sports Sci Med*, 14(3), 648–656. Tschakert, G., & Hofmann, P. (2013). *Int J Sports Physiol Perform*, 8(6), 600–610. Contact florian.spendier@edu.uni-graz.at, peter.hofmann@uni-graz.at

## EFFECTS OF RESISTANCE TRAINING ALONE OR COMBINED WITH NUTRITIONAL SUPPLEMENTATION AND COGNITIVE TRAINING ON CHRONIC LOW-GRADE INFLAMMATION OF OLDER ADULTS

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Introduction Ageing, inactivity and obesity are associated with chronic low-grade inflammation contributing to a variety of lifestyle-related diseases. While it is generally accepted that aerobic exercise exerts beneficial effects on several aspects of immune function even in older

adults, the effect of resistance training remains unclear [1,2]. The aim of this study was to investigate whether a long-lasting progressive resistance training (6 months) with or without nutritional supplementation (proteins and vitamins) would influence circulating C-reactive protein (hs-CRP), interleukin-6 (IL6) and the anti-inflammatory interleukin-1 receptor antagonist (IL1ra). Methods Older adults (n= 117, 14 men and 103 women, age: 65.0 - 97.4 years, BMI: 18.1 - 50.0 kg/m<sup>2</sup>) were randomly assigned to one of the 3 intervention groups: resistance training (RT), RT plus nutritional supplement (FortiFit, Nutricia) (RTS) or cognitive training (CT) [3]. All three groups met twice a week for 6 months. Physical performance (6-minute walk test (6MWT), handgrip strength and chair stand test) as well as biochemical analyses were performed at baseline and after 3 and 6 months. Circulating hs-CRP, IL6 and IL1ra were measured by high sensitive ELISA kits. Statistical differences between groups were detected by Kruskal-Wallis test, whereas time effects were assessed by Friedman test. Results While similar improvements in RT and RTS were observed for chair stand test (RT: p=0.001; RTS: p=0.003) and 6MWT (RT: p=0.021; RTS: p= 0.015, we did not observe any alterations in hs-CRP, IL6 or IL1ra (p>0.05). However, chair stand performance at baseline correlated negatively with hs-CRP (•= -0.201, p=0.030) and IL6 (•= -0.203, p=0.043), while 6MWT was associated with hs-CRP (•= -0.230, p=0.021). The percentage body fat (27.3 ± 9.0%) and negatively with hs-CRP (•= 0.273, p=0.006) and negatively with IL1ra (•= -246, p=0.016). Discussion Results from this study suggest that RT does not affect the chronic inflammatory state of older adults, although a better physical fitness is associated with lower levels of hs-CRP and IL6. As body fat, and especially visceral fat, is an important source of pro-inflammatory mediators [4], it needs to be proven whether RT would influence chronic inflammation when combined with a weight management programme. References [1] Mathur N & Pedersen BK (2008). *Mediators Inflamm* 2008;109502. [2] Calle MC & Fernandez ML (2010). *Nutr Res Pract* 4(4):259-269. [3] Oesen S, et al (2015). *Exp Gerontol* 72:99-108. [4] Han JM & Levings MK (2013). *J Immunol* 191(2):527-532.

## EFFECT OF PRECONDITIONING EXERCISE ON MUSCLE BEHAVIOUR DURING MAXIMAL ELBOW FLEXOR ECCENTRIC CONTRACTIONS

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Introduction Performing 30 low-intensity eccentric contractions (1) or two maximal voluntary isometric contractions at a long muscle length (2) attenuates changes in indirect markers of muscle damage after 30 maximal eccentric contractions of the elbow flexors. However, the mechanisms underpinning this preconditioning effect are unknown. A recent study (3) showed that changes in the magnitude of biceps brachii distal myotendinous junction displacement (MTJd) over sets were smaller in the second than the first maximal eccentric exercise of the elbow flexors. The present study investigated the hypothesis that performing 30 low-intensity eccentric contractions or two maximal isometric contractions would change MTJd during maximal eccentric contractions. Methods Healthy untrained young men were randomly placed (n=13/group) to a control group that performed 5 sets of 6 maximal elbow flexor eccentric contractions (MaxEC) with the non-dominant arm, or one of two preconditioning groups that performed either 30 low-intensity (10% of maximal voluntary isometric contraction strength) eccentric contractions (10%EC) or 2 maximal voluntary isometric contractions at 20 degree elbow flexion (2MVIC) 2 days before MaxEC with the non-dominant arm. MTJd was assessed by B-mode ultrasound longitudinal images recorded during MaxEC, and its changes over sets were compared among the groups. Changes in several indirect muscle damage markers [e.g. maximal voluntary concentric contraction torque (MVC-CON), range of motion (ROM), muscle soreness] before, immediately after, and 1-5 days after eccentric exercise were also compared among the groups by a mixed-design two-way ANOVA. Results MTJd changes in the first MaxEC set were similar among the groups (7.18 ± 0.20 mm), but the changes over sets were smaller (P<0.05) for the 10%EC [e.g. 5th set: 7.18 ± 0.60 mm) and 2MVIC (6.90 ± 0.60 mm) groups than the control group (7.70 ± 0.80 mm). The 10%EC and 2MVIC groups showed smaller (P<0.05) changes in all muscle damage markers after MaxEC than the control group, without a significant difference in the changes between the 10%EC and 2MVIC groups. Discussion These results confirmed the previous studies (1,2) showing that 10%EC and 2MVIC performed 2 days prior to MaxEC attenuated muscle damage after MaxEC. The magnitude of muscle length changes over sets in MaxEC was reduced when 10%EC and 2MVIC were performed prior to MaxEC, supporting the hypothesis. It appears that the smaller MTJd over sets during MaxEC is a possible mechanism underpinning the protective effect conferred by the precondition exercises. References 1)Chen et al. (2012) *Eur J Appl Physiol*, 112:555-65 2)Chen et al. (2013) *Eur J Appl Physiol*, 113:1545-54 3)Lau et al. (2015) *AJP*, 308:R879-86 Contact: angel65022@yahoo.com.tw

## EFFECTS OF ELECTROSTIMULATION WITH BLOOD FLOW RESTRICTION ON MUSCLE CONTRACTILE PROPERTIES

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Introduction Neuromuscular electrostimulation (NMES) is well known for its potential as a strength training tool for healthy subjects and athletes among a wide range of applications. Some studies have recently used the NMES combined with blood flow restriction (BFR) to induce muscle hypertrophy and strength gain. However, the effects of this technique on muscle contractile properties are unknown. The purpose of this study was to investigate the effects of NMES combined with BFR on muscle contractile properties and peripheral fatigue assessed by tensiomyography (TMG). Methods The motor point of the vastus medialis was determined in nine physically active men (age: 23.0±3.8 years, height: 178.1±5.8 cm, body mass: 71.9±3.9 kg) and electrodes were placed on both legs to apply a NMES protocol and to conduct TMG measurements. One leg was randomly selected to apply BFR combined with the NMES protocol, while the other leg had free blood circulation. A cuff was placed on the BFR leg at groin level and inflated to 300 mmHg for 5 minutes to reduce muscle oxygen considerably before NMES was applied. Immediately after 5 minutes, NMES was concurrently applied on both legs. The protocol consisted of 5 cycles of 72 seconds (1s on, 1s off), with a total of 36 contractions per cycle. Frequency was established at 40Hz and intensity was set at individual tolerable limit. Rest between cycles was 40 seconds. Measurements of TMG (Dm: maximum displacement; Td: delay time; Tc: contraction time) were taken before the NMES protocol (PRE), 30 s after each NMES cycle (NMESn). A muscle oxygen saturation monitor was placed on the vastus lateralis. Results Muscle oxygen saturation (OXY) stayed below 5% during the whole NMES protocol. Dm decreased gradually along the NMES protocol. It was significantly lower in NMES2,3,4,5 compared to PRE (4.43±1.41mm, 4.19±1.81mm, 4.08±1.94mm, 3.98±1.83mm, respectively vs 7.56±1.65mm, p<0.05). On the contrary, Td increased with the NMES protocol. It was significantly higher in NMES2,3,4,5 compared to PRE (30.55±6.22ms, 34.42±6.22ms, 34.87±9.41ms, 35.68±10.27ms, respectively vs 23.94±1.86ms, p<0.05). Tc did not change significantly. Conclusion The decrease in Dm after the NMES protocol suggests an inability to activate muscle fibers. Besides, the increase in Td suggests lower muscle excitability. Both facts together are related to worse muscular contraction capabilities. Therefore, we can conclude that the combination of a NMES protocol combined with BFR induces higher peripheral fatigue and further impairment of the muscle contraction capabilities. Contact rocio@sport-science.net

**THE EFFECT OF THE ORDER OF CONCURRENT TRAINING ON MUSCLE HYPERTROPHY**

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**Introduction** In many sports, athletes have to show maximum performance during competitions. Therefore, they want to improve energy supply by many ways of energy metabolic mechanism. Much has been studied on the differences in training methods whether those can improve endurance, muscular strength together. Aerobic training increases slow-twitch muscle fiber which causes the body adaptation suitable for the movement to be long-lasting. Resistance training which causes muscle hypertrophy and increase strength. Therefore, there is a conflict of body adaptation caused by differences in the respective training. Concurrent training is one of the training methods to be performed in combination with endurance and resistance training. In this study, we analyzed the change in signals for muscle hypertrophy by the difference of the order of concurrent training. **Methods** 7 weeks of age male DDY mice were divided into 3 groups: control (con), endurance before resistance (EE-RE), endurance after resistance (RE-EE). After 3-week training, mice were sacrificed and plantaris muscles were dissected out quickly from each mouse for subsequent analyses. **EE-protocol** The mice were familiarized with running on a rodent treadmill at 10–20 m/min for 3 days prior to the experiment. Subsequently, they were placed on a flat treadmill and made to run for 30 min at a speed of 20m/min. **RE-protocol** The mice were positioned with their foot on a footplate (the ankle joint angle was positioned at 90°) in the prone posture. The triceps calf muscle was stimulated percutaneously with electrodes which were connected to an electric stimulator and isolator. The gastrocnemius muscle was isometrically exercised (3-s stimulation 10 contractions, with a 7-s interval between contractions, for 5 sets with 3-min inter set intervals). The voltage (30 V) and stimulation frequency (100 Hz) were adjusted to produce maximal isometric tension. **Results** After 3-week training, there were no significant difference in body weight and gastrocnemius wet weight between those of EE-RE, RE-EE and control groups. Using Western blot, we analyzed the change in signal molecules. P70S6K and S6 phosphorylation were significantly increased in RE-EE group compared with control group. S6 phosphorylation of EE-RE group also increased, but not significant. We could not find the difference due to the order of concurrent training was not observed. **Discussion** We found concurrent training promoted muscle protein synthesis. Concurrent training, especially protocol with resistance training before endurance training, it was suggested to promote hypertrophy more efficiently. **Contact** Tennodai 1-1-1, Tsukuba, Ibaraki, 305-8574 Japan Tel : +98-53-2622 E-mail takemasa@taiiku.tsukuba.ac.jp

**INFLUENCE OF A STRENGTH TRAINING PROGRAMME ON BALANCE CONTROL IN OLDER ADULTS**

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**Introduction** Maximal force of the ankle plantar flexor (PF) muscles plays a key role in postural control (1). The decrease in maximal PF force with ageing should therefore contribute to alter balance steadiness in this age group (4). However, some studies reported only modest effects of a strength training programme on bipedal balance control in older adults (3). This may reflect the fact that bipedal upright stance does not require a high level of PF force (4). The purpose of this work was to study the effect of a 6-month strength training programme on the steadiness of upright standing in bipedal and one leg stance in older adults. **Methods** Forty-one older adults (>60 yrs) completed the study. One group (n=21) performed strength training (2 sessions/week) of lower limb muscles for 24 weeks and the other 20 subjects composed a control group. The maximal torque of PF and dorsiflexors (DF) was assessed during maximal voluntary contractions (MVC) performed in isometric condition. The mean centre of pressure (CoP) velocity, forward-backward maximal amplitude (F-Bmax), and standard deviation (F-Bsd) of CoP were analysed while subjects stood upright on a force platform on one or two legs. The surface electromyogram (EMG) of different leg muscles were also recorded. **Results** The MVC torque produced by the PF and DF muscles increased ( $p<0.05$ ) after the training programme by 32 % and 17%, respectively. The F-Bmax and F-Bsd in the sagittal plan decreased during one leg stance (-11% and -7%, respectively;  $p<0.05$ ), whereas no change was observed during bipedal stance. The PF EMG decreased ( $p<0.05$ ) after training during one leg (-16%) and bipedal (-7%) upright standing. The decrease in CoP mean velocity (-11%) was correlated with the increase in MVC torque of the DF ( $r^2=0.47$ ;  $p<0.001$ ) and the decrease in tibialis anterior EMG ( $r^2=0.22$ ;  $p<0.05$ ) during one leg stance. **Discussion** In agreement with our hypothesis, strength training of lower limb muscles increased upright standing steadiness only when performed on one leg. Furthermore, the relation between the decrease in tibialis anterior EMG and the CoP mean velocity suggests that reducing the activity of ankle DF muscles may help controlling upright standing, by improving its role in providing relevant proprioceptive information (2). These results indicate that strength training should be included in fall prevention programmes to improve balance control in more demanding physically daily activities. **References** 1.Billot et al. (2010). Eur J Appl Physiol.109:669-80 2.DiGiulio et al. (2009). J Physiol.587:2399-416 3.Orr et al. (2008). Sports Med.38:317-43 4.Vandervoort & McComas (1986). J Appl Physiol.61:361-7 Severine.Stragier@ulb.ac.be

**Mini-Orals****MO-BN02 Cycling****ESTIMATION OF THE TRUNK MUSCLE FORCE IN BICYCLE PEDALING USING AN INVERSE DYNAMICS COMPUTATION.**

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**Introduction:** In order to evaluate bicycle pedaling skills, it is important to describe the use of the trunk muscles of the subject, such as iliocostalis muscle and major psoas muscle (hip flexors) which is related to the role to lift the lower extremities. We have developed a device that can easily and accurately measure crank angular velocity (1); however, few studies have shown a relationship between pedaling skills (or pedaling effectiveness) and the force of the trunk muscles during the bicycle pedaling. Accordingly, estimation of trunk muscle force during the pedaling may be beneficial for pedaling skills training. In this study, we therefore intended to estimate the trunk muscle force using actually measured value of the pedaling force for inverse dynamics computations in bicycle pedaling. **Methods:** We use reacting force of the bicycle (pedal force, saddle force and handle force), and pedaling action (pedaling posture, crank angle), obtained from a measurement system. And surface muscle force using electromyogram (EMG) was used in order to evaluate the accuracy of the computations. A participant was given the pedaling load (100W and 250W) by bicycle trainer, with specified cadence (60rpm, 90rpm).



Using crank angle obtained from the measurement system, the reacting forces of the bicycle and EMG signals were averaged at crank angle (every 5 degree) at each pedaling condition. Results & discussions: Using the averaged value of pedal force and pedaling action data vary with crank angle, inverse dynamics calculations have been performed by commercially available software (AnyBody). The saddle and handle force was not used for calculations, because it was difficult to take in. Since the freedom of pedaling motion remains, it is necessary to define the constraint condition of pedaling motion in the calculation. Moreover, calculation result was sometimes become unstable. As a result, calculated muscle activity changes can be compared with measured EMG values. However, these values did not match so well. Acknowledgments: This research was supported in part by JSPS KAKENHI Grant-in-Aid for Scientific Research (C), 25350763. References: (1) Tomoki Kitawaki & Hisao Oka A measurement system for the bicycle crank angle using a wireless motion sensor attached to the crank arm J Sci Cycling. Vol. 2(2), 13-19 Contact kitawaki@hirakata.kmu.ac.jp

## EFFECTS OF INSPIRATORY MUSCLE TRAINING ON VENTILATORY EFFICIENCY AND CYCLING PERFORMANCE

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**Introduction** It is well known that inspiratory muscle training (IMT) can improve performance in endurance athletes. However, the mechanisms responsible for these performance improvements remain unclear. Ventilatory efficiency might on factor potentially explaining these improvements (Sheel, 2002). The aim of this study was to investigate the influence of IMT on ventilatory efficiency and cycling performance. **Methods** Eight male and eight female subjects ( $\text{VO}_{2\text{max}}$ ;  $47.07 \pm 5.64 \text{ ml}\cdot\text{kg}^{-1}\cdot\text{min}^{-1}$ ) were randomly assigned to the inspiratory muscles training group, (IMTG,  $n=9$ ) or the control group (CG,  $n=9$ ). Both groups performed an incremental cycle test to exhaustion with respiratory gas analysis, a peak inspiratory pressure test (Pimax) and performed a 10-min time trial (TT) before and after a 6-week lasting inspiratory muscle training period. The IMTG performed 60 IMT sessions, consisting of 30 breathing repetitions with a PowerBreathe® device at 50%Pimax, 2 times per day, 5 days per week. The control group performed the same breathing training without applying any resistance. The Pimax and training load was checked each week. **Results** Pimax, TT and peak power output (PPO) improved significantly within the IMTG ( $p<0.05$ ). The  $\text{VE}/\text{VCO}_2$  slope, ventilatory equivalent of  $\text{CO}_2$  ( $\text{VE}/\text{VCO}_2$ ) and  $\text{VO}_{2\text{max}}$  remained unchanged after the 6-week training period in both groups. Interaction effect was found between groups (group  $\times$  time) in Pimax and TT after IMT. Significant correlations were found between Pimax, TT and PPO in both groups ( $r=0.869$ ,  $p<0.001$ ;  $r=0.873$ ,  $p<0.001$ ). **Discussion** Results are in accordance with previous work which demonstrated that IMT improved time trial cycling performance (Romer, McConnell, & Jones, 2002). However, our findings do not confirm the hypothesis that these improvements would be related to changes in ventilatory efficiency. Apparently the IMT is not able to modify the control of breathing and thus promoting more efficient breathing patterns. The sensitivity of the peripheral chemoreceptors seems not to be modified by the improvements in breathing muscle strength after IMT. Unchanged  $\text{VE}/\text{VCO}_2$  values at the second ventilatory threshold indicate that the mechanical ventilatory efficiency was unaffected after IMT. Therefore, it is conclude that improvements in cycling time trial performance are not related to changes in ventilatory efficiency. However, our results suggested that the improvement in cycling performance might be related to improvements in breathing muscle strength. **References** Romer, L. M., McConnell, A. K., & Jones, D. A. (2002). Inspiratory muscle fatigue in trained cyclists: effects of inspiratory muscle training. *Medicine and science in sports and exercise*, 34(5), 785-792. Sheel, A. W. (2002). Respiratory muscle training in healthy individuals. *Sports Medicine*, 32(9), 567-581.

## CEREBRAL OXYGENATION DURING GRADED CYCLING TO EXHAUSTION IN WOMEN USING ORAL CONTRACEPTIVES

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**Introduction** Reduced maximal oxygen uptake ( $\text{VO}_{2\text{max}}$ ) has been reported in women using oral contraception (WomenOC) when compared to normally-menstruating women (WomenNM; Casazza et al. 2002; Joyce et al. 2013). A reduction in cerebral oxygenation during severe-intensity exercise has been associated with exercise exhaustion (Oussaidene et al. 2013) and may pose as a potential mechanism for the reduced  $\text{VO}_{2\text{max}}$  observed in WomenOC. The aim of the present study was to investigate the effects of long-term use of oral contraceptives on frontal cortex oxygenation (i.e., cerebral oxygenation) during graded cycling to exhaustion in recreationally-active women. **Methods** Eight WomenOC and eight WomenNM performed a graded-cycling test to exhaustion to determine  $\text{VO}_{2\text{max}}$  ( $\text{VO}_{2\text{max}}$  test) and lactate threshold 1 and 2 (LT1 and LT2). Left pre-frontal cortex oxygenation was monitored by near-infrared spectroscopy (NIRS) through concentration changes in oxy-, deoxy-, and total haemoglobin (HbO<sub>2</sub>, HHb and tHb, respectively), along with an index of pre-frontal tissue saturation (TSI). Pulmonary gas exchange was measured throughout the  $\text{VO}_{2\text{max}}$  test using open circuit spirometry. **Results**  $\text{VO}_{2\text{max}}$  was not different between the two groups (WomenNM:  $2.67(0.56) \text{ L/min}$ ; WomenOC:  $2.69(0.47) \text{ L/min}$ ;  $p = 0.83$ ). HbO<sub>2</sub> was lower in WomenOC at rest; yet, the rate and magnitude of increase in HbO<sub>2</sub> from the onset of exercise to LT1 were greater in WomenOC compared to WomenNM. At a work rate equal to that achieved at LT2, TSI declined for both groups, and all measures of cerebral oxygenation were similar between groups at exhaustion ( $p>0.05$ ). **Discussion** When matched for  $\text{VO}_{2\text{max}}$ , we observed different patterns of increase in cerebral oxygenation during graded cycling to exhaustion in WomenOC compared to WomenNM. However, there was no evidence of impaired cerebral oxygenation during severe-intensity exercise in either group. The suppression of 17 $\beta$ -estradiol and progesterone, as well as the elevation of ethinyl-estradiol and progestin associated with oral contraceptive use does not appear to affect cerebral hemodynamics during graded cycling. **References** Casazza, G., Suh S., Miller, B., Navazio, F., & Brooks, G. (2002). *J Appl Physiol*, 93, 1698-1702. Joyce, S., Sabapathy, S., Bulmer, A., & Minahan, C. (2013). *J Strength Cond Res*, 27(7), 1891-1896 Mendelsohn, M. (2002). *Am J Cardiol*, 90(1) F3-F4 Oussaidene, K., Prieur, F., Bougault, V., Borel, B., Matram, R., & Mucci, P. (2013). *Eru J Appl Physiol*, 113(8), 2047-2056 Contact k.quinn@griffith.edu.au

## HOW ACCESS TO AN E-BIKE AFFECTS AMOUNT AND PATTERNS OF BICYCLE USE IN INACTIVE NORWEGIAN ADULTS: A PILOT STUDY.

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**Introduction** Electric assisted bicycles (E-bikes) have become increasingly popular worldwide during the last decade. Bicycle use with an E-bike (E-biking) may be categorized as a physical activity of moderate intensity. Few studies have examined whether access to an E-bike influence bicycle use and fitness. The aims of the present study were to assess the effect of an eight-month intervention with access to an E-bike on (1) the amount of E-biking and (2) assess whether E-biking is associated with changes in maximal oxygen uptake ( $\text{VO}_{2\text{max}}$ ),

among inactive adults. **Methods** Twenty-five inactive Norwegian adults (33 – 57 years of age, 72 % women), who did not cycle or walk to work, were recruited through convenience sampling, in September 2014. Participants were given an E-bike for eight (N = 23) or three (N = 2) months. Prior transportation habits and demographic characteristics were reported with a questionnaire. Bicycle use was measured with GPS bicycle computer (Garmin Edge 500, Southampton, UK). The participants' VO<sub>2</sub> max was directly measured, before and after the intervention, using a modified Balke protocol while walking/running on a treadmill until exhaustion. **Results** At baseline, a large proportion (94 – 100 %) of the participants reported using motorized transport (car or bus) when shopping and during leisure time. During the intervention, participants spent on average 107 ± 62 minutes cycling per week covering 37.6 ± 24 kilometres per week. Distance cycled were significantly (P = 0.035) higher in the fall (47.4 km/week) than in the spring (32.1 km/week). Participants cycled significantly (P = <0.001) more on weekdays (7.1 km/day) compared to weekend days (0.9 km/day). A significant improvement in VO<sub>2</sub> max (7.7 %, P = <0.001) from baseline (34.1 ml/kg/min) to post test (36.4 ml/kg/min) were associated with cycling distance (r = 0.49, P = 0.042). When stratified by cardiopulmonary fitness status at baseline (defined as below or above predicted VO<sub>2</sub> max value), the group with lower fitness had a considerable increase in VO<sub>2</sub> max (9.6 %, P = <0.001) associated with cycling distance (r = 0.64, P = 0.014), while no changes were observed in the group with higher fitness (1.5 %, P = 0.626). **Discussion** Access to an E-bike for eight months resulted in weekly 37.6 km of cycling and average 7.7 % improvements in cardiopulmonary fitness. Cycled distance was positively associated with improvements in cardiopulmonary fitness. E-bikes may contribute to mobilize inactive individuals to initiate transport-related physical activity. Contact lena.h.malnes@gmail.com

### IMPORTANCE OF SLOW COMPONENTS OF HR AND VO<sub>2</sub> KINETICS DURING SUBMAXIMAL CYCLING ON EXERCISE INTENSITY PRESCRIPTION

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**Introduction** Aerobic activities prescription is often based on a linear relationship among pulmonary oxygen consumption (VO<sub>2</sub>) and heart rate (HR) vs. power output. However, it is known that during constant work-rate exercise (CWR) above the gas exchange threshold (GET) the linear relationship between VO<sub>2</sub> and power output is lost and a "slow component" of VO<sub>2</sub> is present (Jones et al. 2011). Something similar seems to occur also for HR (Orizio et al. 1998). The aim of the present study was to test the hypothesis that the slow component of HR kinetics occurs at lower CWR and is more pronounced than the slow component of VO<sub>2</sub> kinetics. **Methods** Nine male (age = 23 ± 2 yr, height = 181 ± 5 cm, mass = 76.5 ± 7.4 kg; VO<sub>2peak</sub> = 52.9 ± 6.2 ml·kg<sup>-1</sup>·min<sup>-1</sup>) well trained subjects performed on a cycle ergometer an incremental test to voluntary exhaustion (to determine VO<sub>2peak</sub> and GET) and 4 CWR in a randomized order: 1) moderate CWR (MOD), at 40 % of VO<sub>2</sub> peak (MOD), 2) heavy CWR (HEAVY), at 25% of the difference between GET and VO<sub>2</sub> peak (25% Δ), 3) severe CWR (SEVERE) at 75% Δ; 4) work rate was continuously adjusted to maintain a HR constant at a value corresponding to that determined at GET (HRGET). Breath-by-breath VO<sub>2</sub>, heart rate (HR) and cardiac output (CO) were recorded during all tests and blood lactate concentration ([La-]) was measured at rest and after exercise. **Results** In MOD: end-exercise VO<sub>2</sub> was 2.036 ± 0.075 L·min<sup>-1</sup> and VO<sub>2</sub> Kinetics followed a monoexponential function; HR reached 135 ± 16 beats·min<sup>-1</sup> and its kinetics was described by a biexponential model, with the slow component amplitude corresponding to 27.4 ± 5.6% of the total response. During HEAVY a biexponential model was described for both VO<sub>2</sub> and HR kinetics, reaching 4.145 ± 0.542 L·min<sup>-1</sup> with a slow component of 26.4 ± 9.2 % and 187 ± 5.6 beats·min<sup>-1</sup> with a slow component of 28 ± 14 %, respectively. In SEVERE no steady state was achieved, and VO<sub>2</sub> and HR continued to rise with time (VO<sub>2</sub> = 4.225 ± 0.694 and HR = 183 ± 6 beats·min<sup>-1</sup>) with a slow component amplitude of 22 ± 11.9 % and 24.5 ± 6.7 %, respectively. During the HRGET test, both work rate (190 ± 21.8 W) and VO<sub>2</sub> (3.050 ± 0.220 L·min<sup>-1</sup>) had to decrease in order to maintain a constant HR. **Conclusion** As hypothesized, the slow component of HR kinetics occurs at lower work rates and is more pronounced than the slow component of VO<sub>2</sub> kinetics (in order to maintain HR constant at its GET value, both work rate and VO<sub>2</sub> have to decrease). This has important implications in terms of submaximal exercise intensity prescription. **References** Jones AM, Grassi B, Christensen PM, Krstrup P, Bangsbo J, Poole DC, Med Sci Sports Exerc., 2011;43:2046-62 Orizio C, Perini R, Comandè A, Castellano M, Beschi M, Veicsteinas, Eur J Appl Physiol 1998;57:644-51

### EFFECTS OF HIGH INTENSITY INTERVAL CYCLING PERFORMED AFTER RESISTANCE TRAINING ON MUSCLE STRENGTH AND HYPERTROPHY

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**Introduction** Human skeletal muscle has a remarkable ability to adapt to external stimuli such as exercise training. Different exercise modes induce specific muscle adaptations which may however oppose one another. For instance, when low intensity-long duration aerobic exercise is combined with resistance exercise muscle hypertrophy is impeded (Wilson et al., 2012). Aim of the study was to investigate whether high-intensity interval cycling performed immediately after resistance training would inhibit muscle strength increase and hypertrophy anticipated with resistance training per se. **Methods** Twenty-two moderately-trained young men (21.8 ± 0.6 years, body height 177.4 ± 1.5 cm, body mass 74.2 ± 2.1 kg) were assigned into either resistance training per se (RE; N=11; 4 set × 6 RM in leg press and half-squat) or resistance training plus high-intensity interval cycling (REC; N=11; 4 set × 6 RM in leg press and half-squat plus 10 set × 60sec in cycle ergometer, 90-95% HRmax, rest 60sec). Lower body muscle strength, rate of force development (RFD), quadriceps cross sectional area (CSA) and vastus lateralis architecture (with ultrasonography), muscle fiber type composition and capillarization, and aerobic capacity were evaluated before and after 8 weeks of training (2 times/week). **Results** Muscle strength and quadriceps CSA were significantly and similarly increased (p≤0.001) after both interventions. Fiber CSA increased significantly and similarly after both RE (I:13.6±3.7%, II:A:17.6±4.4%, II:X:23.2±5.7%, p<0.05) and REC (I:10±2.7%, II:A:14.8±4.3% II:X:20.8±6%, p<0.05). In contrast, RFD was decreased and fascicle angle was increased (p≤0.05) only after REC. Significant negative correlations were found between the percent change in fascicle angle and the percent change in RFD at 50, 100, 150msec (r = -0.54, -0.474, -0.46; p≤0.03). Muscle capillary density and aerobic capacity were increased (p≤0.05) only after REC. **Discussion** The present findings suggest that high-intensity interval cycling performed after heavy-resistance exercise does not inhibit resistance-exercise induced muscle strength and hypertrophy, while it prompts cardiovascular and local muscle adaptations. However, the addition of high intensity cycling after heavy-resistance exercise may decrease RFD partly due to muscle architectural changes. **References** Wilson JM, Marin PJ, Rhea MR, Wilson SMC, Loenneke JP, Anderson JC. (2012). J Strength Cond Res, 26(8), 2293–2307. Contact e-mail: statsit@phed.uoa.gr

**CYCLING ON A BIKE DESK POSITIVELY INFLUENCES COGNITIVE PERFORMANCE AND BRAIN ACTIVITY**

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**Introduction** Cycling desks as a means to reduce sedentary time in the office has gained interest as excessive sitting has been associated with several health risks. However, the question rises if people will still be as efficient in performing their desk-based office work when combining this with stationary cycling. Therefore, the aim of this study was to assess typing, cognitive performance and brain activity during low-intensity cycling on a bike desk. **Methods** After two familiarisation sessions, 23 adults performed a test battery (typing test, Rey auditory verbal learning test (RAVLT), Stroop test and Rosvold continuous performance test (RCPT)) with electroencephalography recording (N200, P300) while cycling at 30% Wmax (trial A) and while sitting on a conventional chair (trial B), in a counterbalanced order. Repeated measures ANOVA's and Wilcoxon signed ranks test were used to analyse the data ( $p < 0.05$ ). Data are presented as mean  $\pm$  SD. Results Typing performance, performance on the RAVLT and accuracy on the Stroop test and the RCPT did not differ between the cycling and the sitting trial. Reaction times on the Stroop test ( $639.6 \pm 22.5$  ms vs.  $663.1 \pm 24.8$  ms;  $p = 0.01$ ) and the RCPT ( $377.9 \pm 27.7$  ms vs.  $404.3 \pm 36.4$  ms;  $p < 0.001$ ) were shorter while cycling relative to sitting. N200 amplitude during the Stroop test was larger in the cycling than in the sitting condition ( $-2.8 \pm 0.3$   $\mu$ V vs.  $-2.4 \pm 0.3$   $\mu$ V;  $p = 0.028$ ). P300 amplitude during the RCPT was smaller in the anterior prefrontal cortex while cycling compared to sitting ( $2.0 \pm 8.6$   $\mu$ V vs.  $6.6 \pm 4.6$   $\mu$ V;  $p = 0.042$ ). **Discussion and conclusion** This study showed that typing performance and short-term memory are not deteriorated when people cycle at 30% Wmax, compared to when sitting on a conventional chair. In contrast to previous research, in this study, cycling had a positive effect on selective and sustained attention, as evidenced by the improved RTs on the Stroop test and the RCPT. These improvements were supported by the change in N200 during the Stroop test and P300 during the RCPT. The inclusion of familiarisation sessions in the current protocol is a possible explanation for these different findings on measures of sustained and selective attention, as familiarisation trials in previous studies were limited to maximum 15 minutes. The findings of this study suggest that implementing cycling desks in office settings could not only contribute to reducing health risks associated with excessive sitting, but could also result in improved cognitive performance, therefore work performance. Contact Tine.Torbeyns@vub.ac.be

**THE EFFECT OF THE MEDIAL-LATERAL FORCE DURING CYCLING**

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**Introduction** Body movement during cycling is kinematically constrained to the pedal/crank path around the bottom bracket and predominantly occurs in a sagittal plane. This limits cyclists optimising their pedalling technique by applying a force in two directions: vertically and in the anterior-posterior direction. Any medial-lateral force (FML) applied to the pedals is considered a waste and does not contribute to the pedalling. Previous research (Ruby et al., 1992) suggests that there is a certain amount of force that is exerted in the medial-lateral direction, but it remains unclear how this affects force effectiveness calculations and how it is linked to frontal plane kinematics. The aim of this study was to test the hypotheses that 1) FML would affect force effectiveness calculations, 2) FML would be different across different cadences and workloads and 3) FML would correlate with frontal plane kinematics of the leg. **Methods** 22 cyclists completed six testing trials at three different workloads (2, 2.5 and 3 W/kg) and three different cadences (75, 85, 95 rpm). During each trial, uni-lateral pedal forces (Cycling Science, Ltd) and lower extremity 3D kinematics (3D investigator, NDI) were recorded. Force effectiveness was initially assessed by using all three force components and then without the FML component. Relative FML was expressed as the percentage of the maximal value of the total force. The root mean square of the relative FML and absolute FML were used for further analysis. Additionally, cross-correlation coefficients between the Q-angle and relative FML were calculated. Results Index of effectiveness was significantly lower and total force was significantly higher ( $p < .05$ ) under all conditions when the FML component was included in the calculations. Absolute FML was significantly different at different cadences and workloads. There was no significant difference in relative FML across the three cadences. However, there was a significant difference in relative FML at different workloads. Moderate correlation was found between the FML and Q-angle. **Discussion** The results of the present study confirm the hypotheses and demonstrate the importance of the FML in the calculations of the total force applied to the pedals and consequently the index of effectiveness. Furthermore, medial-lateral knee movement could be one of the important factors for FML. This challenges the vast majority of biomechanical studies that examined force effectiveness by neglecting the FML component (Bini et al. 2014). Furthermore, the results demonstrate the importance of the FML for non-traumatic knee injuries. Therefore, future research should use technology that allows measuring all three force components at the pedal. References Bini RR, Diefenthaler F, Carpes F (2014) Int Sport J, 15(1), 96–112. Ruby P, Hull ML, Hawkins D (1992) J Biomech, 25(1), 41–53.

**Mini-Orals****MO-PM40 Training & Testing: Swimming/Tennis****SWIMMING COMPETITION AND THE SLEEPING PATTERN**

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**Introduction** The exercise has since long been recognized as a non-pharmacological strategy for the improvement of the sleep pattern. The type the duration, the intensity and the time of the day in which it's performed may condition changes in sleep pattern. In elite athletes is possible that more time of sleep leads to improvements in mental availability, capacity of reaction and perception of athletes in the state of physical recovery, improving muscle function and performance. Taking into account that the behavior of the human being depends a lot on the sleep-wake cycle, an athlete's performance depends both on the quality and the amount of sleep. **Methodology** Assess a control group consisting of 19 sedentary individuals and an experimental group consisting of 12 swimmers. These were assessed in the week with highest workout load at the end of the first cycle, corresponding to a micro cycle (week) of type impact with 10 workout sessions and a high volume, close to 60.000 meters swam. To all individuals was executed a polysomnography study class 1, which allows the monitoring of a large set of neurological, respiratory, cardiac, muscle and postural parameters, leading to completion

of sleep staging and its concrete knowledge. Results Differences were found in sleep NREM 2, NREM 3 and REM, with the swimmers showing a more shallow sleep (NREM of 53.77% versus 47.12% of sedentary) and the control group with greater amounts of sleep NREM 3 and REM (32.03% and 15.99% versus 27.53% and 11.96% on swimmers). Swimmers also showed less willingness to be in bed and then less sleep time. Sleep efficiency was higher in swimmers, although within the range considered normal in both groups. Conclusion The high level competitive swimmers are subjected to a regular and organized workout, have a lower willingness to sleep than individuals who don't practice sports. Such is due to a too short break between afternoon practice and morning practice. Both groups present normal sleep efficiency values, since athletes have a very high sleep efficiency, which translates into a better use of almost all the time available for sleep. Unlike what is described in other studies our athletes showed less sleep NREM 3 and REM, stages where the physical and cognitive recovery occurs more effectively. We conclude that athletes, on this workout plan are subjected to conditioned recovery indexes, which can jeopardize their performance, being recommended a reorganization of the workout temporality.

## SWIMMING STROKE PARAMETERS AND THEIR EFFECTS ON PERFORMANCE

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Stroke parameters and their effects on performance and efficiency is a subject of swimming studies for a long time. The purpose of this study was to investigate the relationship between stroke rate (SR), stroke count (SC) and performance due to the changes in heart rate (HR) and lactic acid (LA) levels of swimmers during a 4x(4x100m) front crawl (freestyle) main set of three consecutive training days. In this study, 7 male (age = 14.14 ± 1.07) and 4 female (age = 14.00 ± 0.00) international level swimmers were participated. Before the study, swimmers' detailed body analyzes have been taken. For male and female swimmers, height (H = 175.28 ± 4.02; 163.25 ± 5.56), weight (W = 69.94 ± 4.20; 58.97 ± 2.77), body mass index (BMI = 22.77 ± 1.56; 22.15 ± 0.86) and percentage of body fat (PBF = 14.3 ± 7.17; 25.05 ± 2.18) data are obtained (Mean ± Standard Deviation, respectively). During the study, SC (for every 100m), SR (for each 75th.m), HR (for the end of every 100m), 100m-lap-times (for each 100m LAP), LA measurements (for the end of every 4x100m) were measured. Relationship between SR, SC, HR, LAP and LA was calculated using Statistical Package for Social Sciences (SPSS) v. 22.0. A cut of point in all the statistical analyses has been taken as p≤0.05.

## HOW TO CHOOSE DIVE FINS BY USING KNEE STRENGTH

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Introduction In skin diving (SD), three main equipment are mask, snorkel and fins, one of them provides more efficiency propulsion during flutter kick to go forward are fins. Several studies indicate that knee strength(KS) positive increases fin swimming speed, elite kick skill gets more (Abe et al., 2014; Kunitson et al., 2015), but how to choose proper fins to reduce drag and save energy still confuse for most diver. Therefore, the aim of this study was to realize the influence between knee strength and five styles of fins performance in college beginners during 50m SD sprint. Methods Eighteen college beginners used knee extension/curl equipment to measure 1RM knee extension/flexion strength and summed up KS, according to the order assigned to low KS (n= 9; mean, age: 20.33yrs; height:160.06cm; body mass: 63.26kg; body fat: 27.29%; KS: 100.47kg, LKS) and high KS (n= 9; mean, age: 20.44yrs; height:174.08cm; body mass: 74.11kg; body fat: 19.93%; KS: 160.79kg, HKS)groups. Five popular fins, F1 (MARES X-STREAM), F2 (SCUBAPRO TWIN JET MAX), F3 (SCUBAPRO JET SPORT ADJUSTABLE), F4 (SCUBAPRO JET FIN ) and F5(SCUBAPRO SEAWING NOVA GORILLA) were tested 50m SD sprint with balance order in each beginner. Repeat one way ANOVA was applied to analyze those data in LKS and HKS. Results After completed 50m SD sprint with each styles of fins, in LKS, velocities of F1, F2, F3, F4 and F5 were 0.91, 0.94, 0.98, 0.99 and 0.93m/s (F=459.09, P<.01), post hoc tests showed that F4>F1 and F5; F3>F1(P<.05). In HKS, velocities of F1, F2, F3, F4 and F5 were 1.07, 1.08, 1.14, 1.20 and 1.07m/s (F=975.72, P<.01), post hoc tests showed that F4>F1, F2 and F5; F3>F1 and F5 (P<.05). Discussion In both groups, we found higher body fat, slower fins speed in LKS, so body fat was inversely proportional to KS, and percent body fat did not contribute to any of the stepwise models to predict swimming performance (Cochrane et al., 2015), young highly trained swimmers had lower fat mass (Rossi et al., 2014), above researches agreed that lower body fat got more speed in our study. Furthermore, five styles of fins performance were some difference in both groups, F4 was the fastest fins than F1 and F5, but F2 was not significant difference in LKS, F4 allowed water to pass through the fins during the recovery stroke of the kick cycle, and prevented water from passing during the power stroke. This reduces efforts during the recovery stroke increasing kick efficiency (SCUBAPRO, 2015) and suitable to HKS. F2 were split fins made kick the fins very easy and greatly reduced the load on your ankles and leg, delivered optimum power with minimum effort (SCUBAPRO, 2015) suitable to LKS. References Abe T, Kojima K, Stager J M (2014). Rejuvenation Res. 17(5),415-421. Kunitson V, Port K, Pedak K (2015). J Human Sport Exer, 10(Proc1), S482-S489. Cochrane KC, Housh TJ, Smith CM (2015). J Strength Cond Res. 29(6), 1473-1479 Rossi FE, Ricci-Vitor AL, Sabino JP (2014). J Strength Cond Res. 28(7), 2047-2053. SCUBAPRO (2015). 54-55. Contact: yctai21@yahoo.com.tw, yctai21@gmail.com

## BLOOD LACTATE ACCUMULATION DURING OPEN WATER SWIMMING EVENTS IN RELATION TO GENDER. A PILOT STUDY

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Introduction Open Water Swimming is challenging and special, compared to other endurance sports. Maglischo (2003) states that lactic acid levels in the muscle ranges between 1.0-2.0 mmol/L at rest and between 25-30 mmol/L during maximum effort lasting 1 minute or more. Lactic acid levels of long distance swimmers are usually in the lower part of this range. Lactate accumulation depends on swimming intensity, duration, frequency, the range of oxygen uptake and the muscle fiber type (Maglischo, 2003). The aim of the present study was to identify differences in lactate accumulation in the blood during a 5000m Open Water Swimming effort, between male and female swimmers. Methods The sample consisted of 5 male, aged 17.5±1.0 years and 6 female, aged 16.4±0.6 years. Lactate accumulation was measured in the 3rd and 10th minute of passive recovery and was analyzed with the portable analyzer Scout Lactate Germany. Heart rate was measured with a Polar device and performance time with a handheld stopwatch Seiko Water Resistant 10bar S140. The research was conducted during a Greek National Open Water Championship, held in June. Results Analysis of variance showed no statistically significant differences between the two genders for all measured variables. This may be due to the small sample as well as the fact that some of the participants were competing for the first time. Discussion What should be noted is that there were no particular differences in the blood lactate values between the two genders at 5000m. This finding leads to the conclusion that the energy production



mechanism might be similar in both genders. Future studies should focus on larger sample in order to achieve more accurate results. References Maglisco WE. (2003). Swimming fastest. Human Kinetics. Champaign, Ill. Vanheest JL, Mahoney CE, Herr L. (2004). J Strength Cond Res, 18(2), 302-305.

### EFFECTS OF SEX AND EXERCISE INTENSITY ON THE VO<sub>2</sub> KINETICS IN SUBMAXIMAL SWIMMING

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**Introduction** The oxygen uptake kinetics (VO<sub>2</sub>K) has been considerably less studied in females than in males and the literature has provided conflicting results regarding the differences between sexes. The aim of this study was to compare the VO<sub>2</sub>K in front crawl between male and female swimmers in moderate and heavy intensity-domains. **Methods** Nineteen well trained swimmers (8 females mean  $\pm$  SD; age 17.9  $\pm$  3.5 yr.; mass 55.2  $\pm$  3.6 kg; height 166  $\pm$  5 cm and 11 males 21.9  $\pm$  2.8 yrs; 78.2  $\pm$  11.1 kg; 181  $\pm$  8 cm) performed a discontinuous maximal incremental test (5 x 200 m swims with 30 s rest intervals for the determination of maximal oxygen uptake (VO<sub>2</sub>max) and ventilatory threshold (VT)) and two 600-m square wave transitions for both moderate (M; 80 %VT) and heavy (H;  $\Delta$ 25% [= VT + 0.25 x (VO<sub>2</sub>max - VT)] intensities in a 50m pool. Cardiorespiratory analysis was performed using a breath by breath gas analyser (K4b2, Cosmed, Italy) and swimming snorkel (Aquatrainer, Cosmed, Italy). The breath-by-breath were 1-s interpolated, time-aligned and averaged together to provide one representative set of data for each swimming intensity. For H swimming, the parameters of the VO<sub>2</sub>k (td1, tau1, A1, td2, tau2, A2; i.e. time delay, time constant and amplitude of the primary phase and slow component, respectively) were determined using a bi-exponential model. For the M swimming the slow component was not considered. **Results:** The time constant of the primary component (tp) was not significantly different between sexes in both intensity domains and was also independent from swimming intensity (M: 15.1  $\pm$  5.6 vs 14.4  $\pm$  5.1 s; H: 13.5  $\pm$  3.3 vs 16.0  $\pm$  4.5 s, for females and males, respectively). Similarly the slow component in the heavy domain was not significantly different between female and male swimmers (3.2  $\pm$  2.4 vs 3.8  $\pm$  1.0 ml·min<sup>-1</sup>·kg<sup>-1</sup>). **Discussion:** The kinetics was similar between female and male swimmers at both moderate and heavy intensities. It has been reported that women have smaller hearts, smaller stroke volumes, cardiac outputs and haemoglobin concentration than men (Wiebe et al. 1998). Furthermore, they have smaller lung volumes and lower maximal expiratory flow rates (Harms 2006) and a less effective matching of the O<sub>2</sub> delivery and O<sub>2</sub> utilization (Murias et al. 2014). However, said lower oxygen delivery to the muscle and the cardiac and respiratory characteristics of women does not seem to affect the oxygen uptake kinetics in moderate and heavy swimming. Harms C (2006). Resp Physiol Neurobiol, 151, 124–31. Murias JM, Keir DA, Spencer MD, Paterson D (2014). Resp Physiol Neurobiol, 189, 530–36. Wiebe CG, Gledhill N, Warburton, DE, Jamnik VK, Ferguson SD (1998). Clin J Sport Med, 8, 272–79.

### METABOLIC AND STRUCTURAL EFFECTS OF WATER TRAINING ON LEFT VENTRICULAR HYPERTROPHY AND STRUCTURAL EFFECTS OF WATER TRAINING ON LEFT VENTRICULAR HYPERTROPHY

NEIVA, C.M.1,2,3,4, TERRA, G.2,4, ROSA, B.2,4, SANTOS, L.4, SILVA, G.4, TAVARES, M.4, CAMPOS, P.A.3, FAITORONE, M.2, TONELLO, M.G.M.2, CIOLAC, E.1, VERARDI, C.E.L., PESSO-FILHO, D.M.4, GARCIA, J.4,5

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**Introduction-** Left ventricular hypertrophy is a multiple etiology progressive disease, and disabling its carrier progressively until death. Recent studies have suggested that some models of physical training can have metabolic and physiological effects in favour of health carriers of this disease. **Objectives -** This study assessed the effects of Water training on the lipid profile and left ventricular structures in hyperlipidemic mice. **Methods -** Twenty-eight male LDLr<sup>-/-</sup> mice were randomly separated into 4 groups: sed-entary, fed a standard diet (C); exercising, fed a standard diet (C+TRE); sedentary, fed a hyperlipidic diet (C+HL); and exercising, fed a hyperlipidic diet (E+HL). The exercising mice trained daily for 60 minutes during 60 days. After 48 hours of the end of the training period and 12 hours of rest fasting the animals were underwent euthanasia and the blood was collected for measuring the plasma levels of triglycerides, total cholesterol and its fractions (LDL, HDL, VLDL). The heart was removed and the left ventricle was weighed fresh to calculate the ratio left-ventricle weight (mg)/body weight (g). **Results -** The results showed that the training was more effective in improving lipid plasma levels when combined with a balanced diet, thereby confirming that it is essential to associate physical exercise and diet. The training protocol resulted in eccentric left ventricular hypertrophy in the standard-diet group and decreased interstitial collagen deposition in the myocardium of the high-fat-diet animals, which may indicate an improved diastolic function with consequent improvement in the systolic function. **Discussion -** It was observed that regular moderate aerobic exercise induce beneficial and prophylactic adaptations to heart which promoted a better health condition and prevention to diseases.

### ANALYSIS OF ENDURANCE IN GERMAN ELITE SWIMMERS OVER THREE DECADES

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**Introduction** Many different distances, strokes, and highly intensive submersed phases lead to a diversified requirements profile in swimming. Endurance, however, remains one of the most important factors. The evaluation and improvement of aerobic capacity is an essential aspect of performance diagnostics. A standardized and well established test in swimming is the Pansold incremental step test. German swimmers were frequently criticized for a lack of basic endurance. Therefore, the aim of this study was to compare the Pansold test results of the German national swimming team with the results of former national teams. **Methods** In the Pansold test, swimmers have to undergo 5 incremental stages in their main discipline. The outcome is a specific lactate performance curve with three characteristic parameters: The maximum lactate level in test (L<sub>max</sub>), "P 4,0" as a predictor of aerobic capacity in % of maximum speed, and the value "b", exponent in the function  $y = ae^{bx}$ , as indicator of gradient of the curve. Despite contradictory views of threshold concepts, Heck (2008) recommend fixed thresholds for comparison of performance curves. 500 data sets of the current national team are evaluated and compared with mean values presented in two publications of Pansold (1994) with 4000 analyzed tests and Rudolph (2000) with 1000 evaluated tests. There are specific data for every point of measurement and discipline. **Results** In every discipline, maximum swimming velocity increases during the three points of measurement. P 4,0 values decrease significantly from measure point to measure point in almost every discipline: On average from 90% to 86.7% to 85.7% of maximum speed at lactate level 4 among men, and from 94.0% to 92.6 % to 91.8% among women. L<sub>max</sub> in the majority increases over the three points of measurement. The development of the value "b" is not consistent, but we can observe specific curve shapes for different disciplines. **Discussion** Based on these findings, we can conclude

that German swimmers today have less aerobic capacity but achieve faster velocity with higher lactate level. This confirms the opinion that German swimmers bring less basic endurance, but they swim faster with higher energetic expenditure. Perhaps this could be the reason for lower physical stress tolerance in several competitions on the same day. Higher endurance may be related to greater training distance and more extensive training at younger ages. References Heck H, Beneke R. (2008). Dt. Z. f. Sportmedizin, 59 (12), 297-302. Löllgen H. (2010). Ergometrie. Pansold B, Zinner J (1994). Stellenwert d. Laktatbestimmung in der Leistungsdiag., 47-64. Rudolph K, Berbalk A. (2000). Schwimmen Lernen und Optimieren (17), 33-55. Contact Christine.hoffmann@tum.de

### JUMP HEIGHT ANALYSIS ON TENNIS SERVE.

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Introduction Tennis serve has become one of the most important shots in modern tennis, allowing players to gain points with no or very short rallies. In order to gain maximal speed during tennis serve the contribution of both upper and lower limbs is necessary. In particular, lower limbs generates about 50% of the total force developed during the serve. On the other hand, limited information are available about lower limbs activity during tennis serve. Therefore, the aim of this study was to investigate possible relationship between the jump height and anthropometric characteristics during serve performance. Methods Eight professional tennis players, 4 elite (300-800 of ATP official ranking) and 4 professional tennis players (age 19±4 y-o; height 181±3 cm; height with racket 283±5 cm) participated in the study. Players performed five first and 5 second balls and five first and 5 seconds serving on a 10 cm wood platform directly in the tennis court. Jump height during tennis serve was measured with a high-speed camera. Serve speed was measured with a radar apparatus placed 2 meters behind the player on the ideal serve trajectory axis. Serve efficacy was evaluated hitting a target zone in the middle of the serve area. In addition, three series of counter movement jump (CMJ) and counter movement jump free (CMJF) with high-speed camera to evaluate jump height were measured. Results Pearson correlation analysis showed a positive relationship between players height and jump height during the first serve ( $R=0.8$ ;  $P=0.03$ ). Unpaired t-test revealed that using both CMJ and CMJF elite tennis players used an high percentage of jump during the first (CMJ: 37±4 % elite vs 27±8 % professional,  $p=0.02$ ; CMJF: 31±2% elite vs 22±5% professional,  $p=0.004$ ), and second ball (CMJ: 38±5% elite vs 29±5% professional,  $p=0.0003$ ; CMJF: 31±4% elite vs 24±4% professional,  $p=0.0001$ ) of the serve. Moreover, during the second serve elite tennis players reached a higher jump height compared to professionals ( $13.6 \pm 2.2$  cm, elite vs  $10.7 \pm 2.3$  cm professional,  $p=0.001$ ). No significant difference in ball speed and efficacy between elite and professionals were detected. When serving on the wooden platform, elite players had a better efficacy in the first serve respect to professional players ( $p=0.028$ ). Also in this situation no significant differences in ball speed between elite and professionals were founded. Discussion Reaching higher jump heights during tennis serve seems not to be effective both in the first both in the second ball. In addition, an acute improvement of height for serving was not an effective solution for improving ball speed and serve efficacy. This because, serve performance requires the coordinate action of several body segments to produce optimal racquet position, trajectory and velocity at ball impact. In conclusion, coaches of top-level athlete have to insist on serve technique rather than jump height. Contact filippo\_dossena@yahoo.it

### SPEED DOES NOT DISCRIMINATE WITHIN DUTCH TOP-30 U14 TENNIS PLAYERS

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Introduction Speed is important for tennis performance (Kovacs, 2006; Kramer et al., accepted). In U14 players, speed discriminates between players ranked top-8 and players ranked 9-150 in the Netherlands (Kramer et al., accepted). However, unknown is if speed discriminates between U14 players within an even more homogenous elite group, or whether it can predict future performance two years later. To improve talent identification, the aim of this study is to investigate whether speed relates to on court performance (i.e., ranking) at U14 in top-30 players, and how far it can explain ranking at U16. Additionally, players' stability in ranking from U14 to U16 is investigated. Methods Speed was measured in 44 boys and 42 girls (age  $M=12.5$ ,  $sd=.25$ ) with 5-and 10-meter sprint tests at U14. All players were top-30 ranked on the Dutch National ranking list at U14, and top-50 ranked at U16 Based on U14 ranking four quartiles were created, running from quartile 1 (ranking 1-5) to quartile 4 (ranking 15-30). The players were also grouped in 4 quartiles based on their ranking at U16. Differences between quartiles at U14 and U16 were analysed for boys and girls with the Kruskal Wallis test. Distribution of players in the quartiles at U14 and U16 were investigated using frequencies. Results In boys and girls, no differences were found between the quartiles at U14 nor at U16 in speed ( $p>.05$ ). Comparison of the distribution over the quartiles at U14 with U16 showed that 26% of the boys reached a higher quartile, 40% was stable and 34% moved to a lower quartile at U16 compared to U14. In girls, 30% climbed to a higher quartile, 42% stayed equal, and 28% moved to a lower quartile. Discussion Speed does not discriminate within the top-30-ranked players U14. Around 40% of players were stable in their ranking in the subsequent two years. The others either increased or decreased in ranking. More research is needed to state which other aspects than speed should be taken into account for identifying players for talent development programs. References Kovacs MS. Applied physiology of tennis performance. Br J Sports Med. 2006;40(5):381-385. Kramer, T, Valente-dos-Santos, J, Coelho-E-Silva, MJ, Malina, RM, Huijgen, BCH, Smith, J, Visscher, C. Modeling longitudinal changes in 5-m sprinting performance among young male tennis players. Percept Mot Skills. (accepted). Contact Tamara.Kramer@han.nl

### IMPACT OF ANTHROPOMETRIC CHARACTERISTICS AND PHYSICAL PERFORMANCE COMPONENTS ON SERVE VELOCITY IN ELITE MALE JUNIOR TENNIS PLAYERS

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Introduction In tennis, modern game has evolved from a primary technical to the current explosive sport becoming increasingly dynamic and faster based on strength, speed and power with higher stroke and serve velocities leading the service game to a key factor of game success. Consequently, velocity production is an obvious prerequisite to proficient tennis serve performance. However, there is no consent whether physical and anthropometric attributes are good predictors of service speed. Therefore, the aim of the study was to examine the impact of physical performance characteristics and anthropometric variables on serve performance (i.e. velocity). Methods 625 male junior squad players of the German Tennis Federation ( $13.7 \pm 1.9$  yrs,  $165.4 \pm 13.4$  cm,  $53.0 \pm 13.7$  kg) participated in this study. All subjects, matched into 2 yrs age categories (U12, U14, U16, U18), performed the standardized German Physical Condition Tennis Test including body height [BH], body mass [BM], sitting height [SH], arm span [AS], serve velocity [SV], medicine ball throw [MBT] overhead [OH], fore-

hand [FH], backhand [BH], hand grip strength [GS], countermovement jump [CMJ], horizontal jumps [HJ], 20m sprint [S], and tennis-specific endurance [E] [1]. Partial correlation as well as multiple regression analysis was used to determine the relation and contribution of anthropometric and physical performance to service speed according to each age group. Results Among all groups, MBTs (U12  $r=.49-.55$ , U14  $r=.52-.63$ , U16  $r=.58-.60$ , U18  $r=.51-.55$ ;  $p<.05$ ) as well as GS (U12  $r=.43$ , U14  $r=.57$ , U16  $r=.59$ , U18  $r=.59$ ;  $p<.05$ ) showed the highest correlations to service speed. Concerning anthropometric data, BW (U12  $r=.47$ , U14  $r=.55$ , U16  $r=.57$ , U18  $r=.44$ ;  $p<.05$ ) and AS (U12  $r=.44$ , U14  $r=.56$ , U16  $r=.56$ , U18  $r=.37$ ;  $p<.05$ ) were the most correlated showing moderate to large values. Results of multiple regression analysis indicated values of  $R^2$  ranging from 41-66% concerning the explained variance of criterion variable (U12  $R^2=.41$  (MBT OH+BH), U14  $R^2=.66$  (MBT FH+OH, GS, AS), U16  $R^2=.62$  (MBT OH+FH, GS), U18  $R^2=.46$  (MBT FH, GS),  $p<.00$ ). Discussion Given a complex stroke as the tennis serve, results of regression as well as correlation analysis reinforce that service speed is strongly dependent on physical performance and anthropometric characteristics. Especially the upper body power/strength and the transfer of power from the lower to the upper body in proper timed sequences, which is needed in the MBT, highlight its importance for the junior player's service while the purely lower body power (e.g. CMJ) seems to be less important. In this regard, intervention programs focusing on the specific requirements are recommended to increase serve performance. References [1] Ulbricht A, et al (2015) J Med Sci Tennis, 20(1), 6-16. Contact janina.fett@rub.de

## Mini-Orals

### MO-PM49 Training & Testing 2

#### EFFECTS OF TRUNK MUSCLES FATIGUE ON SITTING BALANCE, KINESTHESIA AND LOWER LIMB STABILITY DURING SINGLE LEGGED LANDING

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**Introduction** Muscular endurance of the trunk muscles has been shown to be an important prevention factor for low back pain occurrence. However, it is unknown how fatigue of the trunk muscles affects other neuromuscular functions of the trunk, such as kinaesthetic sense and local/global dynamic stability. Therefore the aim of this study was to analyse, how fatigue of trunk flexors, extensors and latero-flexors affect sitting balance, trunk active joint repositioning sense and stability index during unilateral landing. **Methods** Twenty-four young healthy adult subjects completed three 30-s repetitions of sitting balance, three repetitions of active repositioning sense test for trunk (measured at the lumbar region during trunk flexion in standing position, at an angle of proximally 50% of maximal trunk flexion ROM) and three unilateral landings on the dominant leg (from 40 cm height, holding the landing position for 5 s). Sitting balance was analysed using mean sway velocity, average amplitude and frequency of the centre of pressure movement in anterior-posterior (a-p) and medial-lateral (m-l) direction. Averaged difference between the reference and the repositioned angle was used as a measure of active joint repositioning sense. And finally, common stability index, stability index in a-p, m-l and vertical direction were calculated for analysing stability in unilateral (standing dominant leg) landings. These three tests were followed by a fatiguing protocol, consisting of three sets of four exercises (curl-ups, trunk extension, side-curls on each side), performed to exhaustion. Immediately after the fatiguing protocol, subjects repeated the measures of sitting balance, kinesthesia and stability in unilateral landings. Results No statistically significant differences were observed between pre and post fatiguing conditions in sitting balance, kinesthesia or stability indexes during unilateral landing. However, an obvious trend of near to statistically significant increase was observed for m-l sway velocity and m-l average amplitude in sitting balance as well as a decrease in m-l stability index during unilateral landings. **Discussion** Our results indicate that sitting balance, kinesthetic sense and stability of the body during unilateral landings are unaltered following fatigue of the trunk muscles. This could be explained by central adaptations in motor control, possibly by a way of resetting the referent position (Feldman et al., 2013) remaining the sensory and motor functions in-tact. However, body sway in sitting balance and stability index in m-l direction could be affected more than in a-p direction. Further research is needed to understand whether trunk muscle fatigue causes direction specific changes. References Feldman AG, Ilmanen N, Sangani S, Raptis H, Esmailzadeh N. (2013). Neuropsychologia, 51(13), 2590-2599.

#### IN-SEASON AND OFF-SEASON VARIATION IN PHYSICAL FITNESS PARAMETERS OF ELITE YOUNG SOCCER PLAYERS

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**Introduction** The assessment of physical fitness changes at various moments during the development of youth soccer players is of relevance to measure the effectiveness of training. As such, the aim of the present study was to describe the changes in physical fitness of elite young soccer players exposed to systematic training. **Methods** The present study involved a mixed cross-sectional and longitudinal analysis of the development of young soccer players of a professional soccer academy during three competitive seasons. The players started being part of the Under-12 (U12, n=55) category and, subsequently, they passed through the Under-13 (U13, n=39) and Under-14 (U14, n=27) categories. Players were evaluated annually at the beginning (September) and at the end (June) of the competitive season. The following variables were measured: 15 m velocity test, Yo-Yo intermittent recovery test (Level 1) (Yo-Yo IR1) and counter-movement jump (CMJ). A pairwise analysis was employed to establish the percentage change in the variables between consecutive sessions. A one way ANOVA was used to determine if there were any significant differences in the magnitude of the change across different ages. Only players with results for consecutive test sessions were included in each pairwise analysis. **RESULTS** As age increased significant improvements were observed in all the performance tests ( $p<0.001$ ). Besides, a pronounced improvement was observed in all the tests during the U14 season (10.2 %, 51.0 % and 8.1 % for velocity, Yo-Yo IR1 and CMJ, respectively). In contrast, during the off-season between U13 and U14 categories decrements in Yo-Yo IR1 (-1.7%,  $p<0.01$ ) and velocity (-4.1%,  $p<0.001$ ) were found. **Discussion** The present results showed performance spurts in speed, endurance and jump that may occur at different moments depending on the maturation tempo and timing of the players. Indeed, previous research has shown that these improvements may be a contribution of the growth spurt related to the increases in body dimensions and muscle mass (Malina et al., 2004). However, an evident decrement in performance was observed in all the tests in the U13 off-season indicating a possible effect of detraining at this age. Altogether, this information can improve insight into the development of a specific group and can assist in an appropriate talent development program design. Acknowledgements

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### THE EFFECTS OF PERTURBATION TRAINING ON KNEE JOINT STABILITY IN FEMALE ATHLETES

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**Introduction** Perturbation training has been shown to have benefits for patients receiving anterior cruciate ligament(ACL) reconstruction (Erin et al.,2010) . Female athletes are more prone to ACL injuries than male athletes. How to prevent ACL injury has been an important issue for athletes and coaches. Thus, the purpose of this study is to investigate the effects perturbation training on knee joint stability in female athletes. **Methods** Nine female basketball players with an average age of ( $23 \pm 2$ ), an average height of ( $162.6 \pm 6$ ), and an average weight of ( $54.7 \pm 7.4$ ), completed five test sessions on nonconsecutive days within 2 weeks. Using the Bosu ball (BOSU® Official Global Headquarters, U.S.A.), four perturbation training sessions were administered (stand on unilateral and bilateral on the back and front Bosu ball each 1 minute). An elastic band under the tibial tuberosity was applied to all participants who volunteered for this training program. Pretest and protest measured 4 hop score (single hop , triple hop , cross hop , 6M hop ) ,T shuttle run , proprioception by Biodex(System 3, Biodex Medical Systems, New York, U.S.A.) and dynamic balance . Chi-square tests was used for statistical analysis. Results The single hop score (m) improved significantly in the before training conditions ( $1.19 \pm 0.14$ ) as compared to after training conditions ( $1.278 \pm 0.11$  ,  $p < 0.05$ ). For the triple hop score and cross hop score, there was no significant differences between the before and after training sessions. The 6M hop score (sec.) improved significantly in the before training conditions ( $2.68 \pm 0.29$ ) as compared to after training conditions ( $2.36 \pm 0.34$ ,  $p < 0.05$ ). The T shuttle run (sec.) improved significantly before training conditions ( $12.23 \pm 0.94$ ) as compared to after training conditions ( $11.43 \pm 0.66$  ,  $p = 0.006$ ) . The proprioception by Biodex and dynamic balance were showed no significant differences between before and after training condition . **Discussion** The results of this study showed that perturbation training improved knee joint stability in female athletes. .These information may be beneficial for the athletes and coaches. Therefore, perturbation training may be included in the general training program to prevent ACL (anterior cruciate ligament) injury in female athletes. References Erin H. Hartigan , Michael J. Axe , and Lynn Snyder-Mackler. J Orthop Sports Phys Ther. 2010 March ; 40(3): 141–154. doi:10.2519/jospt.2010.3168. Contact E-mail:Pokeryao11@gmail.com

### STRENGTH AND ENDURANCE TRAINING REDUCES THE LOSS OF ECCENTRIC HAMSTRING TORQUE OBSERVED AFTER SOCCER SPECIFIC FATIGUE

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**Purpose:** To investigate the effect of two types of hamstring training protocols on parameters of eccentric peak torque before and after soccer specific fatigue. **Participants:** 20 university level male soccer players; mean ( $\pm$ SD) age, height and body mass were  $22.5 \pm 3.4$  years,  $182.1 \pm 7.5$  cm and  $80.9 \pm 10.4$  kg respectively. **Method:** Isokinetic strength tests at  $60^\circ/\text{s}$  pre and post fatigue, before and after 2 different training interventions. A 45-minute soccer specific fatigue modified BEAST protocol (M-BEAST) was used to induce fatigue. Players were randomly assigned to a 4 week hamstrings conditioning intervention with either a maximum strength (STR) or a muscle endurance (END) emphasis. **Results:** There was a significant effect of the M-BEAST on the Eccentric torque angle profile before training, as well as significant improvements in post-fatigue torque angle profile following both strength and muscle endurance interventions. **Conclusion:** 45 minutes of simulated soccer activity leads to reduced eccentric hamstring torque at longer muscle lengths. Short-term conditioning programs with either a max strength or a muscular endurance emphasis can significantly reduce fatigue induced loss of strength over this time period.

### THE LONG-TERM ERGOGENIC EFFECT OF LONG ACTING B2-AGONISTS

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**Background:** The WADA List of Banned Substances and Methods stipulates that athletes can use up to  $54 \mu\text{g}$  inhaled Formoterol and inhaled Salmeterol as directed by the manufacturer. It is unknown whether large daily therapeutic doses of Formoterol and Salmeterol can improve sprint and strength performance. **Purpose:** To investigate the impact of inhaling  $100 \mu\text{g}$  of Salmeterol (SAL) or  $12 \mu\text{g}$  of Formoterol (FOR) twice daily over a 5 week period on sprint, strength and power performance. **Methods:** In a randomised single blind study 24 male and 15 female non-asthmatic and active participants were recruited (mean  $\pm$  SD; Males age  $28.0 \pm 5.5$  years; weight  $72.1 \pm 10.5$  Kg; height  $164.7 \pm 7.1$  cm; Females age  $24.1 \pm 4.1$  years; weight  $65.4 \pm 9.5$  Kg; height  $168.0 \pm 4.3$  cm). Participants completed three standardised whole body strength and power training sessions per week for five weeks. All the training sessions were supervised by a personal trainer who recorded work performed in each session. During the five week training period participants were assigned to either SAL, FOR or a placebo (PLA) group. Participants took their inhaler twice per day as instructed. Participants completed assessments of sprint, strength and power at week 0 and after 5 weeks of strength and power training. The assessments included 30 m sprint, vertical jump, 1 RM bench press, 1 RM leg press, peak torque flexion and extension, anthropometric evaluation and Rest-Q questionnaires. Mixed Model Repeated Measures ANOVA were performed to investigate the changes in the sprint, strength and power assessments between groups over the course of the 5 week training session. **Results:** 30 m Sprint time was significantly lower in FOR group ( $-0.29 \pm 0.11$  s;  $p = 0.049$ ) and SAL ( $-0.35 \pm 0.05$  s;  $p = 0.04$ ) when compared with compared with Placebo ( $+0.01 \pm 0.11$  s;  $P = 0.000$ ). No significant change was found in 1RM Leg, Squat and Bench Press or during isokinetic evaluation performed at  $60^\circ$  range in flex/ext movement. Jump performance as well as anthropometric measures didn't differ between groups. **Discussion:** The significant changes in FOR and SAL 30m sprint time when compared to PLA suggest the long term use of inhaled  $\beta_2$ -agonists may provide ergogenic advantage. This finding suggests a review of the use of inhaled doses of FOR and SAL by athletes in training and official competition may be necessary.



## RELATIONSHIPS BETWEEN TRAINING LOAD AND PHYSICAL FITNESS' CHANGES IN PROFESSIONAL AND SEMI-PROFESSIONAL BASKETBALL PLAYERS

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**INTRODUCTION** Quantification of training load (TL) is essential for monitoring an effective training process. To date few studies have analyzed different methods to determine TL in basketball (Manzi et al., 2010; Scanlan et al., 2014) and no studies verified the relationships between TL and changes in players' fitness level. Furthermore, there is limited information regarding the TL sustained by players of different competitive levels. The aim of this study was to quantify the perceived TL in professional and semi-professional basketball players and to determine its relationship with changes in physical fitness during the preparation period. **METHODS** Thirty-two professional (n=14, age: 25.6±6.0 yrs, height: 198±10 cm, weight: 95.5±13.0 kg) and semi-professional (n=18, age: 23.3±4.7 yrs, height: 190±9 cm, weight: 82.2±11.6 kg) basketball players participated in the study. Players performed Yo-Yo intermittent recovery level 1 (YIR1) and counter-movement jump (CMJ) tests before and after the preparation period. In addition, physiological responses to a standardized 6-min continuous running (Mognoni's test) and to a standardized 5-min high-intensity intermittent running test (HIT) were measured. The players' perceived TL was assessed using the session rate of perceived exertion method. All data were analyzed using magnitude-based inferences. **RESULTS** Almost certain differences were found for weekly TL and training volume (TV) between professional and semi-professional players (TL: 5241±1787 vs 2408±487 AU, effect size (ES)=1.49±0.46; TV: 914±122 vs 634±71 min, ES=2.17±0.49). Very likely moderate relationships were observed between TL and changes in La- ( $r=-0.48\pm0.23$ ) and H+ ( $r=-0.42\pm0.25$ ) measured after HIT. Very likely moderate relationships were also found between TV and changes in absolute ( $r=-0.39\pm0.25$ ) and relative ( $r=-0.41\pm0.25$ ) peak power produced during CMJ. No clear relationship was found between TL or TV and changes in YIR1 and Mognoni's test. **DISCUSSION** The present results suggest that a low TL in basketball entails a small physiological adaptation to submaximal intermittent running but not to submaximal continuous running or maximal intermittent performance (YIR1). Conversely, high TV can negatively affect CMJ performance during the preparation period. Future studies should investigate the effect of TL on changes in physical fitness during the competitive season. **REFERENCES** Manzi V, D'Ottavio S, Impellizzeri F, Chaouachi A, Chamari K, Castagna C. (2010). J Strength Cond Res, 24(5), 1399-1406. Scanlan A, Wen N, Tucker P, Borges N, Dalbo V. (2014). Int J Sports Physiol Perform, 9(5), 851-856 **CONTACT** davide.ferioli@unimi.it

## TRAINABILITY OF SPRINTING IN YOUTH MALE AND FEMALE SOCCER PLAYERS

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Do not insert authors here **Introduction:** Sprinting and change of direction sprints (agility) is important for youth soccer players. Compared to adult athletes there is less information about the effectiveness of sprint training in youths. The aim of the present study was to examine the trainability of sprint and agility performance in male and female youth soccer players. **Method:** This present study is a collection of four intervention programs, with 10 to 13 year-old boys, and 13 to 15 years-old girls. In total, 57 subjects (34 boys and 23 girls) participated in the intervention programs. The training sessions involved running in short burst with starting, stopping, change of direction, and linear sprints, all executed with maximal effort. Control groups followed ordinary soccer training sessions. The sprint test consisted of 20 m straight-line course, and the agility (change of direction sprint) test was a 20 m standardized course with 90° and 180° turns. Electronic timing gates, wireless connected with a timer was used to record the times (Brower Timing System, US). **Results:** Training groups showed significant improvement in 20 m sprint ( $p<0.05$ ): 10.5 (±0.2) year old boys 20 m from 3.96 (±0.24) to 3.89 (±0.21); 13.5 (±0.2) year old boys; from 3.54 (±0.17) to 3.42 (±0.18); 13.6 (±0.2) years-old girls; from 3.75 (±0.15) to 3.62 (±0.22), 15.5 (±0.7) year old girls from 3.53 (±0.15) to 3.42 (±0.16). Training groups showed significant improvement in agility performance ( $p<0.05$ ): 10 year-old boys from 9.15 (±0.57) to 8.42 (±0.39), 13-years-old boys from 8.23 (±0.34) to 7.69 (±0.34), 13 years-old girls from 8.56 (±0.54) to 8.03 (±0.38), 15 year-old girls from 8.23 (±0.31) to 7.80 (±0.33). **Discussion:** Faster completion of sprinting indicates that the intervention programs consisting of short burst high-speed exercises is effective in youth soccer players. The results are in line with previous findings with youth athletes, showing improved sprint performance with high-intensity speed training, and programs that are specific to the performance tests. The improvement is supposed to be due to that neuromuscular adaptations including recruitment, activation of motor units and better coordination of muscles have occurred. **References:** Pettersen & Mathisen (2012), Rumpf et al. (2012), Milanovic et al. (2013)

## IMPACT OF A STRENGTH TRAINING PROGRAM ON FOOTBALLERS' VO2MAX

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**Introduction** There is considerable variation between football players' BMI and players of other sports such as rugby, hockey or American football. Nonetheless, that contrast is dwindling when it comes to body fat percentage and cardiorespiratory capacity. Many football specialists still believe that hypertrophy will alter footballers' efficiency. However, players from the aforementioned sports succeed in their respective disciplines. The main purpose of this study is to put elite footballers through a resistance training program and demonstrate that this type of training is not deleterious to the footballers' VO2max. The second objective is to verify hypertrophic gains while examining the impact of the program on the players' other attributes. **Methods** The study was conducted on the U-19 players from the academy of professional football club Asec Mimosas; 20 subjects participated in the study (N = 20). A total of seven tests were performed to measure various components: BMI, Body fat percentage, VAMEVAL test, 30m dash, RSA, Illinois test and broad jump test. The experimental design consisted of a single group, with pre and post measures. All results are reported as standard deviation (SD). Results were compared using a paired Student's T test and accepted as significant at  $P<0.05$ . **The resistance training program protocol:** The idea was to develop a 45 to 60 minute in-season training protocol that required minimal equipment. It was also essential that the program involved a majority of various muscle groups. Hence the implementation of functional movement training program followed twice a week. The program was divided into 3 circuits. Circuit 1: Bench Press, DB Rows and Side Plank. Circuit 2: Squats, Hip Thrust, and Pullups. Circuit 3: Deadlift, Overhead Press and Plank. Players performed 3 sets of 5 to 10 reps. **Results** BMI ( $p=.0001$ ) from 20.7± 1.6 to 21± 1.6 kg/m<sup>2</sup>; Body fat percentage ( $p=.0001$ ) from 9.8± 1.4 to 8.2± 1.2 %; Lean body mass ( $p=.0001$ ) from 57.5± 5.7 to 59.5± 6.1 kg; 30m sprint ( $p=.0001$ ) from 4.22±0.1 to 3.98± 0.2 s; RSA ( $p=.0001$ ) from 4.46±0.2 s. to 4.25± 0.2 s; Broad jump ( $p=.009$ ) 2.31± 0.1 to 2.45 ± 0.2m; Illinois test ( $p=.001$ ) from 15.69±0.1s to 15.16 ± 0.1s.; VO2max from 58.78 ±0.6 ml/mn/kg to 59.6 ±0.6 ml/mn/kg **Discussion** The findings suggest that resistance training is not deleterious to footballers' VO2max. For this reason, once elite players reach VO2max standards, it is necessary to imple-

ment a good in-season resistance training program that will help improve VO<sub>2</sub>max, lean body mass, body fat percentage and other footballers' important qualities such as speed, RSA, agility and leg .

### THE EFFECTS OF FIVE WEEKS OF HIGH-INTENSITY INTERVAL TRAINING ON PERCEPTUAL AND LACTATE RESPONSES IN FEMALE FUTSAL PLAYERS: A COMPARISON BETWEEN THE TWO MODELS

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**Introduction** The purpose of this study was to compare the effects of two models of high-intensity interval training (HIIT) performed over five weeks, on the perceptual and blood lactate responses in elite futsal players. **Methods** Sixteen female futsal players (divided in two groups) performed the Futsal Intermittent Endurance Test (FIET) to determine the peak velocity (PVFIET). Both training models (twice a week during five weeks totaling 10 sessions) were designed from shuttle running intervals and consisted of four sets of 4-minute bouts with 3-minutes of rest intervals between the sets. The difference between the two models was the intermittence timing in each set, one being performed by 7.5s of running and 7.5s of resting (HIIT7.5x7.5), and the other by 15s of running and 15s of resting (HIIT15x15). The intensity used for the HIIT7.5x7.5 was ~ 88 %PVFIET and for the HIIT15x15 was ~ 85 %PVFIET. The blood lactate concentration [La] following each set and a session rating of perceived exertion (RPE) were assessed during the second and tenth training sessions. **Results** There were no "training model x time" interactions and main effect for the training model ( $p > 0.05$ ) regarding the RPE score. However, significant main effect findings were found for time ( $F = 25.52$ ,  $p < 0.001$ ) showing that RPE score was reduced from 2nd to 10th training sessions (HIIT7.5x7.5 =  $4.3 \pm 0.8$  vs.  $2.4 \pm 1.1$  au; HIIT15x15 =  $4.1 \pm 0.4$  vs.  $2.9 \pm 0.6$  au, respectively). The ANOVA results also indicated a non significant three-way interaction effect ( $p > 0.05$ ) for lactate responses. However, a significant "time x sets" interaction ( $F = 12.25$ ,  $p = 0.002$ ) was found for lactate responses. After the training period, the blood [La] following each set was similarly reduced in both HIIT7.5x7.5 and HIIT15x15 groups. Thus, the progressive increase in the blood [La] over the 4 sets shown in the 2nd session was not observed in the 10th session, displaying a steady-state pattern between the sets. **Discussion** The present study compared the two models of HIIT performed in shuttle running derived from FIET. The main hypothesis was that the model with more changes of direction (i.e. HIIT15x15) could trigger greater improvements in perceptual and lactate responses. **In conclusion**, the completion of the 10 training sessions in both HIIT models may elicit similar improvements in perceptual and lactate responses in female futsal athletes. **References:** Almarwaey OA, Jones AM, Tolfrey K. (2003). *Med Sci Sports, Exerc.* 35, 480-487. Helgerud J, Engen LC, Wisloff U, Hoff J. (2001). *Med Sci Sports, Exerc.* 33(11), 1925-1931. Contact: luiz.guilherme@ufsc.br

## Mini-Orals

### MO-PM36 Recovery Methods

#### EFFECTS OF KINESIO TAPING ON LOWER EXTREMITY SKIN TEMPERATURE IN YOUNG SOCCER PLAYERS

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M. Quadriceps Femoris and M. Gastrosoleus are the major muscles at lower extremity, facilitating these muscles are very important for prevention of injury. Thermographic imaging can help to assess the skin temperature of these muscles as skin temperature is an important parameter for the assessment of the injured muscle. **Purpose:** To compare the effects of Kinesio Taping (KT) on skin temperatures of Quadriceps (Q) and Gastrosoleus (GS) muscles in young soccer players. **Methods:** Eighteen young soccer players were randomly divided into 2 groups [KT Group ( $n = 9$ ), & Control Group ( $n = 9$ )]. Players were assessed before, 45 min. after the application and at the end of the training. KT Group received bilateral KT facilitation muscle technique for Q and GS muscles. Assessments included the sociodemographic parameters and thermographic assessment of bilateral Q and GS muscles. **Results:** Statistically significant differences were found between groups at 45 min after application (Right Q  $p = 0.000$ , Left Q  $p = 0.008$ , Right GS  $p = 0.008$ , Left GS  $p = 0.004$ ). When comparing three assessments (time factors) within groups, statistically significant differences were found between time factors ( $p < 0.05$ ). These differences were significant in favor of KT group results. **Conclusion:** KT seems very effective in regulating skin temperature of lower extremity muscles after application and training. This simple application may be used as a prevention for injuries that occur during training.

#### KINESIOLOGY TAPE: PATIENT PERCEPTIONS IN THE REDUCTION OF PAIN

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**Kinesiology Tape: Patient perceptions in the reduction of pain** **Introduction** The justification for using Kinesiology Tape (K Tape) as a pain relieving ergogenic aid, post injury, remains uncertain (Williams et al. 2012) with its effects still being established (Lim and Tay, 2015). The aim of the study was to investigate patient's perceptions of K tape in the reduction of pain post injury. **Method** Following University ethical approval a focus group informed the development of a 17 point questionnaire around the perceived magnitude and timing of pain reduction. The questionnaire was posted on social media sites inviting patients, who had used K tape specifically for pain relief (inclusion criteria), to complete. **Results** One hundred and fifty two replies were received (male = 57; female = 93). One hundred respondents (67.5%) reported using K tape to reduce pain following an injury that occurred in a sport or exercise activity. The most common site for the application of K tape was the lower limb (53.3%) while the back and upper limb recorded 15.8% and 14.5% respectively. A total of 113 (74.8%) respondents noted an immediate perceived reduction in pain (within 60mins) whilst 147 (96.7%) noted a reduction of pain within 48hrs. Seventy nine (52.3%) respondents noted an overall pain reduction of 50% or more. Of those who experienced a reduction in pain 76.8% also had additional treatment. Respondents further reported: reduced pain during load bearing activity; improved posture; reduction in swelling; improved circulation; increased support and cushioning; and increased mobility. **Discussion** A perceived immediate reduction in pain was noted from the results. The combination of pre-treatment and K tape application could influence the immediate reduction in pain and its magnitude. The results suggest that the site of application does not appear to affect the perceived influence on pain reduction however application technique and tape quantity could be influencing factors based on the purported mechanisms of K tape (Wil-

liams et al., 2012). Respondent's comments imply a confidence in the treatment process that could be credited to the K tape post treatment. The use of K tape to maintain the effects of the therapists' treatment would seem valuable. Rehabilitation practitioners can be confident that K Tape is beneficial based on patients' perceived reduction in pain. References Lim ECW and Tay MGX (2015). Kinesio taping in musculoskeletal pain and disability that lasts for more than 4 weeks: is it time to peel off the tape and throw it out with the sweat? British Journal of Sports Medicine. 0: 1-15. Williams, S., Whatman, C., Hume, P.A. and Sheerin, K. (2012) Kinesio taping in treatment and prevention of sports injuries: a meta-analysis of the evidence for its effectiveness. Sports Medicine. Vol. 42, No. 2: 153-164.

### **CLINICAL-LIKE CRYOTHERAPY PROTOCOL ATTENUATES OXIDATIVE DAMAGE MARKERS FOLLOWING SKELETAL MUSCLE INJURY IN RATS**

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The action of reactive species following skeletal muscle injury may lead to damage of cellular structures, amplifying the quantity of tissue damaged. The greater the quantity of damaged tissue, the longer it takes to recover. Cryotherapy is commonly used in the management of skeletal muscle injuries, but little evidence about its potential mechanism reducing post-injury oxidative damage is available. Therefore, the aim of this study was to investigate the effects of multiple cryotherapy application on markers of oxidative damage and levels of antioxidants enzymes post skeletal muscle injury. This study was divided into 3 experimental analysis periods: 3, 7 and 14 days after freezing injury of Tibial Anterior (TA) muscle. Thirty-five Wistar rats were equally and randomly distributed into 7 experimental groups: control - no interventions; TA injured, analyzed 3, 7 and 14 days after injury; and TA injured, treated with cryotherapy, analyzed 3, 7 and 14 days after injury. A clinical-like cryotherapy protocol was performed immediately, 24 and 48 h after injury. Crushed ice was applied three times a day for 30-min, every two hours. Dichlorofluorescein reactive substances (DCF-RS), thiobarbituric acid reactive substances (TBARS) and methyl thiazol tetrazolium (MTT) were measured as markers of oxidative damage. Catalase (CAT), superoxide dismutase (SOD) and non-protein thiol (-SH) were measured as markers of antioxidant system defense. DCF-RS levels were 10% lower 7 days and 30% lower 14 days post-injury in cryotherapy groups compared with non-treated ( $p < 0.05$ ). Animals treated with cryotherapy also demonstrated TBARS levels 40% and 50% lower than non-treated animals 3 and 7 days post-injury, respectively ( $p < 0.05$ ). In addition, cryotherapy maintained MTT levels within control range in all analyzed time points ( $p > 0.05$ ), whereas non-treated groups demonstrated higher levels than control group. It was observed lower SOD activity 7 and 14 days post-injury ( $p < 0.05$ ) as well as also lower CAT activity 3 days post-injury ( $p < 0.05$ ) in cryotherapy groups. Cryotherapy prevented the reduction in -SH levels 3 days post-injury ( $p = 0.92$ ). Cryotherapy reduced the quantity of reactive species (DCF-RS), lipid peroxidation (TBARS) and increased cell viability rate (MTT) compared with non-treated. Cryotherapy also limited the reduction in -SH, and the increase in CAT and SOD activities. This results suggest that lower antioxidant response may be associated with lower oxidative damage. In summary, this findings suggest that multiples application of cold during the early phase of regeneration is an efficient strategy to reduce markers of oxidative damage.

### **THE EFFECT OF LOCAL CRYOTHERAPY AFTER EXERCISE INDUCED INDICES OF MUSCLE DAMAGE ON SUBJECTIVE AND OBJECTIVE RECOVERY CHARACTERISTICS: A RANDOMIZED CONTROLLED TRIAL**

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The purpose of this randomized controlled trial was to investigate the effects of local cryotherapy on recovery characteristics during 72 h. Twenty-two female ( $n = 17$ , mean age:  $21.9 \pm 1.1$  yrs) and male ( $n = 4$ , mean age:  $25.4 \pm 2.8$  yrs) adults participated in this study. After the exercise-induced indices of muscle damage (EIIMD, 3 x 30 countermovement jumps) protocol, half of the participants received either a single local cryotherapy ( $+8^\circ\text{C}$ ) or a single local thermoneutral application ( $+32^\circ\text{C}$ ), each 20 min with two thigh cuffs. Subjective recovery characteristics (delayed-onset of muscle soreness and ratings of perceived exertion) and objective recovery characteristics (vertical jump performance and peak power output) were assessed immediately after the application (0 h) and 24, 48, and 72 h after the EIIMD protocol. Cryotherapy failed to significantly affect any subjective recovery variable during the 72 h recovery period ( $p > 0.05$ ). After 72 h, perceived exertion ratings reached baseline values in the thermoneutral group but not in the cryotherapy group. No significant differences could be observed between cryotherapy and the thermoneutral application for accelerating any objective recovery variable. In this experimental study, a 20 min of cryotherapy cuff-application failed to positively affect recovery characteristics.

### **COLD WATER IMMERSION $<8^\circ\text{C}>$ MEDIATES GREATER REDUCTIONS IN LOWER LIMB BLOOD FLOW AND MUSCLE TEMPERATURE COMPARED TO WHOLE BODY CRYOTHERAPY $<-110^\circ\text{C}>$ AFTER ENDURANCE EXERCISE**

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Introduction: Cryotherapy is a widely used recovery method to limit exercise-induced muscle damage and soreness as well as functional deficits after strenuous exercise. Typical methods include cold-water immersion (CWI) and whole body cryotherapy (WBC), the former of which exposes the body to cold water temperatures ( $\sim 10^\circ\text{C}$ ) for  $\sim 10$  min, while the latter of which exposes the body to very cold air ( $-110$  to  $-140^\circ\text{C}$ ) for short durations (2-4 min). It is currently unknown which intervention mediates the greatest reduction in blood flow of the previously exercised limb(s). This is important given that reducing blood flow may directly limit muscle damage and function, thus aiding recovery. The aim of this study was, therefore, to compare the effects of ecologically valid CWI and WBC protocols on post-endurance exercise thermoregulatory, femoral artery and lower limb cutaneous blood flow responses. It was hypothesised that greater reductions in lower limb muscle temperature, femoral artery and cutaneous blood flow responses would occur after CWI. Methods: Ten males completed a continuous cycle exercise protocol at 70% maximal oxygen uptake until a core temperature of  $38^\circ\text{C}$  was attained. Participants were then exposed to CWI ( $8^\circ\text{C}$ ) for 10 min or WBC ( $-110^\circ\text{C}$ ) for 2 min in a randomised cross over design. Rectal and thigh skin, deep and superficial (3,2,1, cm) muscle temperatures, thigh and calf skin blood flow (laser Doppler flowmetry), superficial femoral artery blood flow (duplex ultrasound) and arterial blood pressure (automated sphygmomanometry) were measured prior to and for 40 min post cooling interventions. General linear model repeated measures ANOVA were used to evaluate responses to CWI and WBC conditions. Results: Greater reductions in thigh skin (CWI,  $-5.9 \pm 1.8^\circ\text{C}$ ; WBC,  $0.2 \pm 0.5^\circ\text{C}$ ;  $P < 0.001$ ) and superficial (CWI,  $-4.4 \pm 1.3^\circ\text{C}$ ; WBC,  $-1.8 \pm 1.1^\circ\text{C}$ ;  $P < 0.001$ ) and deep (CWI,  $-2.9 \pm 0.8^\circ\text{C}$ ; WBC,  $-1.3 \pm 0.6^\circ\text{C}$ ;  $P < 0.001$ ) muscle temperatures occurred after CWI. Decreases in femoral artery conductance were greater after CWI (CWI,  $-84 \pm 11\%$ ; WBC,  $-59 \pm 21\%$ ,  $P < 0.02$ ) and greater thigh (CWI,  $-80 \pm 5\%$ ; WBC,  $-59 \pm 14\%$ ,  $P < 0.001$ ) and calf (CWI,  $-73 \pm 13\%$ ; WBC,  $-45 \pm 17\%$ ,  $P < 0.001$ ) cutaneous vasoconstriction was observed following CWI. Reductions in rectal temperature were

similar between conditions (CWI,  $-0.6 \pm 0.4^\circ\text{C}$ ; WBC,  $-0.6 \pm 0.3^\circ\text{C}$ ;  $P = 0.98$ ). Conclusion: CWI may be more effective than WBC in the treatment of exercise-induced muscle damage and injury rehabilitation by virtue of greater reductions in blood flow and tissue temperature.

### EFFECTS OF COMPRESSION GARMENTS ON CARDIAC OUTPUT AND LEG BLOOD FLOW DURING EXERCISE

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**Introduction** Compression garments are frequently used by elite and recreational athletes, although the effects on performance are controversially discussed. Postulated effects are an enhanced oxygen supply including higher  $\text{VO}_2\text{max}$  which is supposed to be due to an increased cardiac output (CO) and improved muscle perfusion. Therefore, the aim of the study was to compare  $\text{VO}_2\text{max}$ , CO and blood flow of the calves during exercise with and without leg compression. **Methods** 16 male triathletes and cyclists ( $\text{VO}_2\text{max}$ :  $64.7 \pm 7.3$  ml/min/kg, age:  $25.5 \pm 3.5$  years) participated at the study. Every athlete completed in total 4 randomized tests on a cycle ergometer (2 incremental tests until exhaustion and 2 submaximal tests (60% of  $\text{VO}_2\text{max}$ , 35min)) each of them with (C) and without (noC) compression of both legs including the thigh (CEP, medi, Germany). CO was measured before (orthostatic test), at the end of the incremental test and during the submaximal test by rebreathing a gas mixture consisting of  $\text{N}_2\text{O}/\text{SF}_6/\text{O}_2$  (Innovision, Denmark). Calf blood flow was determined by venous occlusion plethysmography at rest, during submaximal and immediately after submaximal and maximum exercise. **Results** No difference in performance was found ( $\text{VO}_2\text{max}$ , Watt, blood lactate) between C and noC. However, a marked increase of muscle blood flow was determined with compression at maximal (C:  $19.9 \pm 3.7$  ml/100g, noC:  $15.4 \pm 5.4$  ml/100g,  $p < 0.01$ ) and submaximal (C:  $21.6 \pm 5.2$  ml/100g, noC:  $17.8 \pm 5.6$  ml/100g,  $p < 0.05$ ) exercise. CO was significantly elevated in the orthostatic test with compression (C:  $7.8 \pm 1.4$  l/min, noC:  $7.2 \pm 1.2$  l/min,  $p < 0.01$ ), showed no difference at maximum exercise and a trend to higher values (C:  $21.6 \pm 3.6$  l/min, noC:  $20.7 \pm 3.1$  l/min;  $p = 0.08$ ) during the submaximal test with compression. **Conclusion** Although no impact of compression clothing on performance was found, physiological effects can be demonstrated. The blood perfusion of the legs was increased by 30% and CO tended to be elevated during submaximal exercise. This might be explained by a pronounced Bayliss effect and by an increased venous return. If the higher perfusion under compression is mainly due to higher skin or muscle blood flow cannot be decided here. Furthermore, the lack of increased performance remains to be clarified. The study was financially supported by medi Bayreuth Contact Nadine.wachsmuth@uni-bayreuth.de

## Mini-Orals

### MO-SH07 Physical Education and Pedagogics

#### FEMALE PRACTICE IN SCHOOL SPORTS: A MULTIPLE CASE STUDY IN BARCELONA AND NOTTINGHAM

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**Introduction** This is a multiple case study of three schools located in the cities of Barcelona and Nottingham, with participants from both sexes (ages = 10 - 16 years old). The aim of the study is to detect their practice and perceptions in relation to school sport. **Methods** The methodology is a mixed method (Creswell & Plano-Clarck, 2007) using quantitative and qualitative data for combination (Bericat, 1998). The qualitative data help deeper and better refine the quantitative results of the first phase. The instruments are a questionnaire (N = 610), piloted and validated, and 4 focus group, designed with the results of the first phase. The quantitative data analysis consists of frequency descriptive statistics, using SPSS v.22. Qualitative data was analyzed by the Grounded Theory, with CAQDAS ATLAS.ti v.7.1.8. **Results** Girls' school sports practice is lower than boys, both in Barcelona (90% boys and 76% girls) and in Nottingham (80% boys and 64% girls). The data showed the influence from the peer group and the gender stereotypes (e.g., 'girls don't play football'). Results also showed that they have few female models in the media and even that models often contain sexist connotations favoring feminine stereotypes. For the other hand, both countries, girls practice a greater variety of sports than boys due to the influence of the social environment, due in particular to the media. **Discussion** We agree with López Crespo (2001) who affirm the important influence that the media have on children and young people in the sport, causing more male sports television references than female. In addition, media should provide a more positive image of women in sport, diversified and away from prejudice and gender stereotypes (British Sport Council, 1994). Data also showed that stereotypes are transmitted by the strong influence of peer groups (Valdemoros, Sanz, & Ponce, 2012). **Conclusions** Schools and society must promote women's equality sports. We must be careful with sexist offensive messages, especially among students and peer groups, both boys and girls. **References** Bericat, E. (1998). La integración de los métodos cuantitativo y cualitativo en la investigación social. Significado y medida. Barcelona: Ariel. British Sport Council. (1994). The Brighton Declaration on Women and Sport. A Consejo Superior de Deportes. Retrieved from <http://www.csd.gob.es/csd/estaticos/myd/declaracion-brighton.pdf> Creswell, J. W. & Plano-Clarck, V. L. (2007). Designing and conducting mixed methods research. Thousand Oaks: Sage Publications. López Crespo, C. (2001). La cuestión de género en los valores asociados al deporte. Revista Tandem: Didáctica de la Educación Física, 2, 39-50. Valdemoros, M. A., Sanz, E. & Ponce, A. (2012). Educación informal y ocio juvenil. El influjo de los amigos en el abandono de la practica fisico-deportiva. Pedagogía Social. Revista Interuniversitaria, 20, 203-221. Retrieved from <http://dialnet.unirioja.es/descarga/articulo/3975309.pdf>

#### THE POTENTIAL OF OUTDOOR EDUCATION ACTIVITIES FOR PROMOTING GIRLS' MOBILITY IN PUBLIC SPACE

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**Introduction** It is a major educational objective to support children and adolescents in their development, particularly when it comes to the participation in cultural, public, social as well as sportive concerns (Report on Children and Youth, 2013). Especially girls living in segregated and deprived areas are disadvantaged as they lack in access to public sporting areas and sport clubs (Brandl-Bredenbeck et al., 2015). Urban social spaces enable experiences of places, PA, and encounters with the unknown (Graumann, 2002). The main aim of an outdoor education project was to encourage girls to interact with their social, cultural and public surroundings. By encountering their vicinities they learned how to participate and appropriate public space via PA. The development of social competences and also motor



skills were central. Methods Questionnaires were provided for girls from three schools (N=27, 7-14ys) after every workshops (t1/t2/t3) and 10 weeks after the project (t4). Additionally observation protocols were kept. A year after the project group interviews (N=4) were conducted to evaluate possible changes in mobility and activity behavior. In the last step all data was intermingled. Results Results show that the family and peers are important for an active lifestyle, but environmental factors and perception of surroundings seem not to influence active space appropriation. Although the girls criticize their surroundings they don't leave their nearby areas and don't use their broadened social networks. As it appears guided extracurricular activities and the trainer are of pivotal importance for increasing active mobility. Discussion The findings highlight the great potential of experiential education in the course of extracurricular activity programs for enabling girls to become acquainted with their environments and expanding their social networks and skills. In order to promote sustainable active mobility an increased awareness of the individual lifeworlds (Spatscheck et al., 2009) is crucial. The predominant close relationships between the girls and the trainers appear to be of high significance for enabling girls to participate in and actively appropriate public space. References Brandl-Bredenbeck et al. (2015). 3rd Children and Youth Sports Report. Schorndorf: Hofmann. Graumann, C.F. (2002). In R.B. Bechtel & A. Ts'erts'man. Handbook of environmental psychology (p. 95-113). Spatscheck, C. & Wolf-Ostermann, K. (2009). Retrived from <http://www.sozialraum.de/the-socio-spatial-paradigm-in-social-work.php>. BMFSFJ (The Federal Ministry of Family, Senior Citizens, Women and Youth). (2013). 14th Report on Children and Youth. Contact [sophie.knecht@sport.uni-freiburg.de](mailto:sophie.knecht@sport.uni-freiburg.de)

## HEALTH BEHAVIOUR OF 10-14 YEAR OLD STUDENTS IN THE PERIOD FOLLOWING THE INTRODUCTION OF EVERYDAY PHYSICAL EDUCATION

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Introduction Physical education is a compulsory school subject in all member states, it plays an important role in establishing and maintaining physical and mental balance of health, and it also has key role in the education of healthy lifestyle. Hungary had outstanding results in the proportion of physical education lessons per week in the European Union even before (!) the introduction of everyday physical education (Eurydice Report 2013). However, problems are apparent: taking international researches in consideration, (Strong et al 2005) Hungarian youth do not exercise enough (Perényi 2014), the physical activity of that particular age group is not sufficient regarding their health (Barabás-Nagy 2012). A good number of international researches point to the fact that doing sports regularly (that is, every day) has beneficial effects on health and also on the formation of youth's health awareness (Shephard 2013). In Hungary the everyday physical education lessons were introduced in September 2012, one of the most important main reasons of which was to help the students change their health behaviour and willingness to do sports, in a long term period, and help these changes to be durable as an effect of physical education lessons (NAT 2012, Mikulán 2013). The theoretical bases of our study are the implementational researches (Halász-Fazekas 2012) and the close examination of questions regarding curricular theory (Hamar-Ladislav 2008, Hardman-Marshall 2009, Rétsági 2014). Methods Data collection was conducted in Nyíregyháza (n=285), in May 2014 in four schools, with the help self-completion questionnaires. We were also interested in what kind of harmful behaviour examples can be found within the age group of 10-14 year old youth. Furthermore, aligning our research to the aims of NAT 2012 we sought answer to the question: what kind of values do the positive and negative attitudes regarding everyday physical education have among the students. We have also discussed the differences between gender and grades; we have employed factor analysis besides crosstable reference and frequency analysis. Results When we examine the gender differences in statements in connection with the everyday physical education, higher values appear with results outside school lessons and the affection towards physical activity and exercise for the boys, and doing less sports and being tired for the girls. According to our results, boys and students in general in higher grades consume more alcohol than others. Discussion The importance of our research is highlighted by the fact that the health status of the future generations are essentially important regarding both economical and financial questions and the competitiveness of the country. The everyday physical education lessons may add to this goal with their aims set; our research is also a contribution to this large research.

## EFFECTS OF AN OUTDOOR PARKOUR TRAINING SESSION TO THE EXPECTATIONS FOR AN UPCOMING INDOOR TRAINING SESSION – A QUALITATIVE INTERVIEW STUDY WITH YOUNG TRACERS

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Introduction: Parkour is a way of training, which allows us to confront obstacles. Expectations take an important part in training and performing Parkour. Tracers (Athletes of Parkour) can practice in urban terrain or in a gym. Preceding outdoor training sessions appear to have an impact on the expectations for upcoming indoor practices. This research displays the effects of self-efficacy experiences (outdoors) on the training expectations of young Tracers. Methods: 3 male Tracers (15, 17 and 18 years; at least 18 months Parkour training experience inside the gym/ no experience outdoor) participated in this study. Interviews were made right before a usual indoor Parkour training session. The intervention contained a common outdoor practice with other experienced Tracers. Right before the next indoor lesson a second interview session was conducted. These methodic interviews emphasized the prospects and the perceived self-efficacy. Transcriptions were made and the responses were ranked in a quaternary system. The categories were stepwise refined. The peculiarities (1 = low-response up to 4 = high-response) of the two interview sessions were listed and compared. Subsequently the Results were discussed on the basis of selected quotes of the transcriptions. Results: The interviews showed many differences in the ranking: All participants specified their personal main goal in the sport (+1, +1, +1). They mainly planned more innovative exercises (+3, 0, +1). One of them had an even better connection to his main goal (+2, 0, 0). Another one got much more autonomy and was able to point out a specific moment of perceived self-efficacy (0, 0, +2; 0, 0, +1). The participants became aware of their own strengths and weaknesses (+1, +1, 0) and increased their aim to confront it (+1, +2, +1). The only aspect that was decreased was the specificity of the target for the day (0, -1, -1). Discussion: The Subjects showed positive changes in all categories, except the concreteness of the day's target. The Tracers explained this decrease with their lack of experience in the new exercises, they planned to face now. The interviews showed an enhanced confidence and motivation for the following training session and their future in the sport. The self-efficacy experience showed a definite impact on the expectations to the following training. Caused by a low number of subjects the research cannot claim generality. However, it can be indicative for further studies or training schedules in this new and mostly uninvestigated sport. Contact: [marius.korthauer@rub.de](mailto:marius.korthauer@rub.de)

## EXAMINATION OF SELF-DETERMINATION WITHIN THE TEACHING PERSONAL AND SOCIAL RESPONSIBILITY MODEL IN PHYSICAL EDUCATION

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**Introduction** The current trend of physical education has turned to the emphasis on holistic development of students. The teaching personal and social responsibility (TPSR) proposed by Hellison (2011) is one of the most iconic models under this context. However, previous studies were still unable to identify the mechanisms of students' responsibility development. Based on the self-determination theory (SDT), different types of motivations are influenced by social factors through satisfying three basic psychological needs – competence, autonomy, and relatedness. (Deci & Ryan, 2002). The social factor described in SDT is conceptually in line with the positive learning environment emphasized by TPSR. Therefore, the study aims to examine whether students satisfied on autonomy, relatedness, and competence in TPSR. It is expected to identify the reason why TPSR can produce positive outcomes and further develop the strategies to enhance the TPSR implementation. **Methods** The participants were high school students in Taiwan. The experimental group (38 students) was the class participating in TPSR-implemented physical education while control group (36 students) received regular PE classes without any intervention. Pre-test was made on the first week and post-test was made on the 18th week. The actual experimental duration was 16 weeks. The measurement for both pre-test and post-test was the BPN-PE. Results MACOVA showed the main effect was significant (Wilks's  $\Lambda = .673$ ,  $F(3, 67) = 10.85$ ,  $p < .05$ ,  $\eta^2 = .33$ ). The between-subject effects suggested significant results in autonomy ( $F(1, 73) = 10.53$ ,  $p < .05$ ,  $\eta^2 = .13$ ) and relatedness ( $F(1, 73) = 23.81$ ,  $p < .05$ ,  $\eta^2 = .26$ ) but not in competence ( $F(1, 73) = 1.72$ ,  $p > .05$ ,  $\eta^2 = .03$ ). The results indicated the scores of experimental group were significantly higher on autonomy and relatedness than control group while there was no significant difference on competence. **Discussion** TPSR focused on the establishment of interpersonal relations between teacher and students as well as peers. The model also granted student with the power of decision making and allow them to have sufficient autonomy. Therefore, students in TPSR showed higher satisfaction on relatedness and autonomy. Nonetheless, no connection to competence was found in the framework of TPSR. Therefore, the effects of TPSR on the responsibility development may be generated by advance the satisfaction on autonomy and relatedness. Owing to the absence of competence support in the framework of TPSR, we suggest that the strategies of competence support could be integrated into TPSR. **References** Deci, E. L., & Ryan, R. M. (2002). *Handbook of self-determination research*. Rochester, NY: University of Rochester. Hellison, D. (2011). *Teaching responsibility through physical activity*. Champaign, IL: Human Kinetics.

## A FOCUS GROUP STUDY OF PE TEACHERS' CONFLICT MANAGEMENT STRATEGIES

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**Introduction** Physical education teachers are faced with a lot of conflicts during their work. This is natural, because interpersonal relationships already contain the conflicts (Coleman et al., 2014). If these conflicts get on surface, PE teachers try to solve them in a variety of ways. In my opinion, the quality of the management of conflicts is strongly influenced by the teaching-learning process efficiency, so we need a deeper analysis of the most common conflicts. **Methods** I conducted a focus group study with seven physical education teachers of different ages and different types of schools (Krueger and Casey 2009; Liamputtong, 2011). Among the participants there were men and women who were at the beginning, the middle and the end of their career of physical education teaching. The questions referred to the different types of physical education classes and the most common places, causes and conflict-resolving methods during different competitions. **Results** The findings of the study were that conflict management strategies were influenced mostly by the situations, the students' communication style, the type of physical education lessons and the age characteristics of the age groups. Such exercises should be differentially planned for the skill-developing lessons during the implementation of which all participants can experience a sense of achievement (Shimon, 2011). Physical education teachers need to create an atmosphere that reduces the probability of conflicts to the minimum. The personal example of physical education teachers may improve the situation. **Discussion** The aim of my lecture is to call attention to the factors which can influence the PE teachers' attitude in teaching-learning process efficiency. By this research I would like to help my PE teacher colleagues to develop effective conflict management. It turned out, that in order to achieve effective conflict management we need the following abilities: self-knowledge, selfcontrol, empathy, the communication style fitting the situation and tolerance. **References** Coleman Peter T. – Deutch Morton – Marcus Eric C. (2014): *The Handbook of Conflict Resolution. Theory and Practice*. Jossey-Bass. Krueger, Richard A.– Casey, Anne (2009): *Focus Groups: a Practical Guide for Applied Research*. SAGE Publications. Liamputtong, Pranee (2011): *Focus Group Methodology. Principles and Practice*. SAGE Publications. Shimon, Jane (2011): *Introduction to Teaching Physical Education. Principles and Strategies*. Human Kinetics. Contact zsolt.nemeth@gamma.ttk.pte.hu

## ROMA AND NON-ROMA CHILDREN'S MOTOR SKILLS

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**ROMA AND NON-ROMA CHILDREN'S MOTOR SKILLS** The Roma children have traditionally been disadvantaged in many cultures (Semoglou et al., 2008; Walls, 2013). Poverty and common social exclusion of that ethnic group largely determine child's academic success, moreover school deprivation and residential segregation could also cause underdevelopment of motor skills and related intercultural differences in overall motor performance. That was partially confirmed in the study by Semoglou et al. (2008), which found that Greek-Roma preschool children significantly underachieved in visual motor integration, but not in the gross motor skills. In another Greek study, Tsimaras et al. (2011) reported that Greek-Roma children (7-10 yrs) performed significantly poorer in locomotion skills, handling skills and general motor ability. Similarly, Zsidegh et al. (2007) found on a sample of Hungarian-Roma boys (7-14 yrs) that they were significantly inferior in running. The aim of the present study was to evaluate possible differences in motor skills among Roma and non-Roma children in Croatia. Convenient sample of 114 children (57 Roma children) aged 10, who attended two primary schools in northern Croatia, were assessed using MABC-2 (Henderson et al., 2007). According to percentile norms of the test, 4 children fall in the category of "motor impairment" while another 5 fall in the "risk for impairment", and 7 of them were Roma minority. To test the differences in motor skills, a MANOVA 2 (gender) x 2 (ethnicity) was applied with 3 component standardized scores (manual dexterity, aiming and catching and balance) and total standard score as dependent variables. MANOVA showed significant gender (Wilks'  $L = .729$ ,  $F(4,107) = 9.956$ ,  $p = .000$ , part. eta sq. = .271) and ethnicity (Wilks'  $L = .754$ ,  $F(4,107) = 8.729$ ,  $p = .000$ , part. eta sq. = .246) effects. Subsequent univariate analysis showed that the girls were better in manual dexterity  $F(1,110) = 15.350$ ,  $p = .000$ , part. eta sq. = .122 while the boys outperformed girls in aiming and

catching  $F(1,110)=12.935$ ,  $p=.000$ , part.  $\eta^2=.105$ . Also, non-Roma children were better than Roma children in manual dexterity  $F(1,110)=23.840$ ,  $p=.000$ , part.  $\eta^2=.178$ ; balance  $F(1,110)=16.565$ ,  $p=.000$ , part.  $\eta^2=.131$ ; and total test score  $F(1,110)=25.610$ ,  $p=.000$ , part.  $\eta^2=.189$ . The MANOVA also yielded gender x ethnicity interaction effect (Wilks'  $\Lambda=.910$ ,  $F(4,107)=2.642$ ,  $p=.038$ , part.  $\eta^2=.09$ ) but the only significant univariate difference was found in aiming and catching favoring non-Roma boys. The current study shows delayed development of the motor skill's in Roma children. The probable cause are different social and environmental factors but also (im)possibilities for learning and practice. References Henderson, S. E., Sugden, D. A., Barnett, A. L. (2007). Movement Assessment Battery for Children-2. London: Harcourt Assessment.

## PRACTICING CONSIDERATION ABOUT NOGUCHI TAISO; CASE STUDY IN A WORKSHOP OF FEMALE COLLEGE STUDENTS

HATANO, Y., OTAKE, R.

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Introduction Dance has become increasingly important in the curricula within Japanese physical education in schools along with growing popularity of dance in modern society. Despite the rapid expansion of educational opportunities for dance, most students seem to have technical difficulties in maintaining a balance between tenseness and relaxation of their muscles during the physical movements of a dance performance. In the present study, the authors focused on techniques for muscle relaxation rather than muscle tension to improve movement skills, and examined the effectiveness of the Noguchi Method, a teaching method for physical education emphasizing relaxation, when teaching dance in a workshop for female university students. Methods The philosophy and details of the Noguchi Method were explored through an examination of written sources. The study also examined the ethnographic aspects, of teaching the Noguchi Method, taught by one of the successors of the Noguchi Method, in a workshop for eight female university students. Results Noguchi Method, which is referred to as "Noguchi Taiso" in Japanese, was established by Michizo Noguchi, as a method of physical exercise in Japan. The concepts of the movements of Noguchi Taiso are characterized as the most economical way to move, and reliance on the weight of the body. The most famous book on the Noguchi Taiso was written by Misao Hatori. Also several Butoh dancers discuss the method as a techniques of contemporary dances on the Web-site of Noguchi Taiso. The workshop students were asked to write their opinions of the workshop. They were categorised based on the KJ method, as 'discovery of their own body', 'the function of Nogu Discussion The students felt how to use their bodies to generate relaxation and power, in ways different from usual movements. At the practitioner's workshop, it was possible to remove muscle movements and power in ways that differed from the usual techniques. It is thought that the Noguchi Method is effective for not only the body but also mind for students in dance education. References Mikami K,(2006).Tatsumi Hijikata-The Reception and Transformation of Dance of Darkness(2)Body, Language, and Image - With insights from the Noguchi gymnastics Method and Miki Morphology -Journal of Kyoto Seika University 31, 135-154 Hatori M, (2004) Nogutitaisou kotoba ni kiku Nogutimitizou Goroku, Syunjusya Hatori M, (1999)Noguti Taisou Sizen Jikiden Nogutimitizou Goroku Hakujusya Kasai T,(2006) The Principle of Somatic Psychotherapy and the Viewpoint of Body-Learning Therapy, SapporoGakuin University Kobayashi K,(2008) The development of "NOGUCHI-TAISO"-Michizo Noguchi's exploration of gymnastics-(<http://gym.tsukubauniv.jp/wordpress/wp-content/uploads/2008/04/mike.pdf>, 1. Feb. 2016) Contact : hatano@kobe-shinwa.ac.jp

## Mini-Orals

### MO-BN12 Motor Learning

#### COORDINATION BETWEEN RACKET AND BALL:AGE EFFECT ON INFORMATION STRATEGY IN TABLE TENNIS SERVICE

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*National Taiwan Normal University*

Introduction Table tennis is a sport of interceptive actions. The coordination between the ball and racket, or timing performance, plays paramount importance in executing the interceptive actions in table tennis. The affordance of the environment reflects the coupling relations between an individual and the environment, which may be considered as an information strategy that is adopted by the individual to guide the skill development. When performing the same interceptive action, table tennis players of different developmental stages may use different information strategies due to their different experience and growth factors. The fast deep flat service is one of the most fundamental yet important table tennis skills that should be mastered in the early stages of training. The purpose of the study was to examine the different information strategies used by children and adult table tennis players when performing the fast deep flat services. Methods 8 male collegiate table tennis club players (19-22 yrs), and 8 boys (9-10 yrs) from the table tennis team of an elementary school participated in the study. Participants were asked to aim for a 30x30 cm<sup>2</sup> target area and performed 20 fast deep flat services. 2 high-speed cameras and the Kwon 3D digitizing system were used to capture the kinematics of the ball and racket. Independent sample t-tests were used to compare the service and timing performances of two groups. Pearson product-moment correlations were calculated to examine the various relations of the timing measures for each group. Results There were no significant differences for the service performances measured in the rate of hit, racket velocity at ball-bat contact, and the maximal forward velocity of the racket between the 2 age groups. However, children had significantly more variability in the performance of movement initiation than adults. In addition, children also showed a significantly higher coefficient of correlation between the racket velocity and the distance to the ball-bat contact at the start of forward acceleration phase. Discussion It was expected that there would be no difference in the service performance between the 2 groups because both groups of participants had been trained in table tennis for about 2 years. However, the differences of the various timing performance measures between the age groups reflected the different information strategies adopted by different age groups as a result of the difference in their developmental stages. Although children had more variability in the movement initiation, they were able to successfully carry out the service performance with the tight coupling between these movement initiation parameters. Adults, on the other hand, were able to use the information of the ball to control the movement initiation and showed a more stable timing performance than children. Future studies will examine table tennis players of different skill levels in order to explore the relation between timing performance and skill level.

## DUAL-TASK PERFORMANCE DIFFERS BETWEEN STAIRCASE ASCENT AND DESCENT IN YOUNG ADULTS

GAILLARDIN, F., BAUDRY, S.

*Université libre de Bruxelles*

**Introduction** Staircase negotiation is among the most challenging locomotor activities, with staircase descent being reported as the most hazardous aspect of staircase negotiation. Previous work has reported that a cognitive task performed while stepping upstairs (2) and downstairs (3) altered the kinetics of staircase negotiation, but no study has compared the dual-task performance between ascent and descent. Furthermore, reporting the pattern of change only in the motor task cannot account of the trade-off for performance between motor and cognitive tasks. The purpose of the present study was to compare the influence of dual-tasking between stepping upstairs and downstairs in young adults. **Methods** Ten young adults stepped up and down a 3-step staircase equipped with force platforms in two conditions: 1/ without concurrent cognitive task (single motor task); 2/ while recalling a list of words provided prior to staircase negotiation (dual-task). The cognitive task was also performed in a seated position (single cognitive task). Performance in motor and cognitive tasks was measured as the duration of the ascent or descent, and the number of words recalled, respectively. Motor and cognitive dual-task costs (DTC) were calculated as follows: (dual task performance – single task performance)X100/single task performance. The combined DTC was calculated as follows: (cognitive DTC + motor DTC)/2 (4). **Results** The duration of staircase negotiation was greater in dual- than single-task condition ( $p=0.002$ ). Motor DTC was greater during staircase descent ( $+34.2\pm26.4\%$ ) than ascent ( $+15.0\pm21.5\%$ ;  $p=0.004$ ). In contrast, the cognitive score did not differ between single- and dual-task conditions ( $p=0.077$ ), with no difference in cognitive DTC between staircase descent ( $-4.0\pm11.0\%$ ) and ascent ( $-9.9\pm13.8\%$ ;  $p=0.29$ ). The combined DTC was greater when stepping downstairs ( $+19.1\pm16.6\%$ ) than upstairs ( $+12.4\pm13.4\%$ ;  $p=0.035$ ). **Discussion** This study is the first to compare DTC between staircase ascent and descent. The results indicate that the combined DTC was greater during staircase descent than ascent, mainly due to the greater motor DTC during descent. This may rely on the greater biomechanical constraints of staircase descent (1), which may reduce the ability to share adequately the attentional resources. These results can have relevant implications for our understanding of the greater risk of falls in staircase descent. **References** 1. Reeves et al. (2008). *J Exp Biol* 19:57-68 2. Vallabhaiahosula et al. (2015). *J Biomechanics* 48:921-929 3. Telonio et al. (2014). *Exp Gerontol* 50:26-33 4. Logie et al. (2004). *Neuropsychol* 18:504-513 This study is supported by a grant of the King Baudouin Foundation (Belgium). [florence.gaillardin@ulb.ac.be](mailto:florence.gaillardin@ulb.ac.be)

## SUCCESSFUL NATIONAL SAILORS EXHIBIT BETTER VISUAL SEARCH STRATEGIES DURING A RADIO CONTROLLED SIMULATED EVENT

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The aim of the present research was to investigate the visual search strategies of South African sailors during a radio controlled simulated race. Twenty-two sailors completed three radio controlled match races while wearing a mobile eye tracker (ASL Mobile Eye). Races lasted an average of 197.51 ( $s = 40.05$ ) seconds. Assessed variables included the race performance, the search rate (total fixations, average fixation duration, frequency) and the percentage viewing time. Sailors were grouped according to professional sailing history rank, success rate in the simulation and their respective sailing classes. The results revealed that the top ranking group performed 13.9% fewer fixations per second compared to the bottom ranking group ( $p = 0.03$ ). In terms of success rate, the successful group exhibited a more efficient visual search strategy consisting of fewer fixations ( $p = 0.01$ ) of longer duration ( $p = 0.34$ ). The dinghy class differs between the keelboat class ( $p = 0.02$ ) and the multihull class in the percentage viewing time to the BOAT HULL location. This suggests that these sailors identified this location as a more valuable source of information.

## DOES VISUAL SEARCH STRATEGY CHANGE DURING SOCCER PENALTY KICKS TAKEN WITH THE DOMINANT VS. NON-DOMINANT FOOT?

BAKER, J., SCRUTON, A., VAN PARIDON, K., TIMMIS, M.A.

*Anglia Ruskin University*

**Introduction-** When taking a soccer penalty kick, research has shown that a number of factors impact a player's visual search strategy. To date, there is no research investigating whether the visual search strategy during penalty kicks changes when comparing the dominant against the non-dominant foot. This was the focus of the present study. **Methods-** 10 soccer players were recruited and took two penalty kicks with the dominant and non-dominant foot. The study took place indoors in accordance to The Football Association (F.A.) guidelines for indoor football. A goalkeeper stood in the centre of a goal measuring 3.66m wide by 1.83m high. A football was placed 6 metres from the centre of the goal. Eye movements of the penalty takers were recorded using SMI Eye tracking glasses. Peak horizontal velocity and resultant velocity for both the dominant and non-dominant foot were recorded along with the end location of the football. **Results-** The football was kicked with significantly greater velocity with the dominant compared to the non-dominant foot ( $m=14.3\pm1.4m.s^{-1}$ ,  $11.6\pm1.5m.s^{-1}$  respectively,  $p=.005$ ). Furthermore, the ball was kicked significantly wider towards the edge of the goal in the dominant compared to non-dominant foot / penalty ( $p=.002$ ). The overall duration of the penalty was significantly longer in the non-dominant compared to the dominant penalty ( $m= 5.20s \pm 1.16$ ,  $4.53s \pm 0.76$ , respectively  $p=.013$ ). When executing the penalty with the dominant foot, players showed a trend of longer relative fixation length towards the edge of the goal compared to the non-dominant foot ( $p=.052$ ). Relative fixation length was significantly shorter on the ball ( $p=.004$ ) with fewer relative number of fixations on the ball in the dominant compared to non-dominant foot ( $p=.004$ ). In the dominant penalty, players have longer fixation in the 'gap' between ball and goal compared to the non-dominant penalty ( $p = .030$ ). **Discussion/conclusion-**Results highlight a difference between visual search strategies when executing a penalty with the dominant compared to non-dominant foot. With the dominant penalty, players fixated and kicked wider within the goal compared to the non-dominant penalty. Penalties executed with the non-dominant foot took significantly longer to complete with greater frequency and length of fixation on the ball. Interestingly, with the dominant foot, players fixated the gap between the ball and goal, appearing to utilise peripheral vision to guide the approach to the ball. These findings suggest an association of increased skill mastery on the dominant foot. Further work should address this association in professional players.



## IS VISUAL SEARCH STRATEGY DIFFERENT BETWEEN SCORED AND SAVED PENALTY KICKS FROM THE SAME SOCCER PLAYER?

TIMMIS, M.A., VAN PARIDON, K.N.

*Anglia Ruskin University*

**Introduction-** The visual search strategies employed by soccer players when executing the penalty kick has received widespread research interest. To date, there is no research investigating the differences between visual search strategies in consecutive penalties which are scored and saved by the same soccer player. This was the focus of the present study. **Methods-** 30 amateur soccer players were recruited and took 2 placement penalty kicks, indoors, according to The Football Association (F.A.) guidelines for indoor football. The placement penalty required players to kick the football accurately to a corner of the goal. Eye movements of the penalty taker were recorded using SMI Eye tracking glasses. End location of the football was also recorded. Only those players who both scored and had their penalty saved by the goalkeeper (either order) were retained for analysis; 12 players met this criteria. **Results-** Saved penalties were kicked significantly more centrally in the goal ( $p < .001$ ). This was a result of increased length of time ( $p = .002$ ) and frequency ( $p = .011$ ) spent fixating to the goalkeeper in the approach phase prior to taking the penalty. This subsequently resulted in reduced fixation time on the ball ( $p < .001$ ). In the final steps of the approach, immediately prior to kicking the ball, players who had their penalty saved increased length of time spent fixating on the area immediately ahead of the ball ( $p = .005$ ) and initially fixated to this area earlier in the approach ( $p = .025$ ). The earlier fixation on the area immediately ahead of the ball in the saved penalty resulted in players having reduced quiet eye (QE) period ( $p = .03$ ) which ended earlier prior to kicking the ball ( $p = .008$ ). **Discussion/conclusion-** The current study found that saved penalties were the result of the penalty taker kicking the ball more centrally in the goal i.e. closer to the goalkeeper. This effect may be attributed to the distracting effect of the goalkeeper (despite standardising goalkeeper instructions; Wood and Wilson, 2010). During the saved penalty, in the final approach to the ball, players disengaged (fixated away) from the ball earlier prior to kicking the ball. Shorter QE periods, which also end earlier prior to the end of the action have been identified as a cause of task failure. Fixating away from the ball and making a predictive saccade in anticipation of tracking the ball after being kicked (c.f. Mann et al., 2013) may have impacted the quality of foot-ball contact, subsequently affecting kicking accuracy. Mann, DL. Spratford, W. Abernethy, B. 2013. doi: 10.1371/journal.pone.0058289 Wood, G. Wilson, MR. 2010. doi: 10.1080/02640414.2010.495995.

## DEVELOPMENT AND VALIDATION OF A PROXY FOR GAZE BEHAVIOUR MEASUREMENT IN FOOTBALL.

OPPICCI, L.1, PANCHUK, D.1,2, SERPIELLO, F.R.1, FARROW, D.1,2

*Victoria University*

**Affiliation:** 1: Institute of Sport, Exercise and Active Living (ISEAL), Victoria University, Melbourne, Australia. 2: Australian Institute of Sport (AIS) **Introduction:** Wearable, head-mounted eye trackers are widely used in sport-psychology research to assess eye movements and provide insights into perceptual-cognitive changes underpinning the development of sport skill. Where possible, the assessment of eye movements should take place in the performer's natural environment as decision making and attentional processes are constrained by the environmental cues the performer is responding to. However, quick head movements and ground impact in dynamic tasks, such as football games, affect the reliability in detecting eye features, limiting the evaluation of gaze location. We developed a new approach to deal with this issue and validated a method that uses head orientation as a proxy for gaze measurement in football. A window, using gaze coordinates, was designed to derive the gaze location in the absence of point-of-gaze references and validated against the gold standard point-of-gaze method. **Methods:** Forty-eight youth football players performed 6 v 6, small-sided games on a modified pitch. The raw gaze coordinates on the x- and y-axes of 6 players were plotted to analyse the dispersion of gaze. Two standard deviations from the mean were used to capture the majority of gaze behaviour (95.44%) and in turn develop an empirical coding window to classify the gaze in two gaze regions of interest, described as player-directed or ball/ground-directed. To validate the new method, footage collected from the eye tracker of 12 players were coded frame-by-frame using the empirical window and compared to the standard point-of-gaze coding. **Results:** The overall agreement between the two methods was 90%. However, this rate of agreement does not account for the agreement expected by chance. Cohen's kappa value, which corrects for this, was 0.64 ( $p < 0.001$ ). Furthermore, the distribution of the categories in the data was skewed as 2830 belonged to one category and 597 belonged to the other. The kappa value was influenced by this prevalence issue and the adjusted-kappa (PABAK) was 0.80, indicating substantial agreement between the two methods. **Discussion:** Locomotor activities, in general, create noise in gaze data and this new coding method, using a window derived from gaze location coordinates, is a valid approach to overcome potential issues when assessing eye movements in dynamic tasks, such as football small-sided games. Researchers operating in the field may use this approach when dealing with poor quality data and it may encourage researchers to perform their experiments in participant's natural environments. Contact luca.opplici@live.vu.edu.au

## RELATIONSHIP BETWEEN FUNDAMENTAL MOVEMENT SKILL COMPETENCE AND BEHAVIORAL MOVEMENT PATTERNS DURING FREE PLAY IN PRESCHOOL CHILDREN

SASAKI, R., ISHIZAWA, J.

*Keio University*

**Introduction** Children with greater access to physical activity may have more opportunities to develop their fundamental movement skills (FMS); in contrast, children with limited access may have correspondingly fewer opportunities (Gallahue et al., 2012). It would be important to provide children with many opportunities to experience various physical movement patterns in early childhood. In the present study, we compared behavioral movement patterns among children with and those without sufficient FMS competence during free play activities to determine what support preschool children may require in FMS acquisition. **Methods** Participants were typically developing children (both boys and girls) aged 5–6 years. We made video recordings of participants during a free play period in their kindergarten for 30 minutes consecutively. From this video footage, we observed and categorized children's movements in terms of moment-to-moment changes in all behaviors (e.g., "walk," "run," "sit/squat," "throw," "kick"). Then, we analyzed the numbers of occurrence of movement, the frequency that it occurred on a minute-by-minute basis, and the time duration of each movement. We then compared the behavioral patterns of children according to their FMS competence. **Results** We observed more movement categories among children with higher FMS competence than among children with lower competence. Furthermore, children with higher FMS competence tended to engage in each movement more frequently per minute and for longer than did children with lower FMS, particularly at the beginning of the observation period. Sedentary behavior was more frequently observed among children with lower FMS competence, particularly among girls. Among children with higher FMS competence, we observed whole body movements and multiple movements more frequently. **Discus-**

sion The results indicated that children with higher FMS competence tended to have longer and more varied and complex behavior patterns (e.g., multiple simultaneous movements). Although children with lower FMS competence did engage in locomotion, their movements were rather simple (e.g., walking and running) and less varied during free play activities. Previous research has indicated that greater motor competence promotes higher levels of physical activity, which in turn gives children more opportunities to enhance their FMS competence (Gallahue et al., 2012). Notably, we observed gender differences in sedentary behaviors, with them occurring more frequently among girls than among boys. In a previous study, it was suggested that improving FMS competence can potentially lead to more physical activity and less sedentary time among children (Capio et al., 2015). Based on our findings, we must point out that there is a need to provide organized opportunities that facilitate children's acquisition of FMS, which may include teaching unfamiliar movements, usage of play equipment, and providing appropriate spaces. References Gallahue et al. (2012), Understanding Motor Development, 7th. Capio et al. (2015), J Sport Health Sci., 235-243.

## **A SYSTEMATIC REVIEW OF GAIT PERTURBATION PARADIGMS FOR IMPROVING REACTIVE STEPPING RESPONSES DURING WALKING AND REDUCING FALLS IN OLDER PEOPLE**

MCCRUM, C.1,2, GERARDS, M.1, KARAMANIDIS, K.2, ZIJLSTRA, W.2, MEIJER, K.1

1: Maastricht University, The Netherlands. 2: German Sport University Cologne, Germany.

**Introduction** Falls in older people most often occur due to trips or slips during walking (Berg et al. 1997). Consequently, there is a need to prepare older adults to cope with unexpected mechanical disturbances to gait. As involuntary, compared to voluntary, stepping responses to perturbations are faster (Luchies et al. 1999), unexpected gait perturbations may be the most task-specific stimulus (Oddsson et al. 2007). Therefore, we systematically searched for studies that applied unexpected mechanical disturbances to walking in older adults, in order to determine which characteristics of such paradigms can improve reactive stepping responses during walking and reduce falls in older people. **Methods** A systematic search of PubMed, Web of Science, MEDLINE and CINAHL databases was conducted with sets of terms relating to gait, perturbations, adaptation and ageing. Inclusion criteria were that the studies were conducted with healthy participants with a mean age of 60 years or older, that the studies applied repeated mechanical perturbations of an unpredictable nature during walking, and that reactive stepping responses to gait perturbations or numbers of laboratory or daily life falls were recorded. **Results** The search yielded 3332 unique results. After title, abstract and full text screening, 10 studies met the inclusion criteria, with two using the same experiment. In these studies, moveable floor platforms (n=5), ground surface compliance changes (n=2) and treadmill belt accelerations or decelerations (n=3) were used to perturb gait in older people. Single sessions of 5 (n=1), 16 (n=1), 20 (n=1) and 24 (n=4) perturbations led to improved reactive stepping responses to perturbations, with one study showing transfer to another perturbation task. Two studies did not report the number of perturbations used. One study reported retention and a 50% reduction in daily life falls over the 12 months post-session. One study assessed the influence of additional sessions, reporting improved retention at six months, when an additional single perturbation was experienced three months post-session. **Conclusion** Single sessions of repeated gait perturbations can improve the reactive stepping responses of healthy older adults. Two studies have found that adaptations can be retained, but this requires further investigation, as it is unclear how perturbation magnitude, variability, frequency, number and type affect retention or falls incidence after undergoing perturbation sessions. **References** Berg et al. Age Ageing, 1997;26:261-8. Luchies et al. J Gerontol A Biol Sci Med Sci, 1999;54:140-4. Oddsson et al. Eur Rev Aging Phys Act, 2007;4:15-23. Contact [chris.mccrum@maastrichtuniversity.nl](mailto:chris.mccrum@maastrichtuniversity.nl)

**16:15 - 17:45**

## **Invited symposia**

### **IS-PM06 HIT training - Mechanisms and applicability**

#### **HIT TRAINING - MECHANISMS OF ADAPTATION**

GIBALA, M.

McMaster University

Interval exercise refers to the basic pattern of alternating periods of more intense effort with period of less intense effort, or complete rest, within a single training session. Owing to the wide variety of terms used to describe this basic type of exercise, a classification scheme was recently proposed to delineate "high intensity interval training" (HIIT) from "sprint interval training" (SIT) (1). HIIT generally refers to submaximal exercise protocols in which the workload elicits a relative intensity corresponding to  $\geq 80\%$  of peak heart rate. SIT describes protocols in which the intensity corresponds to  $\geq 100\%$  of the workload that elicits maximal oxygen uptake ( $\text{VO}_{2\text{max}}$ ). Dating back several decades, numerous studies have examined physiological adaptations to HIIT and traditional moderate-intensity continuous training (MICT), matched for total work or energy expenditure. While these have yielded equivocal results, several recent systematic reviews and meta-analyses have concluded that HIIT elicits superior physiological adaptations in both average healthy individuals and people with lifestyle-induced cardiometabolic disease (1-3). Research over the last decade in particular has shed new light on the potency of low-volume interval training, which involves a relatively small total amount of exercise, to elicit physiological adaptations that are comparable to MICT in a time-efficient manner (4). Studies that have directly compared MICT to low-volume HIIT or SIT protocols have reported similar improvements in markers of aerobic energy metabolism, as well as clinical indices of health status, despite large differences in total exercise and training time commitment. Recent evidence supports the general contention that exercise intensity is more important than duration for exercise training-induced increases in cardiorespiratory fitness (5). In contrast, the specific roles of intensity, duration and volume on aspects of exercise-induced skeletal muscle remodelling, in particular mitochondrial biogenesis, are equivocal (6). Recent work suggests the potential for SIT to promote greater and faster mitochondrial adaptations in human skeletal muscle than does HIIT or MICT despite a much lower training volume (7). It was also reported in humans that muscle fibre-type specific responses to SIT were strikingly similar to MICT despite lower training volume (8). (1) Weston KS, et al. Br J Sports Med. 48:1227-1234, 2014. (2) Bacon AP, et al. PLoS One. 8:e73182, 2013. (3) Milanović Z, et al. Sports Med. 45:1469-1481, 2015. (4) Gibala MJ, et al. J Physiol. 590:1077-1084, 2012. (5)

Ross R, et al. Mayo Clin Proc. 90:1506-1514, 2015. (6) Bishop DJ, et al. Biochim Biophys Acta. 1840:1266-1275, 2014. (7) Granata C et al. FASEB J. 2015 Nov 16. (8) Scribbs B et al. PLoS One. 9:e98119, 2014.

## HIT TRAINING IN HEART PATIENTS - DOES IT WORK?

PRESSLER, A.

*Technical University Munich*

Twenty years ago chronic heart failure was considered a contraindication for regular physical activity. Many believed to be counterproductive to recovery and perhaps harmful to chronic heart failure patients. However, in recent years numerous studies have proven the feasibility and safety of exercise training in heart failure patients. Exercise now plays a pivotal role in the treatment of systolic heart failure in addition to medical or device-related therapy. Regular exercise has been shown to increase exercise capacity and quality of life, as well as reduce symptoms and lower hospitalization rates. It also has the potential to increase left ventricular ejection fraction and reduce mortality. However, the dose of exercise to induce these effects is still uncertain. During recent years high-intensity exercise has been investigated in heart failure patients. These data reveal superior effects than with moderate training, however, large data sets are scarce and optimal medical therapy has to be assured. Including HIT into the regular treatment of patients with heart failure needs a detailed medical examination and a tailored exercise program including also other modes of exercise as moderate intensity endurance and resistance exercise.

## HIGH INTENSITY INTERVAL TRAINING AS A CURE FOR TYPE 2 DIABETES?

DELA, F.

*University of Copenhagen*

Type 2 diabetes is characterized by a combination of insulin resistance, insufficient insulin secretory capacity and genetic disposition combined with excess energy intake and physical inactivity. Physical training alleviates insulin resistance, may improve insulin secretory capacity and improves glycemic control in patients with type 2 diabetes. Large clinical studies lifestyle interventions including weight loss and increased physical activity have shown fewer hospitalizations, fewer medications, and lower health-care costs, but on specific cardiovascular endpoints the results have been disappointing in large scale studies. Thus, while there is no question about the effectiveness of physical training as medicine for insulin resistance, the major problem is that the patients do not take the medicine. There are many barriers to overcome and motivation, safe environments, convenience and lack of time are considered to be among the major reasons for not exercising on a regular basis. High intensity interval training (HIIT) with short periods of intense exercise interspersed with brief periods of rest is a time efficient exercise modality which might surpass some of the barriers. As with almost any kind of exercise, an acute high intensity training bout will lower glucose concentrations in patients with type 2 diabetes. However, the longer term (training for 2 weeks or more) studies that have been conducted in patients with type 2 diabetes have generally used insufficient methods for determining the effect of HIIT on insulin secretion and sensitivity, which are the key parameters in the pathophysiology of type 2 diabetes. Hence, by using measurements of interstitial glucose concentrations, HOMA or HbA1c, either marginal or no effect and significant effects of HIIT on glucose homeostasis have been reported. None of the previous studies have used the gold standard for assessment of insulin sensitivity, the glucose clamp technique and none have studied specifically skeletal muscle, which the tissue that takes up the vast majority of glucose during insulin stimulation. Previous studies have addressed the molecular effects of high intensity interval training in skeletal muscle but only one study in patients with type 2 diabetes. In general these studies shows that HIIT leads to increases in proteins (activity and/or content) related to mitochondrial biogenesis, such as citrate synthase (CS), complexes in the mitochondrial respiratory chain, silent mating-type information regulator 2 homolog 1 (SIRT1), peroxisome proliferator-activated receptor  $\gamma$  coactivator-1 $\alpha$  (PGC-1 $\alpha$ ), mitofusin (Mfn)-2. Also skeletal muscle GLUT4 protein and glycogen content seem to increase with HIIT, and furthermore, an increased capacity to fat oxidation (less exercise induced decrease in glycogen and increased hydroxyl-acyl-dehydrogenase (HAD) activity) takes place after HIIT.

## Invited symposia

### IS-PM07 Mitochondrial function and adaptation to stressors

#### EFFECTS OF HIGH INTENSITY TRAINING ON MITOCHONDRIAL FUNCTION IN SUBCUTANEOUS ADIPOSE TISSUE AND SKELETAL MUSCLE

LARSEN, S.

*University of Copenhagen*

In the last couple of years high intensity training (HIT) has again been studied intensively. HIT has been shown to increase maximal oxygen uptake (VO<sub>2</sub>max) and skeletal muscle mitochondrial oxidative phosphorylation (OXPHOS) capacity in young male subjects. Furthermore it has also been reported that HIT improves glucose tolerance in young subjects, this effect could potentially be via a reduction in reactive oxygen species (ROS) production from the skeletal muscle, but this has never been investigated after HIT before. The literature is sparse, when it comes to HIT in older females and males. Furthermore mitochondrial respiratory capacity has not been investigated after HIT in subcutaneous adipose tissue previously. During the talk it will be discussed if the effect of HIT is similar between young and old subjects when it comes to mitochondrial respiratory capacity. Furthermore it will also be discussed if HIT improves glucose tolerance in a similar way as endurance training, and if this potential improvement can be linked to an improved ROS level in the skeletal muscle.

## ARE RESISTANCE TRAINING-INDUCED IMPROVEMENTS OF MITOCHONDRIAL FUNCTION EFFECTIVE FOR THE MANAGEMENT OF METABOLIC DISEASES?

PESTA, D.

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The prevalence of type 2 diabetes (T2D) is rapidly increasing with about 9% of the adult population affected worldwide, thus putting an enormous economic burden on healthcare systems. Non-pharmacological treatment strategies to manage and prevent this disease are urgently needed. Resistance training is gaining recognition as an effective means to promote health benefits through an increase in muscle mass and strength. However, resistance training can induce health benefits beyond those associated with augmented skeletal muscle mass, such as qualitative adaptations within skeletal muscle including enhanced glucose transport and improved mitochondrial function. Impaired mitochondrial function is frequently observed in individuals with T2D and is implicated as one of the underlying causes for T2D progression. In particular, mitochondrial adaptations triggered by resistance training provide evidence for this type of exercise as a promising lifestyle recommendation to combat T2D. Future clinical intervention studies in humans should elucidate the link between resistance training and mitochondrial function in order to validate the benefits of this training modality on mitochondrial adaptations in individuals with type 2 diabetes.

## MITOCHONDRIAL FUNCTION, HYPOXIA AND REACTIVE OXYGEN SPECIES - FRIEND OR FOE?

BAILEY, D.

*University of South Wales*

Photosynthesising cyanobacteria breathed life into what was, until a billion years ago considered a reductive atmosphere, thus providing a selective pressure for the evolution of (oxygen) O<sub>2</sub>-dependent micro-organisms that began with the autotrophic eukaryotes. Since these primordial times, the respiring mammalian cell has become entirely dependent on molecular O<sub>2</sub> since it serves as the terminal electron acceptor in mitochondrial oxidative phosphorylation and multiple enzymes require O<sub>2</sub> as a substrate. The human brain exemplifies this reliance on O<sub>2</sub> since, unlike most other tissues, it is committed to a continually active state. However, this obligatory high rate of cerebral O<sub>2</sub> consumption comes at a cost, since it is associated with a correspondingly high vulnerability for failure. Given that the brain's O<sub>2</sub> supply is so delicate, it would seem likely that evolution has favoured a feedback mechanism that senses tissue pO<sub>2</sub> and consequently transmits a signal to the vasculature coupling local O<sub>2</sub> delivery to tissue metabolic demand. Though traditionally considered damaging toxic "accidents of chemistry" (the bad and ugly!), the current presentation will reappraise emerging evidence for mitochondrial reactive oxygen species (ROS) as "upstream" signal transductants that can signal the onset of hypoxia through thiol redox signaling and "downstream" activation of transcription factors and initiation of post-translational responses that collectively serve to defend vascular O<sub>2</sub> homeostasis (the good!).

## Invited symposia

### IS-SP01 Heat and altitude training for elite athletes sponsored by Aspetar

#### APPLICATIONS OF HEAT ACCLIMATION FOR COMPETITIVE SPORT PERFORMANCE

DAANEN, H.

*TNO*

**Introduction** It is well established that competition in the heat without sufficient heat acclimation (HA) prior to the event leads to sub-optimal performance. It is however less clear how the period of heat acclimation interferes with the tapering process. **Methods** The literature describing experiments regarding de-acclimation and re-acclimation is reviewed with special focus on the duration of physiological process changes and compared to the literature on tapering. **Results** In contrast to common belief, several papers (e.g. Weller et al., 2007; Daanen et al. 2011) show that the positive effects of HA are maintained for at least a month, and that the full state of HA can be reestablished in only 3 days of re-acclimation. **Discussion** The finding that HA is maintained for a long period of time enables the reduction of exercise intensity several weeks prior to the event in the heat. Thus, the recommendations to taper for 8-14 days (LeMeur et al. (2012)) can be accommodated. It is, however, recommended to reserve a few days for re-acclimation just prior to the event. **References** Daanen, H.A.M., Jonkman, A.G., Layden, J.D., Linnane, D.M., Weller, A.S. (2011). Optimising the acquisition and retention of heat acclimation International Journal of Sports Medicine, 32 (11), 822-828 Le Meur, Y., Hausswirth, C., Mujika, I. (2012). Tapering for competition: A review. Science and Sports, 27 (2), 77-87. Weller, A.S., Linnane, D.M., Jonkman, A.G., Daanen, H.A.M. (2007). Quantification of the decay and re-induction of heat acclimation in dry-heat following 12 and 26 days without exposure to heat stress European Journal of Applied Physiology, 102 (1), 57-66. Contact Hein Daanen (hein.daanen@tno.nl)

#### HIGH INTENSITY TRAINING AT ALTITUDE FOR TEAM SPORTS ATHLETES

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Athletes seem compelled to include some forms of altitude training in their preparation expecting additional performance gains compared to equivalent training at sea-level. For long, they spent weeks at altitude to enhance oxygen delivery to the muscles with "live high-train high" or "live high-train low" altitude camps. For the last twenty years, the development of hypoxic facilities largely facilitated various forms of "live low-train high" (LLTH) methods where athletes live at or near sea level but train in hypoxia. Until recently, most LLTH strategies involving any form of continuous or intermittent training in hypoxia were classified under the "intermittent hypoxic training" (IHT) denomination. A comprehensive analysis IHT studies highlights only poor extra benefits of adding a hypoxic stimulus for sea-level performance improvement despite positive molecular adaptations observed after various IHT modalities (2). To overcome some limitations hindering additional performance benefits with hypoxia, our research group recently developed novel maximal intensity exercise proto-



cols in hypoxia, e.g., repeated sprint training in hypoxia (RSH) (3), incidentally well adapted to team sports athletes. Fundamental mechanisms (likely with positive adaptations in the behaviour of fast-twitch fibres) underpin the efficacy of RSH and differentiate it from IHT in the updated panorama of contemporary altitude training methods (5). With RSH, performing 'all-out' efforts in hypoxia may provide additional activation of anaerobic and neuromuscular pathways beyond that observed in normoxia. The role of exercise intensity per se in the training induced responses in hypoxia should now be recognized and RSH may indeed potentiate the effects of adding a hypoxic stress to a training stimulus by challenging at most the adaptive mechanisms of the tissue working in hypoxia to promote subsequent performance gains in normoxia (4). Although there is no consensus on best-practice strategies with altitude training for team sports, adding RSH during an altitude training camp may trigger most adaptive mechanisms for improved team performance (1). Although numerous factors influence match running performance and overall game results in team sports, individual player performance improvement is crucial. Proposing RSH in team sports may thus boost players' physical performance, prepare their organism to subsequent more sports specific training and potentially delay premature in-match fatigue. References 1. Brocherie F, Millet GP, Hauser A, Steiner T, Rysman J, Wehrli JP, and Girard O. (2015). *Med Sci Sports Exerc*, 47(10):2140-9. 2. Faiss R, Girard O, and Millet GP. (2013). *Br J Sports Med*, 47 Suppl 1:i45-50. 3. Faiss R, Leger B, Vesin JM, Fournier PE, Eggel Y, Deriaz O, and Millet GP. (2013). *PLoS one*, 8(2):e56522. 4. Millet GP, and Faiss R. (2012). *Sports Medicine*, 42(12):1081-3. 5. Millet GP, Faiss R, Brocherie F, and Girard O. (2013). *Br J Sports Med*, 47 Suppl 1(suppl):i6-7.

## COMBINING HEAT AND ALTITUDE TRAINING

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Originally in the form of terrestrial altitude, altitude exposure has evolved to the 'living high – training low' model to maintain sea-level training intensity while promoting haematological adaptations (i.e. an increase in haemoglobin mass). More recently, repeated-sprints at altitude have also been shown to improve aerobic performance due to specific muscle adaptations. However, despite these refinements in altitude / hypoxic training methods, more and more athletes are looking for other training environments such as heat-acclimation. Two years ago, the number of AFL team going to hot ambient conditions for their pre-season training camp was even higher than the number of team going to altitude. This increasing interest for heat acclimation is linked to recent studies suggesting that this might improve performance in temperate conditions as well as at altitude via cross-acclimation pathways. Beyond comparing altitude and heat adaptations, it has been suggested that these two environments could induce complementary hematological adaptations; namely, an increase in hemoglobin mass and plasma volume. Recent studies have examined this concept in elite athletes. This is of particular interest for team-sport athletes as many of the physiological adaptations are triggered by the environmental conditions allowing saving time for tactical and technical training (Buchheit et al 2013). Of note, combining altitude and heat requires careful consideration as altitude adaptations require longer than those developing in the heat. The latest research has consequently combined the short-term muscle adaptations obtained by high-intensity training in hypoxia, with the short-term cardiovascular adaptations acquired by training in the heat. This lecture will highlight the most recent and relevant findings from elite athletes, and attempt to provide recommendations for cross-acclimation training. Buchheit M, Racinais S, Bilsborough J, Hocking J, Mendez-Villanueva A, Bourdon PC, Voss S, Livingston S, Christian R, Périard J, Cordy J, Coutts AJ (2013). *Brit J Sports Med*, 47 (Suppl. 1), i59-69.

## Oral presentations

### OP-PM03 Oxygen Uptake & Metabolism

#### METABOLIC COST, VO<sub>2</sub> AND VELOCITY OF WHOLE BODY, ARMS ONLY AND LEGS ONLY SWIMMING, CONTROLLING FOR STROKE AND KICK RATE

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1: UQ (QLD, Australia), 2: QAS (QLD, Australia), 3: SAL (Australia)

**Introduction** Previous research examining the metabolic cost and velocity contributions of the upper and lower limbs in elite swimmers has not considered the impact of stroke and kick rate. This study aimed to determine the metabolic cost, VO<sub>2</sub> and velocity production of arms only and legs only swimming relative to whole body swimming at different intensities while controlling stroke and kick rate. **Method** Twenty elite swimmers completed six 200m swimming trials; two with the whole stroke (swim), two with the arm stroke only (pull) and two with the leg kick only (kick). The swim trials were completed at two submaximal intensities (60% and 75% of the fastest 200m freestyle time at the 2012 Olympic Games). In the pull trials, swimmers matched the stroke rates recorded during the swim trials, while the kick rates from the swim trials were matched in the kick trials. Oxygen uptake (VO<sub>2</sub>) was continuously measured throughout, with metabolic cost and velocity calculated for each 200m effort. One-way repeated measures ANOVAs were used to identify differences in velocity, VO<sub>2</sub> and metabolic cost among swim, pull and kick trials. Results Irrespective of intensity, mean velocity and VO<sub>2</sub> of the pull and kick trials were lower than the swim trials ( $p < 0.01$ ). For both intensities, the metabolic cost of pull was lower than swim ( $p < 0.02$ ), while the metabolic cost of kick was equal to swim ( $p > 0.05$ ). Velocity, VO<sub>2</sub> and metabolic cost of the swim trial were all significantly lower than the sum of pull and kick at both intensities ( $p < 0.01$ ). When the sum of pull and kick was normalised to the magnitude of swim, the arms contributed  $63.3 \pm 6.4\%$  and  $59.7 \pm 4.4\%$  of velocity, utilised  $55.5 \pm 6.9\%$  and  $51.9 \pm 4.6\%$  of the VO<sub>2</sub> and were responsible for  $43.9 \pm 9.5\%$  and  $46.0 \pm 8.1\%$  of the metabolic cost at the low and high intensities, respectively. **Conclusion** To determine the relative contributions of the upper and lower limbs to performance, simply summing the velocity and/or energy consumption of arms only and legs only swimming, even when stroke and kick rates are matched among testing conditions, will be misleading. Normalising the sum of pull and kick data to swim data indicates that the legs may contribute more to velocity than previously reported. While VO<sub>2</sub> during whole body swimming appears to be divided evenly between the upper and lower limbs based on the normalised data, the upper limbs use this energy more effectively. Implementation of this testing protocol before and after a pull or kick training block will enable sports scientists to identify how the velocity contributions and/or metabolic cost of the upper and lower limb actions have responded to the training stimulus. Contact k.morris3@uq.edu.au

### MAXIMAL OXYGEN UPTAKE IS RELATED TO MUSCLE FIBRE OXIDATIVE CAPACITY - FROM CHRONIC HEART PATIENTS TO ELITE CYCLISTS

VAN DER ZWAARD, S., DE RUITER, C.J., NOORDHOF, D.A., STERRENBURG, R., BLOEMERS, F.W., DE KONING, J.J., JASPERS, R.T., VAN DER LAARSE, W.J.

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Background: Maximal oxygen uptake (VO<sub>2</sub>max) is presumably constrained by oxygen delivery rather than mitochondria's ability to consume oxygen. It has been suggested that animals exploit only 60-80% of their in vitro oxidative capacity when they exercise at VO<sub>2</sub>max. In humans, however, the quantification of mitochondrial overcapacity remains unclear. In vitro fibre VO<sub>2</sub>max under hyperoxic conditions can be predicted from succinate dehydrogenase (SDH) activity in muscle fibres, which therefore enables quantification of the difference between VO<sub>2</sub>max and in vitro oxidative capacity in humans. Purpose: To determine to what extent VO<sub>2</sub>max attained during cycling exercise differs from in vitro oxidative capacity as predicted from SDH activity of the vastus lateralis muscle in chronic heart failure patients, healthy controls and elite cyclists. Methods: Forty-eight subjects (28 elite cyclists and 20 healthy controls) performed maximal incremental cycling exercise to determine VO<sub>2</sub>max normalized to body weight. Biopsy cryosections from m. vastus lateralis were incubated for SDH activity, which was quantified by microdensitometry. Similar data of 13 chronic heart failure patients and 6 controls were obtained from Bekedam et al. (1). In vitro oxidative capacity normalized to body weight was predicted from SDH activity in 67 subjects using estimated skeletal muscle mass and the relationship between in vitro fibre VO<sub>2</sub>max and SDH activity of isolated single muscle fibres and myocardial trabecula under hyperoxic conditions (2). SDH activity was corrected for estimated quadriceps muscle temperature at maximal effort. Results: Predicted in vitro VO<sub>2</sub>max is closely related to VO<sub>2</sub>max measured during cycling ( $r^2 = 0.88$ ,  $p < 0.001$ ), indicating that SDH activity is an important determinant of VO<sub>2</sub>max across patients, controls and elite cyclists (VO<sub>2</sub>max ranging from 9.8 to 79.0 ml/kg/min). The relationship between predicted in vitro VO<sub>2</sub>max and measured VO<sub>2</sub>max (slope =  $0.79 \pm 0.04$   $p < 0.05$ ; intercept =  $2.5 \pm 2.1$ ,  $p > 0.05$ ) differs significantly from the line of identity indicating that also humans do not fully exploit their oxidative enzyme capacity (~85%). Conclusion: Human maximal oxygen uptake and oxidative capacity predicted from skeletal muscle SDH activity are closely related but are not equal likely due to limited oxygen supply to muscle mitochondria. Contact: s.vander.zwaard@vu.nl References: 1. Bekedam MA, et al. Clin Physiol Funct Imaging 23: 337-343, 2003. 2. Des Tombe AL, et al. Microsc Res Tech 58: 412-420, 2002.

### THE METABOLIC COST OF QUADRUPEDAL WALKING IN HUMAN

KINUGASA, R., KUBO, S., OGANE, R.

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Introduction Human quadrupedalism may provide us with some important clues about the transition from quadrupedality to bipedality, but the nature and efficiency of human quadrupedal walking remains unknown. The purpose of this study was to compare oxygen consumption and muscle activity between quadrupedal and bipedal walking in human. Methods Five male volunteers participated. A three speeds, 1.0, 1.5, 2.0 km h<sup>-1</sup>, were examined in bipedal and quadrupedal methods as the subjects walked on a treadmill. During treadmill walking, oxygen consumption and surface electromyography (EMG) were collected. The net rate of oxygen consumption was divided by body mass, and the mass-specific rate of oxygen consumption was calculated for speeds matched to the walking. This rate of oxygen consumption was then divided by speed to give the mass-specific cost of transport (COT, ml of O<sub>2</sub> kg<sup>-1</sup> m<sup>-1</sup>), the cost to travel a meter. Surface electrodes were placed over the 12 muscles (lower limb 5 muscles; upper limb 5 muscles; trunk 2 muscles). The EMG signal for each muscle was full-wave rectified and averaged. Results The mass-specific COT for quadrupedal (ranged 0.416-0.480 ml of O<sub>2</sub> kg<sup>-1</sup> m<sup>-1</sup> in three different speeds) walking was much expensive than bipedal (ranged 0.102-0.114 ml of O<sub>2</sub> kg<sup>-1</sup> m<sup>-1</sup> in three different speeds) walking ( $P < 0.05$ ). A significant trend was not found between COT and walking speed. The EMG for almost muscles was much greater in quadrupedal walking than in bipedal walking ( $P < 0.05$ ), except for calf muscles. Discussion We found that human quadrupedal walking is more costly than bipedal walking. This finding is not consistent with previous work on juvenile chimpanzees (Taylor & Rowntree, 1973), which indicated that bipedal and quadrupedal locomotion were equally costly. Therefore, differences in bipedal and quadrupedal cost may be varied among individual species. Differences in kinematics and muscle activation explained observed differences in cost between bipedal and quadrupedal walking. An increase in EMG and longer contact time, which defined as the duration of foot-ground contact for one step, by approximate 350% during quadrupedal walking compared with bipedal walking. This difference corresponds closely to observed 332% increase COT during quadrupedal walking. References Taylor CR, Rowntree VJ. (1973). Science, 179, 186-187 Contact rk@jindai.jp

### INFLUENCE OF "PRIMING" EXERCISE ON PULMONARY OXYGEN UPTAKE AND MUSCLE DEOXYGENATION KINETICS DURING HEAVY-INTENSITY CYCLE EXERCISE IN TYPE 2 DIABETES.

ROCHA, J.I, GILDEA, N.I, O'SHEA, D.2, GREEN, S.3, EGANA, M.1

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1:School of Medicine, Department of Physiology, Trinity College Dublin, Dublin 2, Ireland. 2:Endocrinology, St Columcille's and St Vincent's Hospitals, Dublin, Ireland. 3:School of Science and Health and School of Medicine, University of Western Sydney, Sydney, Australia. We tested the hypothesis that priming exercise (PE) would increase the speed of the adjustment of the primary phase (taup, tp) of pulmonary oxygen uptake (VO<sub>2</sub>) and/or reduce the amplitude of the slow component of VO<sub>2</sub> during high-intensity cycling in type 2 diabetes (T2D) given that muscle oxygen supply appears to be limited in T2D. Ten middle-aged participants with uncomplicated T2D ( $49.6 \pm 7.2$  years,  $30.8 \pm 5.0$  kg.m<sup>2</sup>; 8 men / 2 women) and 10 non-diabetic (ND) controls ( $44.6 \pm 9.2$  years,  $30.8 \pm 4.2$  kg.m<sup>2</sup>; 8 men / 2 women) were recruited. Participants completed four bouts of constant-load cycling corresponding to 50% between their ventilatory threshold and VO<sub>2</sub> peak power outputs, (i.e. 50%Δ) previously established during a ramp incremental test. Two of these bouts were completed without priming exercise and two bouts were undertaken with prior heavy-intensity (50%Δ) priming exercise. VO<sub>2</sub> kinetics was calculated from continuously measured breath-by-breath data, while the rate of muscle deoxygenation (i.e., deoxygenated hemoglobin, HHb) was continuously measured by near-infrared spectroscopy (NIRS) at the vastus lateralis muscle. At baseline the time constant of the primary phase, tp, was approximately 17% slower ( $P > 0.05$ ) in T2D, and PE tended to reduce tp ( $P = 0.06$ ) in both groups by a similar magnitude (T2D,  $37.9 \pm 17.7$  vs.  $33.7 \pm 10.6$  s; ND,  $31.0 \pm 5.8$  vs.  $28.0 \pm 6.3$  s). The amplitude of the slow component (As) was overall significantly lower ( $P < 0.05$ ) in T2D; and PE tended to overall reduce it ( $P = 0.09$ ). These reductions were of approximately 50% in T2D and only 5% in ND controls (T2D,  $0.29 \pm 0.13$  vs  $0.18 \pm 0.10$  L.min<sup>-1</sup>; ND,  $0.39 \pm 0.18$  vs  $0.37 \pm 0.21$  L.min<sup>-1</sup>), however, there was no significant interaction between diabetes status and priming bout in As ( $P = 0.22$ ). The rate of adjustment or amplitude of deoxygenated hemoglobin (HHb) did not show

any differences between groups. These preliminary data suggest that in middle-aged adults with T2D, priming exercise prior to heavy-intensity exercise can potentially speed the primary phase VO<sub>2</sub> kinetics and reduce the amplitude of the slow component possibly due to an improvement in oxygen delivery. Nevertheless interindividual variability in responses precluded the attainment of statistical significance. Borgespj@tcd.ie

### HIGH INTENSITY INTERVAL TRAINING IN HANDCYCLING: THE EFFECTS OF A 7 WEEK TRAINING INTERVENTION IN ABLE-BODIED MEN.

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*University of Essex*

1University of Essex, Colchester, United Kingdom. 2University of Groningen, Groningen, the Netherlands. **INTRODUCTION:** In handcycling, a high maximal oxygen uptake (VO<sub>2</sub>peak) and high peak power output (POpeak) show to be important determinants of race performance (Fischer et al., 2015). To achieve successful endurance performance, optimal training is a necessity to improve the physiological capacity of athletes. Unlike most endurance sports, propulsion in handcycling depends on the endurance and muscular capacity of the upper body, and limited research is available how to improve this endurance capacity. The aim of the current study therefore was to evaluate the effects of high intensity interval training (HIIT) and continuous training (CT) on the physiological capacity and handcycling performance of able-bodied men in a well controlled laboratory setting. **METHODS:** 24 Recreational active men (22±2 years; 184±4 cm; 79±10 kg) were matched on incremental handcycle pretest performance and then randomly assigned to HIIT, CT or a non-training control group (CON). Participants in HIIT and CT visited the lab three times per week for seven weeks, to complete a total of 21 training sessions. HIIT completed 14 training sessions of 4x4 minutes intervals at 85% heart rate reserve (HRR) and 7 continuous training sessions at 55% HRR (every 2nd session). CT performed 21 training sessions of 30 minutes at an average training intensity of 55% HRR. After the intervention, changes in VO<sub>2</sub>peak and POpeak were compared between HIIT, CT and CON. **RESULTS:** Baseline testing showed no differences between groups in participants' characteristics. The average external training load per training session was higher in CT compared to HIIT, but not significantly different (2.32±0.3kJ vs 2.28±0.3kJ respectively, p>0.05). Improvements after HIIT in VO<sub>2</sub>peak (+22.2%) and POpeak (+43.7%) were significantly larger (p<0.01) compared to CT and CON. Improvements after CT in VO<sub>2</sub>peak (+9.7%) POpeak (+31.1%) were higher compared to CON (p<0.01). No significant changes were found in CON after the training period. **DISCUSSION:** As in other endurance sports, HIIT proved to be effective in improving physiological capacity and therewith handcycle performance. Whilst physiological capacity in both training groups improved significantly compared to CON, the present study shows that VO<sub>2</sub>peak and POpeak improved more after HIIT than after CT in able-bodied men. This is despite HIIT taking 22% less time than the CT. It is therefore advised to include high intensity interval training into training regimes of competitive handcyclists. **REFERENCES:** Fischer G., Figueiredo P., Ardigo LP. (2015). *Int J Sports Physiol Perform*, 10(8), 965-971. **CONTACT:** ppscho@essex.ac.uk / fjhett@essex.ac.uk

### Invited symposia

### IS-BN05 INTEGRATIVE FALL PREVENTION – NOVEL STRATEGIES TO TEST AND TRAIN NEUROMUSCULAR AND CARDIAC FALL RISK FACTORS IN THE ELDERLY

#### DOES HEART RATE VARIABILITY SERVE AS A POTENTIAL FALL RISK FACTOR IN THE ELDERLY?

PECCHIA, L.

*University of Warwick*

Biomedical signals reflecting autonomous nervous system (ANS) and cardiovascular system (CVS) could be promising means to assess the risk of falling and to predict accidental falls in the short term. The association between HRV and risk of falling was first investigated in 2015, with a retrospective study enrolling 168 subjects over 65 years of age. Forty-seven of them experienced fall events within 3 months since registration. Using data-mining methods, abnormal HRV patterns were discovered and the odds ratio (OR) of falling in subjects exposed to these patterns was analyzed. The OR of falling in subjects presenting these depressed HRV pattern was significant (OR 4.32, CI 95% 1.61-11.56, p<0.01), suggesting that a depressed HRV was associated with an increased risk of falling (Melillo et al. 2015). A Multinomial Naïve Bayes classifier achieved satisfactory results through a rigorous validation procedure, enabling to predict fallers within three months from the baseline recordings with a sensitivity rate of 72% and a specificity rate of 61% (Castaldo et al 2016). The proposed method was based on 1 hour ECG recording and short term HRV analysis, which are already in use in many outpatient clinics and could be used widely in outpatient settings to identify high-risk patients who need further assessment and could benefit from fall prevention programs. Starting from these results, we focused on the prediction of specific risk factors that are clearly dependent from ANS/CVS states, which can be reliably detected using HRV. In a recent study, we developed, validated and patented a mathematical model to predict orthostatic hypotension by analyzing HRV features recorded in the few minutes (from 2 to 5min) before rising from a bed or chair, which account for the 30% of indoor falls. This model predicted the drop down of blood pressure with an error below 4mmHg, which is the measurement error (Sannino et al. 2015). This lecture will present these results, the methods used and their potential future applications and limits. 1. P Melillo, A Jović, N De Luca, L Pecchia 2015, *IET Healthcare technology letters* 2 (2), 1-6. 2. R Castaldo, P Melillo, R Izzo, N De Luca, L Pecchia 2016, *IEEE Journal of Biomedical and Health Informatics*, Accepted 11th March 2016 3. G Sannino, P Melillo, S Stranges, G De Pietro, L Pecchia 2015, *BMC medical informatics and decision making* 15 (Suppl 3), S2

#### HOW DOES TRAINING TO BALANCE ON UNSTABLE SURFACES CHANGE BALANCE CONTROL MECHANISMS?

VAN DIEËN, J.

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Balance training on unstable objects reduces fall risk in older adults (1), but the underlying mechanisms are unclear. Therefore, we investigated motor and sensory changes underlying improvements in balance in unipedal stance on an unstable object. Fourteen participants practiced to balance on one leg on a board that could freely rotate in the frontal plane. They performed 6 16-seconds trials standing on one leg on a stable surface (2 trials without manipulation, 2 with vestibular and 2 with visual stimulation) and 6 trials on the balance

board, before and after a 30-minutes training. Center of mass (COM) movement, segment and total angular momenta and board angles were determined. Trials on stable surface were compared to trials after training, to assess effects of surface conditions. Pre-training and post-training trials were compared to assess rapid (between pre-training trials) and slower (trials before and after training) learning and sensory manipulation trials were compared to unperturbed trials, to assess sensory weighting. COM excursions were larger on the unstable surface, but decreased rapidly with practice. Changes in angular momentum contributed more to COM acceleration on the balance board, but this contribution decreased with practice. With practice, effects of visual and vestibular stimulation increased rapidly. Initially, oscillations of the balance board occurred around 3.5 Hz, which decreased with practice. The initial decrease in sway was associated with up-weighting of visual information, while later changes were associated with suppression of oscillations that we suggest are due to too high proprioceptive feedback gains. The present results are in line with findings of decreased proprioceptive gains after slackline training(2), and indicate that proprioceptive training may be a misnomer for balance training on unstable surfaces. Training gains related to up-weighting of visual information suggest that emphasis on the use of vision in balance training may be beneficial and that interventions specifically targeting vision and strategies to obtain visual information, such as avoiding to look at ones feet, should be tested in fall prevention. 1. Halvarsson A, Franzén E, Farén E, Olsson E, Oddsson L, and Stühle A. Long-term effects of new progressive group balance training for elderly people with increased risk of falling - a randomized controlled trial. *Clin Rehabil* 27: 450-458, 2013. 2. Keller M, Pfusterschmied J, Buchecker M, Mäller E, and Taube W. Improved postural control after slackline training is accompanied by reduced H-reflexes. *Scand J Med Sci Sports* 22: 471-477, 2012.

## ACUTE AND INTERVENTIONAL EFFECTS OF EXERCISE TRAINING ON POSTURAL CONTROL IN SENIORS: APPLICABILITY OF NOVEL TRAINING REGIMES

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Adequate balance and strength training in seniors improve relevant neuromuscular fall risk parameters and can reduce the risk of falling up to 50% (Granacher et al., 2011). In turn, acute exercise (moderate, intense and under hypoxia) yields transient deterioration of static postural control after exercise cessation (Donath et al., 2013, Donath et al., 2014c). Firstly, the present talk provides an overview of the magnitude and extent of exercise-induced alterations of postural control and limb muscle activity. A post-exercise neuromuscular fall-window will be debated. Secondly, three interventional studies of our group (one- vs. two-step stair climbing, fall training, slackline training) that intend to improve relevant cardiocirculatory and neuromuscular fall-risk factors in seniors will be discussed (Donath et al., in revision, Donath et al., 2014b, Donath et al., 2014a) in the context of available RCTs on neuromuscular performance and fall risk in seniors. Finally, an integrative training approach targeting strength, balance and endurance requirements via complex movement patterns with progressively applied and carefully increasing accelerations, decelerations, stop and go patterns, change in directions, eccentric plyometrics and rotations with demanding spatial orientation tasks will be introduced. Donath et al. 2014a, *J Aging Phys Act*, 22, 324-33. Donath et al. 2014b, *Scand J Med Sci Sports*, 24, e93-101. Donath et al. 2014c, *Gerontology* (in press) Donath et al. 2013, *Eur J Appl Physiol*, 113, 661-9. Granacher et al. 2011, *Sports Med*, 41, 377-400.

## Invited symposia

### IS-BN06 EVIDENCE BASED SPORT PHYSIOTHERAPY: UNWEIGHTING AS A TOOL FOR EARLY RETURN TO SPORT?

#### NEURAL AND KINETIC ADJUSTMENTS IN SHORT TERM UNWEIGHTING RUNNING

NICOL, C.1, SAINTON, P.1, CABRI, J.2,3, CHAVET, P.1

1: AMU (Marseille, France), 2: NSSS (Oslo, Norway), 3: LUNEX (Luxembourg)

**Introduction** Lower body positive pressure (LBPP) technology provides the opportunity to study the neuromechanical adjustments to partial unweighting and reloading over repeated running cycles. Unweighting leads to decreased vertical ground reaction forces (e.g. Grabowski and Kram, 2008) and to mirrored changes with reloading (Sainton et al. 2015). However, despite the reduced leg muscle activities previously reported (Liebenberg et al. 2011; Hunter et al. 2014), Sainton et al. (2015) revealed different neural adjustments during the pre-and post-impact phases. This study focuses on the time course of the neuromechanical adjustments. **Methods** Nine healthy males performed 2 randomized runs of 9 min at preferred speed on an LBPP treadmill. Each series included 3 successive running conditions of 3 min (at 100% body weight (BW), 60 or 80% BW). The unweighting and reloading transition phases were progressively initiated and lasted 10-15 s. Vertical ground reaction forces, center of mass accelerations and surface electromyographic (EMG) activity recorded from 7 leg muscles were analysed for the first and last 30 s of each running condition as well as along the transition phases. **Results** Unweighting led to increased flight time, unchanged contact time and reduced vertical ground reaction forces whereas reloading resulted in opposite changes. During both transitions most mechanical changes varied linearly with the LBPP-induced BW changes, so that only few parameters differed between the end of the transition and once the running pattern stabilized. The preactivation phase presented for most muscles no EMG change whereas the braking and the push-off phases revealed selective changes of the thigh and shank muscle activations, respectively. **Discussion** This study demonstrates for the first time the linearity of the relationships between the unweighting- and reloading-induced changes with most mechanical stride parameters. Distinct neural adjustments during the preactivation, braking and push-off phases as previously observed are confirmed (Sainton et al. 2015). The unchanged preactivation of most muscles reinforces the major intervention of passive mechanisms before impact (Müller and Blickhan 2010), but the effect of the lack of visual cues at foot touchdown during LBPP running remains to be investigated. The braking and push-off phase EMG analyses highlight mirrored progressive adjustments to unweighting and reloading while emphasizing the inter-muscular differences. Considering the use of LBPP treadmill in rehabilitation, additional detailed studies are needed on the neural adjustments over longer and repeated periods of running. **References** Grabowski AM, Kram R. (2008). *J Appl Biomech* 24(3), 288-97. Hunter L, et al. (2014). *J Electromyogr Kinesiol* 24(3), 348-52. Liebenberg J, et al. (2011). *J Sports Sci* 29(2), 207-14. Müller R, Blickhan R. (2010). *Hum Mov Sci* 29(4): 578-89. Sainton P, et al. (2015). *Eur J Appl Physiol* 115(5), 1135-45. Contact Caroline.nicol@univ-amu.fr



**SHORT-TERM INFLUENCE OF UNWEIGHTING ON MUSCLE FASCICLE LOADING**

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Unweighting treadmill devices with lower body positive pressure (LBPP) technology have been recently used as a tool for the postoperative rehabilitation after lower limb injuries. The advantages of these devices can reduce impact forces, rates of force development and muscle activities during the LBPP running (Sainton et al. 2015, Liebenberg et al. 2011). However, the effects of unweighting on neuromuscular system have not been fully investigated during human locomotion. For example, the tendon loading can influence the contributions of afferent feedback to locomotor muscle activities (af Klint et al 2009) and efficacy of utilization of tendon elastic energy (e.g. Ishikawa and Komi 2008) during human locomotion. The question we have to ask here is how unweighting and reloading situations would influence our neural and mechanical systems during stretch-shortening cycle (SSC) exercises, such as running and jumping. In general, impact forces can be utilized to enhance the performance and efficiency as the elastic strain energy in tendon and stretch-induced reflex potentiation in muscle fascicles during locomotion. As similar to the intensity and movement specific muscle fascicle regulation (e.g. Ishikawa and Komi 2008), unweighting and reloading conditions can modify muscle fascicle length not only in standing but also in movement conditions. At standing, for example, the muscle fascicles of gastrocnemius and soleus muscles are getting longer (8.0%, at the 20% of body weight) and Achilles tendon are shorter (2.0-3.0%, at the 20% of body weight) with unweighting. In this presentation, we will show how muscle fascicles and tendons are modified as well as behave during SSC exercises with unweighting and reloading situations. The gastrocnemius medialis and Achilles tendon length during running and hopping were measured by musculoskeletal ultrasonography together with muscle activities and ground reaction forces, simultaneously. These short-term adjustments of muscle-tendon interaction during SSC exercises with unweighting can also provide the potential mechanism of afferent feedback contribution to locomotor muscle activities. References af Klint R, et al. (2009) *J Neurophysiol.* 101:1705-1712. Ishikawa M and Komi PV (2008) *Exerc Sport Sci Rev.* 36:193-199. Liebenberg J et al. (2011) *J Sports Sci* 29:207-214. Sainton et al. (2015) *Eur J Appl Physiol.* 2015 115:1135-1145.

**LOWER BODY POSITIVE PRESSURE RUNNING: A TOOL FOR EARLY RETURN TO SPORT?**

CABRI, J.1, NICOL, C.2, ISHIKAWA, M.3, CHAVET, P.2

*(1) Norwegian School of Sport Sciences, (2) Aix-Marseille Université, (3) Osaka University of Health and Sport Sciences*

Several studies have investigated the effects of reducing gravity on locomotion kinematics and kinetics. Lower body positive pressure (LBPP) treadmill allows running in partial unweighting conditions and is proposed as a tool for early return to sport. This invited symposium focuses on the influence of short term unweighting on running patterns. Quantifying the pre- and post-impact phase lower limb muscle activities and muscle-tendon loading in healthy as well as in patients 6 months after ACL reconstruction, it provides a multi-scale screening of partial unweighting effects on locomotor patterns. The first presentation entitled "Neural and kinetic adjustments in short-term unweighting running" deals with the unweighting and reloading induced-changes in the vertical ground reaction forces and of the activity of major lower limb muscles. Special emphasis is put on the timing of neuromechanical changes. Short-term unweighting and reloading are found to result in mirrored changes. The unweighting phase shows increased flight time with unchanged contact time. In the absence of modification of the triceps surae EMG during preactivation and braking, the observed overall decrease in vertical ground reaction forces is attributed to the vertical support provided by the anti-gravity treadmill chamber. The increased EMG stability with body weight reduction is considered as a protective mechanism facing such unusual loading condition. This limits the expected improvement in running economy, but favors the readjustments to normal body weight condition. The after-effects highlight the fact that 3 min of unweighting are sufficient for an updating of the running pattern. The second presentation focuses on "the short-term influence of unweighting on muscle fascicle and tendon loading" in standing, hopping and running conditions. As similar to the intensity and movement specific muscle fascicle regulation, unweighting and reloading conditions can modify muscle fascicle length not only in standing but also in movement conditions. However, it is not clear how our neuromuscular system is regulated under unweighting and reloading conditions. This presentation highlights muscle-tendon interactions together with the neural adjustments during human movements under unweighting and reloading conditions. The third presentation is dealing with "the use of unweighting running to detect proprioceptive functional impairments". ACL ligamentoplasty leads to long lasting proprioceptive and functional deficits. In rehabilitation, LBPP treadmill running is considered allowing earlier return to practice. Our own running protocol performed 6 months post ACL reconstruction revealed increased interlimb asymmetry in temporal dynamics and muscle activity while running in unweighting conditions. This highlights the interest of such protocol for detecting remaining locomotor impairments.

**Invited symposia****IS-SH05 PSYCHOLOGICAL DISORDERS IN ELITE SPORTS****BURNOUT AND DEPRESSION IN HIGH LEVEL YOUNG ATHLETES**

BECKMANN, J., NIXDORF, I., FRANK, R.

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Burnout and Depression in High Level Young Athletes Introduction Previous research has shown high levels of chronic stress, coping strategies, and the balance of physical and psychological stress and recovery to influence the development of burnout and depression in elite athletes (Nixdorf et al., 2013). High level young athletes seem to be especially vulnerable to these factors. To deal with this problem a burnout and depression screening instrument for young athletes was developed based on the findings from 3 studies. Methods In a cross-sectional study (Nixdorf et al., submitted), questionnaires on Team Cohesion, Perfectionism in Sport, Sport Attributional Style, and Depression were administered to German junior elite athletes (N = 199; M age = 14.96; SD = 1.56). The data was analyzed by a mediator analysis using path analysis with bootstrapping. In a longitudinal study with 3 repeated measures (N=246; M age=15.22; SD=1.99), in addition to depression athlete burnout was assessed along with experienced stress and recovery. A qualitative study further explored major stressors in elite athletes (Nixdorf et al., 2015). Results In all 3 studies athletes in individual sports showed significant higher scores in depression than athletes in team sports. In the cross-sectional study attribution after failure accounted for a mediation with a significant indirect effect ( $\beta = .07$ ;  $p < .05$ ) and significant coefficients with sport discipline ( $\beta = .27$ ;  $p < .001$ ) and to the dependent variable depres-

sion ( $\beta = .26$ ;  $p < .01$ ). Whereas cohesion showed a significant negative relationship to depression, perfectionism was positively related to depression. In the longitudinal study a medium correlation between burnout and depression was found ( $r = .52$ ,  $p < .001$ ). The qualitative study detected three main sources of stress: double burden, sport specific demands and conditions. Discussion All 3 studies furnished concurrent findings on sport specific mechanisms contributing to depressive syndromes and burnout in high level young athletes. The assessment instruments used in the longitudinal study proved to be relevant for an early assessment of burnout and depression symptoms. They were included in a screening instrument that is further tested. References Nixdorf, I., Frank, R., Hautzinger, M. & Beckmann, J. (2013). Prevalence and determinants of depression in German high achievement athletes. *J Clinical Sport Psychology*, 7(4), 313-326. Nixdorf, I., Frank, R., & Beckmann, J. (2015). An explorative study on major stressors and its connection to depression and chronic stress among German athletes. *Advances in Physical Education*, 5, 255-262. <http://dx.doi.org/10.4236/ape.2015.54030>. Nixdorf, I., Frank, R., & Beckmann, J. (submitted). Why athletes in individual sports are more prone to depressive syndromes than athletes in team sports – searching for a psychological mediator in junior elite athletes. Contact [juergen.beckmann@tum.de](mailto:juergen.beckmann@tum.de)

## WHEN ACHIEVEMENT STRIVING GOES AWRY: CHALLENGING THE DUAL NATURE OF PERFECTIONISM

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This presentation sets out to challenge arguments put forward in support of the dual nature of perfectionism. In particular, the idea that perfectionism, with its accompanying tendency for overly critical evaluation (Stoeber, 2011), can manifest as a universally constructive quality, which not only activates striving to achieve exacting standards, but elicits performance appraisal processes with the capacity to sustain adaptive patterns of motivation and foster psychological well-being. The presentation will demonstrate that perfectionism is a complex multidimensional personality characteristic that reflects an irrational way of thinking about achievement, which makes it difficult to sustain adaptive motivational qualities and endorse personal mastery especially when experiencing adversity (Flett & Hewitt, 2016; Hall 2016). While perfectionism may energise motivation and bring about exceptional accomplishments, under adverse conditions it is always likely to trigger dysfunctional cognition that may lead to performance impairment and emotional distress. The presentation will outline why perfectionism is best thought of as a source of vulnerability in sport participants and it will offer some thoughts about research strategies that might be employed to examine that contention. It will first reflect upon the paradoxical effects of perfectionism and challenge arguments put forward to suggest that perfectionism can manifest in both adaptive and maladaptive forms. It will further contend that whether perfectionism is considered to be a trait, an inter-personal style or a pattern of ruminative thought, it is difficult to argue that it is capable of evoking universally adaptive qualities that will facilitate either sustained performance or psychological well-being in athletes performing at any level, unless it is accompanied by other sources of resilience. The presentation will then outline important psychological mechanisms and processes that are elicited by perfectionistic thinking, in order to illustrate why perfectionism is a vulnerability factor. It will critically evaluate the emerging research base in sport and physical activity to explain what is known about the influence of perfectionism. Finally, it will provide some thoughts on new research directions which will further challenge arguments that have been put forward in support of the dual nature of perfectionism. References Flett G. L. & Hewitt. P. L. (2016). Reflections on perfectionism and the pressure to be perfect in athletes, dancers and exercisers: A focus on perfectionistic reactivity in key situations and life contexts. In Hill, A. P. (Editor) *Perfectionism in Sport, Dance and Exercise*. Routledge Hall, H. K. (2016). Reflections on perfectionism and its influence on motivational processes in sport dance and exercise. In Hill, A. P. (Editor) *Perfectionism in Sport, Dance and Exercise*. Routledge. Stoeber, J. (2011). The dual nature of perfectionism in sports. Relationships with emotion. *International Review of Sport and Exercise Psychology*, 4, 128-145. Contact [h.hall@yorksj.ac.uk](mailto:h.hall@yorksj.ac.uk)

## EFFECTIVE PREVENTION OF BURNOUT IN ELITE ATHLETES AND HIGH-LEVEL COACHES

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It has been argued that only individuals originally fueled by a passion or a sacred fire for their involvement and dedication to an activity, may experience the debilitating consequences of burning out (Pines, 1993). Representing more than a simple reaction to an accumulation of stress, burnout in athletes and coaches is a multidimensional syndrome that is typically manifested by a feeling of dysphoria affecting the welfare of the individuals, leading to a reduction in the levels of vitality and the quality of motivation, as well as affecting the individuals' efforts towards a desired goal. Based on a series of subsequent studies on elite athletes and high-level coaches, this presentation will make the argument that the early identification of at-risk profiles represents an effective measure to prevent burnout in elite athletes and high-level coaches. Athletes and coaches motivated by unrealistic or unstable goals are more predisposed to develop symptoms of burnout and engage in a downward spiral leading individuals from exhaustion to disengagement from sports. While most athletes and coaches will typically describe their initial commitment to sports as being highly intrinsically motivated, these reasons for being involved in sports may change during a season or a career. When their motivation becomes purely extrinsic or that they lose the motivation to be involved in sports, as they persist in their sport-related role they will become increasingly at-risk of burning out (Lemyre, Hall, & Roberts, 2008; Bentzen, Lemyre, & Kenttä, 2015). Their actions are no longer self-determined, an imbalance develops between the perception of effort and the perceived return on personal investment in sports. Current study findings clearly suggest that assessing one's motives for competing or coaching in sports, one's perceived achievement climate and felt level of need support, as well as one's perceived level of competence and expression of perfectionist tendencies, allows for a reliable identification of at-risk profiles burnout. Subsequent systematic monitoring of changes in quality of motivation and perceived need support in individuals with at-risk profiles serves an effective prevention tool to justly intervene prior to coaches and athletes burning out. References Bentzen, M., Lemyre, P.-N., & Kenttä, G. (2015). Development of Exhaustion for High-Performance Coaches in Association with Workload and Motivation - A Person-Centered Approach. *Psychology of Sport and Exercise*, 22, 10-19. Lemyre, P.-N., Hall, H.K. & Roberts, G.C. (2008). A Social Cognitive Approach to Burnout in Elite Athletes. *Scandinavian Journal of Medicine and Science in Sports*, 18, 221-234. Pines, A. (1993). Exhaustion: An existential perspective. In W. B. Schaufeli, C. Maslach, & T. Marek (Eds.), *Professional burnout: Recent developments in theory and research* (pp. 33-51). New York, NY: Taylor & Francis.

## Invited symposia

**IS-SH06 (SELF-)IMPROVEMENT IN AND THROUGH SPORTS AND PHYSICAL EXERCISE – HISTORICAL PERSPECTIVES****THE CREATION OF THE BODY UNDER THE FITNESS-PARADIGM SINCE THE 1970S IN CENTRAL EUROPE**

MUELLNER, R.

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Andreasson & Johansson (2014) argue that within the last four decades fitness has become a “global industry” with a sales volume of around about 75.7 billion U.S. \$ per year, with 153.000 fitness clubs and with 131.7 million club members. These numbers indicate the importance of the phenomenon fitness and justify a systematic scientific analysis of the modern fitness culture and also of its historic development. This paper focuses not only on the organizational history of the modern fitness cultures on its way from the USA to Western Europe but also asks how and if the fitness movement can be examined more generally under the theoretical framework of fordist and post-fordist sports. The key elements of the shift can be found especially in the number and type (age, gender) of participants, the forms and types of organization, the contents and goals or in changing body concepts. In particular we are going to focus on the important aspect of how ideals of being and keeping fit have become hegemonial in society and how fitness practices have been adopted by individuals. Thus, we follow Foucault’s concept of “Biopolitics” and additionally the theorists of post-fordist subjectivation theory. We assume that the power which controls the body has shifted to the individual. That means that self-control and self-monitoring have become more and more common. Fitness has become a physical practice situated between “self-submission” and “self-empowerment”.

**WHAT’S NATURAL? TECHNOSCIENCE AND THE FEAR OF CYBORGS IN SPORT.**

GUENTER, S.

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Since there are sporting competitions, there is also something like body enhancing technology. The use of performance-enhancing technical devices and supplements has a long history, stretching back to Ancient Greece and continuing within contemporary sport. While in the ancient world mostly dietary methods were used to improve performance, nowadays we deal with hormones, technical devices or even doped genes. ‘Human Enhancement’ is a fascinating prism that reflects questions of participation, justice, equality and the autonomy of the subject in the social fields of sport. The area of elite sports is particularly affected by ‘human Enhancement’, according to the principle of exceeding what has come before, of aiming higher, faster and further. This paper analyses the postulated ‘naturalness’ in the regulative and normalising function in the area of elite sports, in connection with Foucault’s theory of governmentality and the methods of critical discourse analysis. Using different historical and current cases, the negotiating processes in relation to the argumentation logic, dynamics and resistance in shifting distinctions are presented using the fundamental documents of the IOC, IPC, CAS and IAAF. Represented through the inclusion and exclusion processes are hierarchies of the body that are (re)consolidated and transformed. The central question emerges as to how the worth of equal opportunity and fairness in regard to ‘naturalness’ has been reconsolidated or/and transformed in the past and present. Do not insert authors here

**TRANSFORMATIONS IN THE ACCEPTANCE OF THE DIS-EASED FEMALE BODY IN THE PUBLIC SPACE SINCE THE MID-20TH CENTURY: THE ROLE OF SPORT AND PHYSICAL EXERCISE**

HOFMANN, A.

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Throughout history the female body was seen as different from the male body, weak and frail which were reasons for exclusion in many sports. The argumentation was often connected to medical explanations and health issues, as Patricia Vertinsky shows in her work ‘The Eternally Wounded Female Body’ where she wrote about “anatomy is destiny”. Still neglected is the issue of women whose bodies do not match the societal norms, because of health issues or disabilities. These women also participate(d) in physical exercises and sport, but their access to it was and still is even more difficult. Thus, this paper takes up the dis-eased female body in a double sense. ‘Diseased’ meaning not being comfortable in one’s body due to an illness, and ‘dis-eased’ of what society made of the disease - in this case breast cancer, an illness that has been tabooized and stigmatized for a long time, and still is in many regions. Under the framework of Goffman’s theory of ‘Stigma’, both issues will be discussed in connection to breast cancer patients’ public access to physical exercise and sport throughout the last decades. Especially Germany will be taken as an example where there are special ‘sport after breast cancer’ classes in public sports clubs since the early 1980s.

## Oral presentations

**OP-BN15 Neuromuscular Fatigue****FATIGUE AND RECOVERY OF NEUROMUSCULAR FUNCTION AFTER A SIMULATED SOCCER MATCH**

THOMAS, K., DENT, J., HOWATSON, G., GOODALL, S.

*Northumbria University*

**INTRODUCTION** Soccer match-play induces transient and on-going decrements in physical function that persist for up to 72 hours post-game (Nedelec et al., 2012; Minnet & Duffield, 2014). There are frequent congested periods in the competitive schedule that require multiple games per week, separated by as little as 48 hours. Consequently, understanding and managing fatigue and the associated recovery post-match is an important consideration. Previous work has characterised the recovery of peripheral function after a soccer

match, but there is sparse data on the recovery of neuromuscular function (Rampinini et al., 2011). The aim of the study was to assess the fatigue and recovery of neuromuscular, physical and perceptual responses following a simulated soccer match. METHODS Fifteen semi-professional male soccer players completed a 90 min simulated soccer match. Pre-, immediately-post and at 24, 48 and 72 h participants completed a battery of tests. Maximum voluntary force (MVC) and twitch responses to femoral nerve stimulation during isometric knee-extensor contractions and at rest were measured to assess central (voluntary activation, VA) and peripheral (quadriceps potentiated twitch force, Q<sub>tw,pot</sub>) fatigue. Creatine kinase (CK) was analysed from capillary blood samples as a humoral index of muscle damage. Countermovement jump (CMJ), reactive strength index (RSI) and sprint performance (10 & 20 m) were assessed to profile the recovery of physical function, alongside perceptual markers of recovery (active & passive soreness, fatigue). RESULTS Simulated soccer match play elicited decrements in MVC that remained unresolved at 72 h ( $P = 0.01$ ). Q<sub>tw,pot</sub> declined by 13% post-match ( $P < 0.001$ ) and remained depressed until 72 h post. VA was reduced by 8% post-match and remained below baseline at 72 h ( $P = 0.049$ ). CK was elevated post-match and remained elevated at 72 h post ( $P < 0.001$ ). CMJ performance remained depressed at 72 h ( $P < 0.01$ ), RSI was decreased at 48 h ( $P < 0.01$ ) but recovered by 72 h, and sprint performance recovered by 24 h. Perceptual markers of fatigue were elevated until 48 h post ( $P < 0.01$ ) and had recovered by 72 h. DISCUSSION Simulated soccer match-play induced significant fatigue that was both central and peripheral in origin. The loss in maximal voluntary force was not restored by 72 h post-match, and was accompanied by persistent central fatigue. The similar time-course recovery of neuromuscular function, jump performance and perceptual markers of fatigue indicates these tools might be useful as indices of fatigue and recovery in soccer players. REFERENCES Minnet G, Duffield R. (2014). *Front Physiol*, 5, 24. Nedelec et al. (2012). *Sports Med*. 997-1015. Rampinini, E. et al. (2011). *Med Sci Sports Exerc*, 43, 2161-2170. CONTACT kev-in2.thomas@northumbria.ac.uk

### INTENSITY DEPENDENT NEUROMUSCULAR FATIGUE PROFILES DURING REPEATED ISOMETRIC KNEE EXTENSOR CONTRACTIONS

CAMPBELL, M.1, MILEVA, K.2, BOWTELL, J.1

*University of Exeter*

Introduction Critical torque is suggested as a demarcation point, above which fatigue develops and exercise termination will occur (Burnley, 2009). Distinct profiles of neuromuscular fatigue have been demonstrated above and below critical torque (Burnley, Vanhatalo & Jones 2012), however the neuromuscular processes underpinning fatigue development at intensities exceeding critical torque have not been investigated. Therefore, the aim of the study was to investigate fatigue development during repeated maximal isometric knee extensor contractions (MVC) at two intensities exceeding critical torque, employing electrical stimulation of the femoral nerve. Methods Young healthy individuals ( $n=10$ , 4 males, MVC  $132 \pm 13$  Nm, height  $1.69 \pm 0.12$  m, body mass  $67.2 \pm 15.2$  kg) completed intermittent isometric knee extensor exercise to exhaustion at 90% (H) and 55% (M) MVC. Performance variables (time to fatigue, peak torque) were measured. Electrical stimulation of the femoral nerve was applied during knee extension MVCs and at rest, pre and post intermittent exercise to quantify voluntary activation (VA), peripheral (M-wave) evoked responses in m. vastus medialis as well as electromechanical delay and twitch responses. Results Time to fatigue was significantly longer (M:  $1412 \pm 195$  vs H:  $144 \pm 25$  s, interaction effect  $p < 0.001$ ) and change in peak torque was significantly greater in the 55% than 90% condition (M:  $-81.4 \pm 3.6\%$ , H:  $-25.3 \pm 4.6\%$ ; interaction effect  $p < 0.05$ ) after fatiguing exercise. Peripheral excitability significantly decreased in the 55% but not 90% condition (M-Wave area/MVC, M:  $-29.5 \pm 5.5\%$ , H:  $-3.9 \pm 7.4\%$ , interaction effect  $p = 0.006$ ), whereas electromechanical delay significantly decreased in the 90% but not 55% condition (M:  $3.97 \pm 8.74\%$ , H:  $-28.1 \pm 5.76\%$ , interaction effect  $p = 0.03$ ). Voluntary activation was decreased after fatiguing exercise ( $p = 0.004$ ), but the change was not significantly different between conditions. Discussion Fatigue profiles above critical torque were intensity dependent, unsurprisingly, with extended exercise duration at the lower contraction intensity. Termination of exercise occurred after a similar magnitude decline in voluntary activation in both conditions; yet peripheral excitability was not reduced in the shorter duration, but higher intensity protocol. Differences in the rate and magnitude of extracellular potassium and hydrogen ion accumulation, resulting changes in membrane potentials, as well as altered excitation-contraction coupling are likely to be implicated. References Burnley, M., Vanhatalo, A., & Jones, A. M. (2012). *Journal of Applied Physiology*, 113 (3), 215-223. Burnley, M. (2009). *Journal of Applied Physiology*, 106 (3), 975-983. Contact Mc443@exeter.ac.uk

### RECOVERY OF NEUROPHYSIOLOGICAL FACTORS AFTER AN INTERMITTENT FATIGUE PROTOCOL DESIGNED FOR MOTORCYCLE RIDERS

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Introduction The neuromuscular system is highly demanded during a motorcycle race and fatigue levels are high especially in their forearms. The purpose is to describe the time course of recovery of different neurophysiological parameters on the exerted and contralateral extensor digitorum (ED) following an intermittent fatigue protocol (IFP). Methods Twelve males ( $31.3 \pm 7.5$  years) participated in this study. The IFP was performed in a specially designed road race motorcycle simulator (Marina, et al., 2013) with subjects operating both the braking and gas handle. Subjects performed work/rest cycles until exhaustion consisting of 6 brakes of 6s duration at 30% of the maximal voluntary contraction (MVC), and 4s in which they turned the throttle twice. Pre- and Post-exercise we (1) stimulated the radial nerve to obtain the maximal M-wave in the ED muscle of the fatigued limb; (2) stimulated the ED cortical motor area with transcranial magnetic stimulation to elicit motor evoked potentials at rest (MEPR) and facilitated (MEPF) and the cortical silence period (CSP) in both the exercised and contralateral limb. The recovery period consisted of 20 minutes and the assessment was taken at 0, 3, 5, 10 and 20 min (T0, T3, T5, T10 and T20) after the IFP. Results There was significant difference in MVC values of exercised limb at the end of the IFP which remained depressed after 20 min. Regarding the M-wave, there was a significant depression at T0 and an early recovery between the first 3 minutes. We observe a prolongation of the CSP at T0 and again a depression in MEPR and MEPF of the fatigued limb. While CSP recovered early in the first 3 min, MEPF recovered in the first 5 min, MEPR needed more than 10 minutes to recover the baseline. Although M-wave values recovered faster than MEPs, we may not overestimate inhibition of cortical excitability because changes in muscle electrophysiological properties could alter MEP amplitude (Gruet et al., 2013). There was no difference neither MVC values nor in any of the neurophysiological variables of the non-exercised limb. Conclusion Despite the recovery of the neurophysiological parameters, the MVC values of the exercised limb remained depressed after 20 min. Although the absence of cross-over effects in the non-exercised limb suggested that local factors have a major role in MVC depression, we cannot conclude this as an absence of central fatigue because other central fatigue indicators are needed. References Gruet, M., Temesi, J., Rupp, T., Levy, P., Millet, G. Y., & Verges, S. (2013). *Neurosci-*



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### EFFECTS OF ANODAL TRANSCRANIAL DIRECT CURRENT STIMULATION ON CORTICOSPINAL EXCITABILITY AND TIME TO FAILURE OF A SUBMAXIMAL CONTRACTION

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**Introduction** Anodal transcranial direct current stimulation (a-tDCS) consists of a low-intensity electrical stimulation that can increase corticospinal excitability when applied over the motor cortex (3). Previous work reported that a-tDCS increased time to failure of a sustained submaximal isometric contraction of elbow flexors performed 60 min after a similar contraction (1). Furthermore, it has been shown that during this type of fatiguing contraction, corticospinal excitability changes differently between agonist and antagonist muscles during sustained contractions (2). The aim of this work was to study the effects of a-tDCS on time to failure in relation with changes in excitability of the corticospinal pathway of two agonist (biceps brachii (BB), brachioradialis (BRD)) and one antagonist triceps brachii (TB) muscles during a sustained isometric contraction performed with the elbow flexors. **Methods** Eleven young adults performed 2 isometric contractions until failure at an intensity of 35% of maximal voluntary force separated by one hour in 2 separate sessions. During one session, a-tDCS was applied over the motor cortex for 10 min at the end of the rest period between the 2 fatiguing contractions whereas during the other session, sham stimulation was applied. Surface electromyogramme (EMG) was recorded for BB, BRD and TB during the first (C1) and second (C2) fatiguing contraction. Changes in corticospinal excitability during C1 and C2 were assessed by recording, in the same muscles, motor evoked potential (MEP) elicited by transcranial magnetic stimulation of the motor cortex. **Results** Time to failure was briefer for C2 than C1 in both experimental sessions, but the reduction was less pronounced ( $p = 0.04$ ) after a-tDCS ( $-14.4 \pm 12.7\%$ ) than sham stimulation ( $-23.3 \pm 11.9\%$ ). In contrast, changes in MEP amplitude and EMG activity in both agonist and antagonist muscles were similar between C1 and C2, and did not differ between sessions ( $p > 0.05$ ). Similarly co-activation did not change during the different contractions ( $p > 0.05$ ). **Discussion** In agreement with previous work (1), time to failure of C2 was increased following a-tDCS. However, a-tDCS did not influence muscle activity (EMG) and corticospinal excitability (MEP) during C2, neither in agonist nor antagonist muscles. These results suggest that the effect of a-tDCS on time to task failure should rely on other neural structures than the corticospinal pathway or on cognitive functions involved during sustained isometric contractions. **References** 1. Cogiamanian et al. (2007). Eur J Neurosci. 26:242-9 2. Lévênez et al. (2008). J Neurophysiol. 99:554–63 3. Nitsche et al. (2008). Brain Stimul. 1:206-23 Contact aabdelmo@ulb.ac.be

### PERFORMANCE IMPROVEMENT DURING A DECEPTIVE CYCLING TIME-TRIAL IS ASSOCIATED WITH GREATER CENTRAL FATIGUE BUT SIMILAR PERIPHERAL FATIGUE

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Time to task failure during high-intensity, exhaustive cycling exercise might coincide with a severe degree of peripheral fatigue, which is never voluntarily exceeded by the exercising human (i.e. a “critical threshold”). However, data showed that it is possible to improve performance time during cycling time trial (TT), by misleading participants into believing they are racing against a virtual avatar reproducing a previous TT when, in fact, power output was greater (i.e. deceptive TT). The neuromuscular consequences underpinning this performance improvement remains to be determined. Therefore, the present study aimed to investigate the influence of deceptive TTs on end-exercise peripheral and central fatigue. Ten participants performed, on separate days, one maximal 5km TT (5KCTRL) and three deceptive 5km TTs, during which they had to strictly adjust their pace to match the one of a virtual pacer. Whilst participants were informed that the virtual pacer reproduced the pattern of power output measured during 5KCTRL, which was true in only one session (5K100%), power output was in fact 5% (5K105%) and 10% (5K110%) greater in two other sessions. Maximal voluntary contraction (MVC) and peripheral fatigue were quantified via changes in pre- to post-exercise isometric quadriceps force and potentiated quadriceps twitch force (QTW) as evoked by supramaximal electrical stimulation of the femoral nerve, respectively. Central fatigue was estimated via changes in pre- to post-exercise quadriceps voluntary activation (VA). Power output ( $229 \pm 64$ W vs  $219 \pm 61$ W,  $P < 0.001$ ) and performance time ( $9.03 \pm 1.2$ min vs  $9.16 \pm 1.2$ min,  $P < 0.001$ ) were improved by  $5 \pm 2\%$  and  $2 \pm 1\%$  in 5K105% compared to 5K100%, respectively. These improvements were associated with a  $14 \pm 6\%$  and  $28 \pm 9\%$  greater reduction in MVC ( $-41 \pm 14\%$  vs  $-36 \pm 14\%$ ,  $P < 0.01$ ) and VA ( $-19 \pm 10\%$  vs  $-15 \pm 9\%$ ,  $P < 0.01$ ) but unchanged QTW ( $-51 \pm 8\%$  vs  $-50 \pm 9\%$ ,  $P = 0.55$ ) in 5K105% vs 5K100%, respectively. During 5K110%, participants failed ( $P > 0.25$ ) to improve power output ( $223 \pm 60$ W) and performance time ( $9.12 \pm 1.1$ min) compared to 5K100%. Following 5K110%, reduction in MVC ( $-40 \pm 14\%$ ), VA ( $-16 \pm 9\%$ ) and QTW ( $-51 \pm 8\%$ ) were not different compared to 5K100% ( $P > 0.23$ ). Our data showed that performance improvement during a deceptive TT is limited to small increments in power output and occurred at the expense of a centrally-mediated reduction in the muscle force generating capacity. This rise in central fatigue might assure that muscle activation does not surpass a level that would cause a further accumulation of peripheral fatigue beyond an invariable level.

### NEUROMUSCULAR FATIGUE DEPENDS ON RELATIVE BLOOD-FLOW RESTRICTION LEVELS

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**Introduction:** The acute neuromuscular response to blood flow restriction exercise (BFRE) is yet to be understood, particularly with different relative levels of BFR. This study aimed to resolve methodological limitations reported in literature (Loenneke, 2015), and to extent the findings of past research on the neuromuscular adaptations to BFRE performed at different levels of pressure (Loenneke, 2015; Yasuda, 2008). We examined the acute effects of low-intensity knee extensions (20% 1RM) with BFR, on neuromuscular fatigue and torque of the rectus femoris (RF) and vastus medialis (VM) muscles. **Methods:** Fourteen young men ( $24.8 \pm 5.4$  yrs; height:  $175.2 \pm 4.4$  cm; body mass:  $71.1 \pm 6.9$  kg) were tested on 3 different conditions of unilateral knee extension exercise (20% 1RM: 4 sets of 30+15+15+15 reps) with BFR. Conditions were determined by various BFR levels normalized to the pressure value of absolute vascular occlusion, determined at rest (40, 60 and 80%BFR). Torque was collected from a Biodex System 3 (Shirley, NY), during pre and post-exercise MVCs. Neuromuscular fatigue was determined through EMG signal - median frequency (MF); using Trigno™ wireless system (Delsys, USA). MF was calculated through 3 sustained isometric contractions (20% MVC), at 4 time-points: pre 1 – baseline; pre 2 – 1 min after cuff inflation; post 1 – immediately after exercise; post 2 – 1 min after cuff release. Paired t tests were used to explore differences in torque and MF parameters, for

each condition (40, 60 and 80%BFR). A two-way repeated measures ANOVA [condition (40 vs. 60 vs. 80%BFR) x time (pre1 vs. pre2 vs. post1 vs. post2)] was conducted to determine the effects pre to post-exercise on MF. Results: Torque only decreased (-5.2%) in the 80%BFR condition ( $p < 0.01$ ). One minute after cuff inflation (pre1 to pre2), MF was only significantly different in the 80% BFR condition for the RF muscle (-7.8%,  $p < 0.01$ ). After exercise with various levels of BFR (pre2 to post1), MF decreased significantly in the RF muscle (40%BFR: -8.4%, 60%BFR: -15.2%, 80%BFR: -21.2%,  $p < 0.01$ ) and in the VM muscle (60%BFR: -3.2%, 80%BFR: -7.5%,  $p < 0.01$ ). After cuff release (post1 to post2), MF increased significantly in both muscles for all conditions, although MF of the RF was still significantly different between pre1 and post 2 (-11.8%,  $p < 0.01$ ), after the 80%BFR condition. Discussion: This study demonstrated that the magnitude and duration of neuromuscular fatigue is dependent on the relative level of vascular restriction. Accordingly, within resistance training context, BFR should not be prescribed using standardized values of occlusion pressure, as the relationship between relative and absolute values of BFR pressure can be very different. Loenneke J, Kim D, Fahs C, Thiebaud R, Abe T, et al. (2015). *Muscle Nerve*, 51(5):713-721 Yasuda T, Brechue W, Fujita T, Shirakawa J, Sato Y & Abe T (2008). *J Sports Sci* 27(5):479-489

## Oral presentations

### OP-BN08 Sport Technology: Movement Monitors

#### RELIABILITY OF A LASER SYSTEM WITH AN AUTOMATIC CONTROL TRACKING FOR MONITORING THE RUNNING OF ATHLETES USING COMPUTER VISION

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Introduction Laser sensors for analyzing velocity in real-time is adequate (Ferro et al, 2014) although its use has been limited to placing them on tripods (Graubner and Nixdorf, 2011) or to guide them manually, being easy to lose the beam contact with the athletes' backs. The purpose was to analyze the reliability test re-test of a laser system (BioLaserSport®) equipped with an automatic tracking which is controlled by computer vision for monitoring the athletes in order to obtain their running velocity. Methods Eighteen male, recreationally active healthy students (age=20.18  $\pm$  1.56 years, height= 1.77  $\pm$  0.05 m, body mass=69.19  $\pm$  5.34 kg) took part in two series of 30 m sprint during two days in the same week. Distances were measured in real time by a laser system Biolasersport® (Ferro, 2012; Ferro and Flórida, 2010) using a LDM301-Jenoptik-type1-laser at 2000 Hz. For to develop an algorithm that allows tracking clearly and concise of the location of the marker used by the athlete, we use the open library Open Computer Vision-open CV. It allows to apply techniques of computer vision. Calchist function, to select the region of interest (the color reference) for calculating the histogram was used. The center of region or center of mass provides x,y coordinates into the image analyzed. This coordinates were used to make the control of the positions and orientations of Biolasersport®. An integral proportional control (IP) to calculate the error between the center of the frame and center visual reference for provide the correction signal required on the system was used.. Average velocities ( $V_m$ ) and maximum velocities ( $V_{max}$ ), over sections 0-10, 10-20 and 20-30 m were analyzed. Intraclass correlation coefficient (ICC) with confidence interval (CI) of 95%, standard error of measurement (SEM) and the minimum difference (MD) to be considered "real" were used to analyses Intrasession and intersession reliability. Results The ICC intrasession and intersession values obtained were 0.85-0.93 for  $V_{max}$  and 0.85-0.97 for  $V_m$ . SEM was lower than 0.14 m/s for  $V_{max}$  and 0.09 m/s for  $V_m$ . MD was lower than 0.28 m/s for  $V_{max}$  and 0.24 m/s for  $V_m$ . Discussion The ICC intrasession was excellent being higher in  $V_m$  than in  $V_{max}$  and better than ICC intersession. The minimum value at which a change in performance would be considered would exceed 4.67%. The automatic control implemented in the laser system by computer vision can improve reliability in the analysis of the velocity in real time, eliminating human error produced when aiming the laser sensor manually. Also, it can be used in competition conditions without the colours or shapes the environment affect their measure. References 1. R. Graubner, R. Nixdorf, E. (2011). *New Stud. Athlet.* 26, 19-53. 2. 2. Ferro A., Flórida P., Villacieros J., Aguado R. (2012). *Rev. int. cienc. Deporte*, 30, 357-370. 3. Ferro, A. (2012). *BioláserSport*. Trademark nº3019808/9. BOPI:12.06.2012. 4. Ferro A, Flórida P. (2010). Patent ES2331170A1 (A61B 5/11-G01S 11/00). BOPI: 22.12.2009. Contact amelia.ferro@upm.es

#### RELIABILITY OF WEARABLE MICROSENSORS TO MEASURE PHYSICAL ACTIVITY IN HANDBALL

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Introduction In recent years, there has been an increased use of wearable tracking technology to measure the physical activity in elite team sports. However, there is currently limited published information on the reliability of these devices (Chambers et al., 2015). Therefore, the aim of this study was to assess the reliability and sensitivity of a commercially available microsensor technology to measure the specific physical activity demands in handball. Methods A total of twenty-two, male and female, elite and highly-trained handball players (age, 22.6  $\pm$  3.7 years; body mass, 84.0  $\pm$  14.2 kg; height, 184.4  $\pm$  12.0 cm; mean  $\pm$  SD) participated in the study. The subjects were instrumented with two devices (Optimeye S5, Catapult Sports, Melbourne, Australia), and partook either in a laboratory assessment ( $n = 10$ ) or field assessment ( $n = 12$ ). The laboratory assessment consisted of seven different handball specific movement tasks. The field assessment consisted of twelve handball-training sessions. Selected inertial movement analysis (IMA) variables were extracted from the manufacturer's software (Catapult Sprint, Catapult Sports, Melbourne, Australia), including IMA magnitude and counts, in addition to PlayerLoad™. The reliability and sensitivity was estimated using typical error  $\pm$  90% CI (expressed as coefficient of variation (CV)) and smallest worthwhile difference (SWD) (Hopkins, 2015). Results Laboratory assessment: IMA magnitude showed good reliability (CV 2.9%) in well-controlled movement tasks. The CV increased (4.4 to 8.2%) in more chaotic movement tasks. Field assessment: IMA counts showed a good reliability (CV 2.4%) when displayed as total counts. However, the CV increased when categorized into low (1.5-2.5 m.s<sup>-1</sup>; 2.9%), medium (2.5-3.5 m.s<sup>-1</sup>; 5.5%) and high (>3.5 m.s<sup>-1</sup>; 5.6%) intensity bands. Medium/high band (combined) showed a CV of 3.9%. The CV for low, medium/high and total counts was less than the SWD. Furthermore, it was observed a good reliability (CV 0.9%) for PlayerLoad™, which was less than the SWD. Discussion The reliability of IMA counts was acceptable, given that data were expressed as low, medium/high and total counts. PlayerLoad™ also demonstrated acceptable reliability. As the CV of the aforementioned variables were below the SWD, this suggests that the Optimeye S5 microsensors and its software are sensitive to detect "real and worthwhile" differences in

typical handball activity. References Chambers, R., Gabbett, T.J., Cole, M.H., & Beard, A. (2015). *Sports Med.*, 45: 1065-1081. Hopkins, W.G. (2015). *Sportscience* 19, 36-42 ([sportsci.org/2015/ValidRely.htm](http://sportsci.org/2015/ValidRely.htm)). Contact: [matt.spencer@nih.no](mailto:matt.spencer@nih.no)

## DEVELOPMENT OF A MULTI-AXIAL MECHATRONIC STRENGTH TRAINING AND TESTING DEVICE

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**Introduction** Strength and power are very important in elite sport so high quality training and testing is imperative. Mechatronic systems utilizing mechanical, electronic and software components are commonplace in industry. Published documentation of robotic applications in elite sport is rare, with the exception of isokinetic devices (Haddadina et al., 2009). The aim of this project was to develop a multi-axial mechatronic-based leg strength training and testing device. **Methods** The following demands in the development process of the new device must be met: linear and curvilinear movements, variable speeds, bilateral and unilateral training, concentric and eccentric as well as sport-specific training. The athlete should have force and position visual feedback and a test mode should be available for all movements. **Results** The developed device (Evo) is constructed as a right/left leg independent system, each consisting of two synchronized servomotors for the horizontal and vertical plane connected to spindles and servo controllers. The Evo operates with a programmable logic controller (PLC) used for automation of electromechanical input and output processes. Training and testing software are downloaded onto the PLC. The coach operates the Evo with a handheld terminal with a 6.5" VGA TFT display. The prototype allows for both single axis (horizontal and vertical linear movement) and for two coordinated axes (curves, circles and ellipses) training and testing. The maximum speeds of horizontal and vertical movements are 2.5m/s and 3.3m/s, respectively. Maximum load capacities are 4.8kN horizontally and 1.6kN vertically. The form of the ellipse (steeper or flatter angle) or circle as well as the repetitions per minute (up to 100) can be chosen on the handheld control. Additionally several stretch shortening cycles or stochastic shocks can be included. To measure the force values two 3-dimensional force plates were integrated into the foot plates. **Discussion** The Evo utilizes mechatronics allowing a multitude of general and sport-specific movement combinations of concentric and eccentric exercises for leg/hip extension and flexion muscles with visual force and position feedback. Training and testing on the Evo offer basic research opportunities such as the analysis of stretch-shortening cycles and stochastic shocks in the different training modes and speeds. Additionally eccentric hamstring training on the Evo in the vertical plane and with curves could have potential for injury prevention. Mechatronics can transform training conceptions into reality for high performance athletes. **References** Haddadina S, Laue T, Frese U, Wolfa S, Albu-Schäffer A, Hirzinger G. (2009). *Robot Auton Syst*, 57, 761-775. Contact [[Christian.Raschner@uibk.ac.at](mailto:Christian.Raschner@uibk.ac.at)]

## RECOGNITION OF DYNAMIC AND STATIONARY ACTIVITY TYPES IN OUT-OF-LAB CONDITIONS USING HEART RATE AND ACCELEROMETERS DATA FUSION

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**Introduction** Of particular interest in healthcare monitoring, automatic recognition of human activity has become an extensively researched topic. Unlike the majority of recognition systems, our study focuses on the classification of dynamic and stationary activities extended to natural out-of-lab conditions, with a two-fold purpose: (i) find the optimal sensors placements on the body and (ii) assess the effect of combining the heart rate (HR) information to the acceleration. **Methods** The dataset was established on 8 volunteers freely performing 5 activities: run, walk, cycle, car ride, and rest (stand or sit). 4 nodes manufactured by the SHIMMER Company (Dublin, Ireland) recording 3D raw acceleration signals (in gravity unit: g) were attached to the ankle, chest, wrist and hip of the subjects and 6 electrodes were placed on the chest to extract the HR measures from the RR waves of the recorded Electrocardiogram (ECG) signals. The recognition model is based on a previously developed method (AbdulRahman et al., 2015) that extracts the spectral distances features from acceleration data. These features are then used as input for 3 commonly used classifiers: the K-Nearest neighbors (KNN), the Naive Bayes (NB) and the Decision Tree (DT) for activity prediction (Lara et al. 2013). **Results** With the 4-position accelerometers, an overall classification rate of  $99.0\% \pm 0.4$  was achieved by the KNN classifier, while the NB and the DT classifiers marked  $87.8\% \pm 1.1$  and  $95.9\% \pm 1.1$  respectively.  $89.8\% \pm 1.0$ ,  $94.5\% \pm 0.8$ ,  $95.4\% \pm 0.7$  and  $95.7\% \pm 0.7$  are the system responses when considering the single node on the chest, the wrist, the hip and the ankle respectively. These accuracies raise to  $94.1\% \pm 1.1$ ,  $97.9\% \pm 0.6$ ,  $98.7\% \pm 0.5$ , and  $98.7\% \pm 0.3$  when coupling the HR information to each corresponding position. **Discussion** The lower limbs sensors hold the most valuable information for the prediction of the dynamic and stationary activity types. Unlike the 'rest' and 'car ride' activities, 'run' and 'walk' are correctly detected, which support the idea that ambulation behaviors involve quasi-periodic movement of the body (Altun et al. 2010). Combining acceleration and HR data enhance the accuracy of the identification. Thus, with an HR monitor and only a single unit accelerometer, it is accurately sufficient to classify dynamic and stationary activities (mean accuracy higher than 97%). **References** AbdulRahman H., Carrault G., Prioux J., (2015) ICABME, Lebanon. Altun K., Barshan B., Tuncel O. (2010), *Pattern Recognition*, 43(10), 3605-3620. Lara, OD. Labrador, MA. (2013). *Comms. Surv. Tut.*, IEEE, 15(3), 1192-1209.

## MOBILITY PERFORMANCE MEASUREMENT IN WHEELCHAIR BASKETBALL

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**Introduction** The current level of play in wheelchair basketball requires a professional approach in optimizing overall game performance, including the mobility performance of each individual athlete. This mobility performance describes the kinematics of the wheelchair-athlete combination. The goal of this research was to evaluate a mobility performance measurement method by measuring athletes of different competition level and classification in wheelchair basketball. Given the level of impairment, kinematic based mobility performance was expected to differ between classification groups. Differences due to competition level or gender, were expected to be more subtle and with differences mainly in the strength and skill related (rotational) acceleration. **Methods** Using a three inertial measurement unit configuration (Van Der Slikke et al. 2015), wheelchair kinematics of 29 national and international level athletes were measured during a match. The following wheelchair kinematics were measured: displacement, speed, acceleration, rotation, rotational speed and rotational acceleration. The new measurement method was rated as accurate, if expected differences in kinematics showed significant with large Cohen's d effect sizes. **Results** All calculated kinematics differed significantly between classification groups, with less impaired athletes being faster, with higher accelerations. National level players rotated significantly slower than international players and with significantly lower rotational acceleration from standstill. All significant differences uncovered also showed large ( $> 0.8$ ) Cohen's d effect

sizes. Discussion The method was concluded to be accurate, since it was able to detect all expected differences in mobility performance between groups. The true value of the new method showed in picking up differences in (rotational) acceleration between competition level or gender groups, something to our knowledge was not measured before. The application of the inertial measurement unit configuration allowed for a more detailed and more accurately quantified measure of wheelchair mobility performance. The method proved to be able to discriminate well between expected differences of aspects of mobility performance, between athletes of different classification, competition level or gender. The measured between-group differences in higher order outcomes, mark the need for including (rotational) acceleration in the quantification of mobility performance. Consequently, the new method measures important aspects of mobility performance and it enables individual athlete evaluation. In such way, it is a crucial tool in professionalizing wheelchair sports, since it supports evaluation of interventions in wheelchair settings or athlete training. References Van Der Slikke, R. M. A., Berger, M. A. M., Bregman, D. J. J., Lagerberg, A. H., & Veeger, H. E. J. (2015). Journal of Biomechanics, 48(12), 3398-3405. Contact Mail: R.M.A.vanderSlikke@hhs.nl

## Oral presentations

### OP-PM19 Soccer & Rugby Performance

#### DEVELOPMENT OF PHYSICAL AND SPORTS SPECIFIC PERFORMANCE OF YOUTH SOCCER PLAYERS FOR THE PERIOD OF ONE SEASON.

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Introduction The purpose of this study is to reveal possible developments between two performance groups within the same team for the period of one season. It has already been shown that jumping and sprinting abilities can be increased through strength training interventions (Wirth et al., 2011). The aim of this study is to disclose how one different training session influences sports motoric and soccer specific performance parameters although training and match volume keeps the same. Methods The subjects (n=15; age= 9.17 ± 0.28; sex= 14 m, 1 w) played all for the same team, but participated in different training sessions (2 groups). Once a week the training of the high performance group members was replaced by a session at a performance centre (LAZ) and they were selected by talent scouts of the Austrian Football Association (OEFB). Performance parameters were analysed for Drop Jumps (DJ) from various heights (16,24 and 32 cm), Squat Jumps (SJ), Countermovement Jumps (CMJ), Sprints (10 and 30 Meters), a soccer specific version of the Illinois Agility Tests (IA) and for the Loughborough soccer passing test (LSPT) over 12 weeks (autumn season). Data was analysed with a two-way analysis of variance (ANOVA) with post hoc Test Bonferroni by using the statistics software SPSS (Version 20.0). Results The study indicated a significant ( $p < 0.05$ ) decrease in sprint performance of both groups over 10 and 30 meters. Regarding repeated measurement factors no interactions for any parameter between the groups has been found over the period of the season. Discussion Due to no significant varying development of both groups, the one different training session of the high performance group has no influence on the development of the measured performance parameters. Regarding declining sprint times, environmental influences like variable temperature, minimal discrepancies of the light barrier system positioning or the possible error created by the design of the light barrier system (one sensor system) can not be ruled out. References Wirth, K., Sander, A., Keiner, M., & Schmidtbleicher, D. (2011) Leistungsfähigkeit im Dehnungs-Verkürzungs-Zyklus sportlich aktiver und inaktiver Kinder und Jugendlicher. Deutsche Zeitschrift fuer Sportmedizin, 62(11), 345.

#### PHYSICAL AND TECHNICAL PERFORMANCE OF ELITE YOUTH SOCCER PLAYERS DURING INTERNATIONAL TOURNAMENTS: INFLUENCE OF OPPONENT QUALITY AND TEAM SUCCESS

VARLEY, M., GREGSON, W., MCMILLAN, K., BONNANO, D., STAFFORD, K., MODONUTTI, M., DI SALVO, V.

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Introduction: This study investigated the positional differences in physical performance of elite youth footballers across two international club tournaments and the influence of team success and opponent quality on team physical and technical performance. Method: Match performance observations were collected using a semi-automated multi-camera tracking system across two elite under-17 international club tournaments from all players and teams (n=1,457 individual cases). To investigate if the exclusion of substituted players influenced the physical performance profile, data of only players who completed a full game and data of all players were analysed in relative (m.min<sup>-1</sup>) terms. Teams were classified based on their final tournament rank as top (1-4 rank), middle (5-8 rank) and bottom (9-12 rank). Technical performance measures were expressed in absolute terms and relative to the time the team was in possession of the ball. Positional differences in physical performance and the influence of team success and opponent quality on team match performance were identified using a generalized linear mixed model. Results: Positional differences were similar to that observed in elite senior players. Full game players experienced a clear reduction in relative very-high speed running distance in the 2nd half, however when all players were analysed there were no clear reductions. Top ranked teams performed a greater number of absolute and relative shots and shots on target than bottom teams (Effect Size = 0.67 to 0.82). Passing and organising variables had unclear effects between team rankings. Top ranking teams performed a greater number of relative tackles than bottom and middle teams (ES; 0.44 to 0.70). When playing against top ranking opponents the number of absolute shots and shots on target, shot conversion and passing accuracy were lowest compared to playing against middle and bottom opponents (ES; -0.86 to -0.31). Discussion: In an elite youth tournament setting, opponent quality has a greater influence on match performance than team success. Practitioners should account for these contextual factors when analysing match performance data to assist in their match preparation. Finally, match analysis should include full game players and all players to avoid to understand the influence of substitutes on team physical performance.



**PLAYER'S SUCCESS PREDICTION IN RUGBY UNION: FROM YOUTH PERFORMANCE TO SENIOR LEVEL PLACING**

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Union Rugby National federations and clubs regularly engage in youth draft camps, where anthropometric and functional characteristics are evaluated towards early talent identification and selection of the potentially elite athletes. Yet the relative predictive power of single characteristics in future career development remains to be determined. **PURPOSE:** this study aims at determining if and to what extent specific anthropometric and functional characteristics can accurately predict subsequent career progression. **METHODS:** Anthropometric and functional characteristics of 531 male players in the U16 age category, as recorded during 2006-09 Italian National Draft Camps, were retrospectively analysed in relation to senior level placing at age 21-24. Players were classified as International (I, National team and international clubs) or National (N, 1st, 2nd and other divisions, dropout). Multivariate analysis of variance (One-way MANOVA) tested the difference between I and N along a combination of anthropometric (weight, height, body fat, fat-free mass) and functional variables (SJ, CMJ, t15m, t30m, VO2max). A Discriminant function (DF) was determined to predict group assignment based on a linear combination of variables and corresponding coefficients. Correct level assignment was expressed as % hit rate. **RESULTS:** The youth players enrolled in draft camps represent a very selected sample that does not reflect the anthropometric characteristics of the reference population (> 95th percentile for weight and height). 39 players (7%) were classified as I, while 492 (93%) were classified as N. The results of MANOVA analysis indicate that a combination of anthropometric and functional characteristics reflects future level assignment (I vs. N) ( $V = 0.27$ ,  $F(28, 1356) = 3.45$ ,  $p < 0.05$ ). Furthermore, players' success can be accurately predicted (hit rate = 81% and 77% for I and N respectively) by a DF ( $\lambda = 0.88$ ,  $\chi^2 = 45.1$ ,  $p < 0.05$ ) that combines anthropometric and functional variables as measured at ~15 years of age. Among these, % body fat and speed appear to be the most influential predictors of group stratification within the discriminant function. **CONCLUSIONS:** Within a group of 15 year-olds with exceptional physical characteristics, future player's success can be predicted using a linear combination of anthropometric and functional variables, among which a lower % body fat and higher speed over a 15m sprint provide the most important predictors of the highest career success. The early identification of the athlete's potential allows to "customise" the development programme based on the individual's needs and deficits and to maximise the overall efficiency of the formation process. ales-sandro.colosio@univr.it

**TAPERING IN TEAM SPORTS: PHYSICAL PERFORMANCE RESPONSE IN ELITE RUGBY SEVENS PLAYERS**

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**Introduction** As for endurance sports, appropriate tapering is considered critical for maximizing team sports performance. However, there is little scientific information available to guide coaches in prescribing efficient tapering strategies for team sports players. The aim of this study was to monitor the changes in physical performance in elite rugby sevens players during a 3-week taper immediately following the pre-season training camp. **Methods** 10 male international rugby sevens players were tested before (Pre) and after (Post) a 4-week pre-season training camp, and each week during a subsequent 3-week taper (T1, T2, T3). During each testing session, maximal lower limb strength and explosiveness, sprint acceleration mechanical outputs and performance, and repeated sprint ability were assessed. **Results** At Post, both sprint performance and maximal isometric force output remained unchanged, while an almost certain small increase in both mean (MPO) and peak cycling power output (PPO) was reported ( $+6.0 \pm 1.7$  % with a 100/0/0 % chance to observe a positive/trivial/negative change in performance and  $+4.5 \pm 2.1$  %; 99/1/0 % for MPO and PPO, respectively). During the taper, the 30-meter sprint time improved almost certainly ( $-3.1 \pm 0.9$  %, 0/0/100 %, large). A moderate negative correlation ( $r = -0.50 \pm 0.45$ ) between change in sprint running performance and change in Pmax was reported. Maximal force output during the mid-thigh pull improved very likely during the taper ( $+7.3 \pm 6.4$  %, 95/3/2 %, small). Both MPO and PPO also improved almost certainly during the same period ( $+9.0 \pm 2.6$  %, 100/0/0 %, moderate;  $8.6 \pm 2.7$  %, 100/0/0 %, moderate, respectively). For all variables tested, peak performance occurred on average between 9th and 16th day of taper. **Discussion** Although maximal strength, sprint performance and repeated sprint ability kinetics differed, a 2-week tapering timeframe seems optimal to maximize the overall physical performance response in elite rugby sevens players. We also found a substantial inter-individual variability, which supports the importance of an individualized training load during the tapering period.

**NEUROMUSCULAR, BIOCHEMICAL, PERFORMANCE AND PERCEPTUAL RESPONSES FOLLOWING A SELF-PACED SOCCER MATCH SIMULATION**

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**Aim:** A soccer match is characterised by high-intensity, intermittent running, including directional changes, rapid accelerations and decelerations, resulting in both biological and psychological disturbance. Match simulations used to assess responses in a controlled environment lack ecological validity due to external pacing. Recently, an ecologically valid and reliable self-paced protocol has been developed using a non-motorised treadmill (NMT). The aim was to assess the neuromuscular, biochemical, performance and perceptual responses to that protocol. **Method:** Twelve male team-sport athletes ( $24.5 \pm 3.9$  y,  $76.8 \pm 5.1$  kg,  $VO_{2peak} 52.3 \pm 4.0$  ml•kg<sup>-1</sup>•min<sup>-1</sup>) performed a self-paced 90-min match simulation on a NMT. Match running performance and the following variables were collected Pre-, Half-time (except blood), Post-, 2-h post-, and 1-4 days post-match: - Quadriceps function via a maximal voluntary contraction and magnetic stimulation assessing central (voluntary activation) and peripheral (potentiated twitch torque) fatigue - Endocrine response (testosterone and cortisol), oxidative stress (uric acid) and muscle damage [creatine kinase (CK)] - Countermovement jump, squat jump (SJ) and isometric mid-thigh pull (IMTP) performance - Rating of perceived exertion and self-report wellness questionnaire Statistical analysis included magnitude of change calculations between time points compared to pre-match using effect size statistics ( $\pm 90\%$  CI) and regression analysis. **Results:** Participants covered  $12445.8 \pm 768.7$  m at  $87.1 \pm 3.2\%$  maximal HR, similar to actual match observations. Central and peripheral fatigue was evident at Half-time ( $-0.38 \pm 0.46$  and  $-0.79 \pm 0.30$ , respectively) and persisted post-match. SJ height was reduced at Half-time ( $-0.42 \pm 0.31$ ) and persisted until Day 4. Perceptual fatigue and soreness peaked at Day 1 ( $-0.92 \pm 0.88$  and  $-1.49 \pm 0.76$ , respectively), as did CK ( $123.4 \pm 70.8\%$ ). Significant relationships arose between numerous variables, including high speed running and soreness ( $r = 0.65$ ), very high speed running and potentiated twitch torque ( $r = -0.78$ ) and IMTP F.kg<sup>-1</sup> Pre with change in CK ( $r = -0.58$  to  $-0.81$ ). **Discussion:** The current protocol allowed detection of central and peripheral fatigue at half time, which has not been previously reported, and this magnitude of change was not increased post-match. Similar to previous work, there was disturbance to

numerous systems, generally returning to baseline in 3 days. Relationships exist between activity profile and perceptual and neuromuscular variables, and higher maximal lower-body strength resulted in less muscle damage post-match. The findings warrant further investigation into the role of central and peripheral fatigue in regulating second half performance and potential interventions to minimise any negative impacts.

### **ANTHROPOMETRIC CHARACTERISTICS, BODY COMPOSITION AND SOMATOTYPE OF FEMALE PLAYERS OF THE SECOND DIVISION OF THE NATIONAL RUGBY LEAGUE.**

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**Introduction** Several studies have described the somatotype and anthropometric characteristics in female team sports like soccer, basketball, handball, volleyball, and also in female individual sports such as tennis and gymnastics. However, there is very little information on the morphometric characteristics of female rugby players. There are only two studies describing anthropometric data of a total of 51 female players from Australia and France (Gabbett, 2007; Bru et al., 2011). The objective of this study is to analyze the anthropometric characteristics of 55 female players from the second division of the national league rugby. **Methods** Anthropometric measurements were performed according to standardized techniques adopted by the International Society for the Advancement of Kinanthropometry (ISAK). Height, weight, body mass index, and sum of 6 skinfold were measured. Three different methods were used to calculate the percentage of body fat (%BF): Faulkner (only 4 skinfolds of the upper extremity and trunk), Reilly et al. (skinfolds of the thighs, legs, triceps and abdomen) and Yuhasz (sum of 6 skinfolds). The somatotype was assessed using the equations of Carter and Heath. **Results** The characteristics of the players were: body mass  $66.0 \pm 10.0$  kg; height  $163.3 \pm 7.1$  cm; body fat  $14.5 \pm 4.2\%$  (Yuhasz),  $16.1 \pm 4.2\%$  (Faulkner),  $17.3 \pm 4.0\%$  (Reilly) and muscle mass  $54.6 \pm 6.2$  kg. The sum of skinfolds was:  $\Sigma 6$  folds,  $121.7 \pm 44.4$  mm;  $\Sigma 4$  (Reilly),  $83.2 \pm 27.0$  mm. The average somatotype was: Endomorphy  $4.47 \pm 1.74$ ; Mesomorphy  $2.65 \pm 0.95$ ; Ectomorphy  $1.74 \pm 0.1$ . There were significant differences ( $p < 0.05$ ) in some anthropometric parameters (body mass and skinfold thickness) between players of different positions: the 'forwards' were heavier and had higher skinfold thickness than the 'backwards'. **Discussion** The results of this study show that female players from the Spanish 2nd League are away from the internationally recommended body composition for female athletes. These sample of rugby league players have a higher body mass and skinfold thickness greater than previously published in other female team sports. These results show the need to analyze and planify interventions on anthropometric parameters to allow players from the second division league rugby tolerate more effectively the physiological demands of competition. **References** Gabbett TM. (2007). J Strength and Conditioning Res, 21, 875–881 Brun JF, Varlet-Marie E, Cassan D, Raynaud de Mauverger E. (2011). Clin Hemorheol Microcirc, 49, 207-214.

## **Oral presentations**

### **OP-SH11 Psychology: Motivation 2**

#### **ANALYSING THE STATE OF OPTIMAL MOTIVATION IN ENDURANCE SPORTS UNDER CONTROLLED CONDITIONS**

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**Introduction** Previous studies showed, that flow experience will occur even if there is no required balance of challenge and skills. Neither subjectively perceived fit nor objective measurements confirmed this assumption regarding a congruence of both influencing factors as a requirement for the occurrence of flow. Therefore, the aim of this study is to test whether the optimal adaption of abilities and demands will be precondition for the development of flow experiences in racing cyclists, even if it's examined under laboratory conditions. Furthermore, it is the target to document the individual dynamics of flow during continuous cycling performances and their correlations with physiological variables. **Methods** The four-week investigation ( $N = 10$ ) was conducted in a climate chamber under controlled conditions ( $T$ :  $18^\circ$  Celsius; relative humidity: 50%; air velocity:  $1\text{m/s}$ ; uniform clothing). Therefore, flow experience should be impaired less as possible since the parameters were selected by insuring physical wellbeing independent of low or high physical stress. The individual predetermined physical strain to pass was examined by using a bicycle ergometer. Physical demands were based on an existing maximal incremental cycling test for each test subject. This allowed an individual setting of load intensity according to usual training zones (KB, GA1, GA2, EB) in cycling. The adjustment was related to the individual anaerobic threshold (IAT) as follows: KB: 55,2%; GA1: 76,7%; GA2: 92,4%; EB: 104,4. Continuous recording of physiological parameters (heart rate; pedaling frequency; wattage; power range) could be ensured at each point of time. Flow was measured with the Flow Short Scale (Rheinberg et al., 2003) close to the desired situation of optimal motivation without interrupting the applied activity at an interval of ten minutes by a verbal query (Schatke et al., 2009). Participants had an achievement-related affinity towards cycling to make flow experience more likely to occur. **Results** Positive correlation between total flow score and pedaling frequency ( $r = 0,90$ ) as well as heart rate ( $r = 0,65$ ). The stated balance between task difficulty and skills ( $M = 6,60$ ) at the end of the EB area (high physical demands) with recognizable incongruent relationship of both factors has a higher Flow score ( $M = 5,75$ ) than any stated fit in the areas EB, GA1 and GA2 with low or moderate strain. **Discussion** It is possible to create Flow on a bicycle ergometer under controlled conditions within the predefined performance areas independent of any perceived balance concerning challenge and skill. Nevertheless test subjects were acquired with an imputed high implicit achievement motive and perceived importance towards cycling. Occurrence of flow however is also motivated due to more influencing intrapsychic factors we didn't measure at all (Kehr, 2004). Physical demand were matched with the individual threshold (IAT). Results are not generalizable caused by the small sample size. Therefore Flow experience among controlled circumstances is no predictor for real terms.

## DIFFERENCES IN MOTIVES FOR RUNNING AND PARTICIPATION IN RUNNING EVENTS BETWEEN RUNNERS WITH DIFFERENT RACE PACE

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**Introduction** For several years it is seen that more and more people participate in recreational sport, which includes running events. It is not only in marathon events but also on shorter races e.g 10K. Recreational running, as a form of physical activity is still gaining popularity (von Bottenburg et al., 2010). It is important to learn more about various factors that encourage people to run and participate in recreational road races. Due to that need, profile of runners in different countries was established (Forsberg, 2012; Petridis, 2013). The purpose of this study was to analyze the profile of three groups of runners with different race pace, who participated in 10K running events, and to analyze the factors related to their perception about their running activity. **Methods** An online questionnaire was used to collect data, which was based on the questionnaire about running from the Danish Institute for Sport Studies. Questionnaire was sent to runners taking part in two 10K running events in Poland. Total of 635 runners questionnaires were analyzed (61% males and 39% females). Runners were categorized in 3 groups regarding their race pace (<4:30min/km, 4:30–5:30min/km, >5:30min/km). Five-point Likert scale was used for answers. **Results** Slower runners (>5:30min/km) see this form of recreation as way of socializing with others, in oppose to faster runners (<4:30min/km). Also slower runners see running as a boring activity. Moderate runners (4:30–5:30min/km) thinks running carries high risk of injuries. It's easier for faster runners to find time for practice and also those runners agree that running is for everyone. Faster runners take part in running events mostly to compete against others and set those events as a training goal. Moderate runners are taking part in running races to set personal best on measured course. **Discussion** Different race pace influence motivation to running. Runners see difference between running everyday and running in road races. Even though slower runners agree that running is a great way to socialize with others but at the same time they don't get easily attached to other runners, but they also run 1 road races because they like to spend time with friends and family. Faster runners are more proud of their activity than other runner groups. Also they see all runners as a specific group, different than groups in other sports. **References** Forsberg, P. (2012). Motionsløbere i Danmark – Portræt af danske motionsløbere. København: Idrættens Analyseinstitut. Petridis, L. (2013). The running movement in Greece: Investigating the profile of the modern marathon runners. *Hellenic Journal of Sport & Recreation Management*, Vol. 10 (2), 43 – 54. Contact czajka@gmail.com

## MOTIVATION CONTAGION IN FITNESS SETTINGS: HOW EXERCISERS' PERCEIVED MOTIVATION AND WEIGHT STATUS INFLUENCE INSTRUCTOR MOTIVATION AND THEIR INTERPERSONAL STYLE TOWARD EXERCISERS

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**Introduction** The effect of perceptions of another individual's motivation on the perceiver's own motivation is referred to as motivation contagion. This present study represents the first experimental test of this concept in a fitness setting. Specifically, the aim of the study was to examine if perceptions of novice exercisers' motivation and weight status influence fitness instructors' own motivation to instruct, their perceptions of the exerciser's efficacy beliefs, and the interpersonal behaviours the fitness instructors would use when interacting with exercisers. **Methods** A randomised, factorial 2 (new exerciser motivation: autonomous, controlled) x 3 (new exerciser weight: average weight, overweight, formerly overweight) between-subjects experimental design. Qualified fitness-instructors (n = 199; Mage (SD)=25.90 (5.55); 57.10% male) were randomly assigned to conditions and presented with an image and cover story of a hypothetical male exerciser. Subsequently they completed a questionnaire pack measuring perceptions of the exerciser's motivation and exercise efficacy and their own motivation to instruct, plus the degree to which they would employ autonomy supportive and controlling interpersonal behaviours when instructing the target exerciser. The questionnaires were completed online. Factorial ANOVA and MANOVAs were employed to analyse the data. **Results** The instructors reported higher levels of autonomous motivation to instruct, more autonomous supportive behaviours, and perceived the exercisers to be more efficacious, when exercisers were portrayed as being autonomously motivated to exercise, compared to when they had controlled motivation. Further, instructors reported more controlled motivation to instruct and more controlling interpersonal behaviours with an overweight exerciser, compared to the average weight or formerly overweight exercisers, reflecting a potential weight bias. **Discussion** The results suggest that the motivation to instruct and interpersonal behaviours of fitness instructors are influenced by their perceptions of exercisers' quality of motivation to exercise and exercisers' weight status. This can have important implications for exercise adherence, and ultimately health, of novice exercisers. The findings suggest that fitness instructors should be made more aware of how cues about exercise clients may affect their own motivation (including behaviours) and how their own weight bias may negatively influence exerciser outcomes.

## A FIGHTER'S LIFE-ATHLETIC CAREER DEVELOPMENT IN PROFESSIONAL CHINESE MARTIAL ARTS ATHLETES

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**Background:** 1. It is meaningful to develop theoretical frame in oriental cultural context. ; 2. Few knowledge of the athletic career in Martial arts and combat athletes has been known. ; 3. For young Fighters, especially for Chinese athletes, they have not been consulted through their professional career for their development and the problems they experienced. **Purpose:** Explore the characteristics of professional development of Chinese martial artists (before, during, termination and post-career). **Method:** 1. Questionnaire. The Athletic and Post Athletic Questionnaire (APAQ) is employed in this study. APAQ was invented and developed by Schmidt and Si based on the three theoretical frameworks mentioned above. In this instrument, four parts of questions of before, during, athletic termination and after the professional career are included. 2. Interview guidelines. According to the statistical analysis work and the interview, APAQ interview guidelines was invented and developed. It can be used in this study. It is also based on the three theoretical frameworks including multilevel and different sets of questions and takes the life-span development as the main time line. The whole process usually takes 40-60 minutes in different cases. **Sampling:** forty five ex-martial arts athletes (42 males, 4 females) were invited into questionnaire survey and five of them took into the section of interview who came from Beijing and Tianjin sport university. They are ranging in age from 19 to 31 years (M=22.22, SD=3.23). Before joining the universities, they were totally active Chinese martial arts athletes (Taolu and Fighting) for several years during which, they were all supported in finance and living by local sport system of government. Up to now, they have already retired more than 2 years. **Result:** Throughout the professional career, family is the strongest support for athletes to counter and solve the problems which is very different from the previous studies of coach influence; throughout the professional career, athletes have

no clear future plan for their life development and have little right and space to decide for themselves; when they join the professional team, their social circle becomes narrow; during the professional phase and termination transition phase, they get little help from government, social organization and sport team for the future development; they encounter serious problems during the retirement transition; they adapt the post-career life and opposite even though they have still high athletic identity which is totally different from previous studies; compared with Chinese sport system, European sport system (France and Sweden) help athletes throughout their professional career to independent decide. The cross cultural and comparison study between European countries and China athletes would be conducted next year.

## Oral presentations

### OP-PM04 Rehabilitation & Training

#### WHAT IS THE EFFECT ON INDEPENDENT RECOVERY OF USING PEDOMETERS AS A TOOL TO PRESCRIBE EXERCISE FOLLOWING TOTAL HIP REPLACEMENT?

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**Introduction** It has been previously shown that following total hip replacements (THR) patients are less active compared to age-matched controls and that interventions to increase post-operative physical activity (PA) have little success (Lowe et al. 2015). There is a need to increase PA in this population using a relatively inexpensive measure, pedometry, to take into account the current strains that national health systems are under. A two arm-randomised control trial (RCT) was undertaken to assess this hypothesis. **Methods** Patients on the waiting list for primary unilateral THR were recruited. Both groups received treatment as usual with the intervention group additionally receiving a target number of steps for two days a week for the first 24 weeks post-operatively and a pedometer to record this. Outcome measures were taken pre-operatively and at four, 12 and 24 weeks post-operatively. Physical activity was measured using the Physical Activity Score for the Elderly (PASE), hip outcome using the Oxford Hip Score (OHS), a two-way repeated measures analysis of variance was used to analyse the PASE and OHS data. **Results** Thirty-three participants were recruited between December 2014 to December 2015 two participants are excluded from the analysis, one due to THR being indefinitely cancelled and one as a bilateral THR was performed. A total of 15 participants were in the control group, mean age=71.3±10.4, three males and 12 females and 16 in the intervention, mean age=67.8±11.0, 10 male and six female. There was no significant difference ( $p>0.05$ ) in baseline pre-operative measures. For the PASE sphericity was assumed ( $W=0.61$ ,  $p=0.58$ ) there was a significant within subject effect ( $F_{3,27}=3.90$ ,  $p=0.019$ ) and non-significant between group effect ( $F_{1,9}=0.02$   $p=0.886$ ), the change preoperatively to week 24 was 39.4±51.1. For the OHS sphericity was assumed ( $W=0.20$ ,  $p=0.06$ ) there was a significant within subject effect ( $F_{3,24}=21$ ,  $p<0.001$ ) and non-significant between group effect ( $F_{1,8}=2.9$   $p=0.13$ ), the mean change for OHS pre-op to week 24 was 22.6±10.6. **Conclusion** This research follows the common theme of exercise interventions not showing a significant effect in this population. Though equally it is surprising as this intervention has worked previously in clinical populations (Bravata et al. 2007). This RCT adds to the complex picture in respect to physical activity following THR. There is still a need to find an intervention that works within this population. **References** Bravata D. Smith-Spangler C. Sundaram V. Gienger A. Nancy L. Robyn L. Stave C. Olkin I, Sirard J. (2004). JAMA, 298(19), 2296-2304. Lowe C, Davies L, Sackley C, Barker K. (2015). Physio, 101(3), 252-65.

#### PERFORMANCE AND PHYSIOLOGICAL EFFECTS OF DIFFERENT DESCENDING STRATEGIES FOR CROSS-COUNTRY MOUNTAIN BIKE PERFORMANCE

MILLER, M., MACDERMID, P., FINK, P., STANNARD, S.

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**Introduction** Physiological variables measured during cross-country mountain bike racing remain steady despite highly intermittent propulsive work demanded by variable terrain (Macdermid and Stannard, 2012), which may be due to musculo-tendonous damping of vibrations that are translated from the riding surface (Macdermid et al., 2014). Reports that descending performance is independent of mechanical propulsive work (Hurst and Atkins, 2006) suggest it may be possible to reduce pedaling on descents and better recover for subsequent ascents. This study investigated the vibrations, metabolic benefits and performance-related feasibility of eliminating pedaling while descending and compared these values to those measured on a road surface. **Methods** Eight nationally competitive mountain bikers took part in this study. 24 hours after a laboratory fitness test, participants completed a field trial consisting of three descending conditions (off-road pedaling (DHP); off-road coasting (DHC), both 1.01 km, -16.3%; road (DHR), 1.03 km, -15.7%). After familiarization with the track used and practicing the coasting strategy, participants cycled uphill at race pace before randomly commencing DHC or DHP. DHR was completed at the mean velocity of the off-road trials. Power, heart rate, VO<sub>2</sub>, and tri-axial accelerations were recorded. **Results** VO<sub>2</sub> was significantly increased during DHP when compared with DHC ( $35.2 \pm 4.8$  vs  $31.7 \pm 3.9$  ml•min<sup>-1</sup>•kg<sup>-1</sup>, respectively) despite no difference in vibrations and relatively low average power output ( $18.8 \pm 11.6$  W). Pedaling did not elicit a performance benefit (DHC=142.5 ±29.2, DHP=139.9 ± 29.2 s) on the descent used in this study. Lower heart rate and oxygen uptake were observed in DHR versus both off-road trials, likely caused by the decrease in vibrations. **Discussion** Despite relatively low power output, metabolic demand is exacerbated when pedaling on off-road descents compared with coasting. Elimination of propulsive work does not change vibration exposure but decreases oxygen cost, and importantly has no negative effect on performance. Vibrations experienced during road descending are relatively low, and accompany further reduce physiological demand. It is recommended that athletes focus on skills to increase descending speed without the addition of pedaling, and that equipment be used to decrease vibrations nearer to those seen on the road. **References** HURST, H. T. & ATKINS, S. 2006. Power output of field-based downhill mountain biking. Journal of Sports Sciences, 24, 1047-1053. MACDERMID, P. W., FINK, P. W. & STANNARD, S. R. 2014. Transference of 3D accelerations during cross country mountain biking. J Biomech, 47, 1829-37. MACDERMID, P. W. & STANNARD, S. 2012. Mechanical work and physiological responses to simulated cross country mountain bike racing. J Sports Sci, 30, 1491-501. Contact m.miller1@massey.ac.nz



## INTENSITY OF GAME-BASED TRAINING DRILLS IN FEMALE TEAM HANDBALL

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**Introduction** The use of game-based training drills is a recommended training modality that promotes physical performance enhancement and training efficiency via a combination of the different components of the game (Corvino et al, 2014). The aim of this study was to compare the intensity and quantity of high intensity events (HIE) of game-based training drills to official matches. **Method** Player movements were observed from two female handball teams, from the first and second level in Norway. The study consisted of monitoring ten sessions, where participants completed game-based training (3vs3 and 6vs6, randomized order) with a duration of 5 min each. In addition, ten official matches were monitored. Twenty-seven players (backs, pivots, and wings) were included in the study. Inertial movement units (Catapult Optimeye S5, Australia) were used for data collection. PlayerLoad™ (PL) and HIE (>2.5 m·s<sup>-1</sup>) were extracted from the raw-files. Magnitude based inferences were used to describe probabilities of substantial differences between conditions. Differences were deemed substantial when there was a likelihood of >75% of the difference exceeding an effect size (ES) of 0.2. **Results** 3vs3 condition: When compared to average match intensity, the 3vs3 condition was substantially higher in PL for backs (100%, ES:4.3), wings (100%, ES:5.0), and pivots (100%, ES:3.6). Substantially higher values were also found when comparing PL against the highest 5-min period in match play (H5-min) for all positions. HIE was higher compared to average match for backs (97.2%, ES:0.6), wings (100%, ES:2.2) and pivots (96.8%, ES:1.2). Wings and pivots showed substantially higher values for HIE compared to H5-min. 6vs6 condition: Higher PL values were found for backs (100%, ES:1.6), wings (100%, ES:1.8), and pivots (95.9%, ES:1.1) compared to average match intensity. Only wings showed substantially higher values (83.5%, ES:0.5) when compared to H5-min. HIE in 6vs6 was not different from average match, however, when compared to H5-min HIE was substantially lower for all playing positions. **Discussion** An overload in general intensity (PL) is evident in both game-based training conditions compared to average match intensity. HIE values show a smaller difference from average match data than for PL, and thus suggests that the increased intensity is mostly due to an increase in lower-intensity accelerative actions e.g. running at a steady velocity. This is especially apparent in the 6vs6 condition. Thus, game-based training drills might not overload the important physical components (Karcher et al. 2014) of team handball. **References** 1. Corvino M, Tessitore A, Minganti C, & Sibila M. (2014). *J Sport Sci Med*, 13(2):297-303. 2. Karcher C, & Buchheit M.. (2014). *Sport Med*, 44(6):797-814. Contact: livesl@nih.no

## QUANTIFYING THE MOST INTENSE PERIODS OF MATCH-PLAY IN RUGBY UNION

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**Affiliations:** 1. Institute of Sport, Exercise and Active Living, Victoria University. 2. Melbourne Rebels **INTRODUCTION:** Understanding match activity profiles may guide training prescription and in-game decision making. Peak periods of activity can be quantified via the mean value in a moving window of a given duration. This approach was applied here to National rugby union matches. **METHODS:** Movement data were collected via global positioning system and accelerometry for the 30 players of an Australian National Rugby Championship team across the eight matches of a season. Mean running speed (m.min<sup>-1</sup>), external load (PlayerLoad (TM)) and metabolic power were analysed using a rolling average method to identify the maximum mean values for periods ranging from 5 s to 10 min. General linear mixed modelling was used to predict these measures, with fixed effects for positional differences (backs, forwards), match half (1st, 2nd), and within-season trend (date as linear numeric), and with random effects for between-player differences, within-player variabilities, and between-match differences. The random effects were combined into intraclass correlation coefficients representing reproducibility of each measure. Effects were quantified using standardization and interpreted with magnitude-based inferences. **RESULTS:** There was an approximately six-fold reduction in mean running speed for the longest window duration compared with the shortest. Backs achieved clearly faster speeds than forwards by 21% (90% confidence limits ±9%) for the 5-s window down to 1.5% (±7.5%; unclear) for the 10-min window. Mean running speed declined clearly by up to 11% in the second half for forwards and backs for most windows of ≥1 min. Mean running speed declined clearly by ~7% over the season for windows of ≥5 min for backs and by 9-14% for windows ≥30 s for forwards. The reproducibility of mean running speed between halves and between matches was poor for the 10-min window (ICC=0.54) and very poor for the shorter windows (ICC <0.50). External load and metabolic power showed effects generally similar to those of mean running speed, but external load was clearly higher for forwards over the 10-min window, and reproducibility of external load was impractical (ICC <0.20) for all but the 10-min window (ICC=0.51). **DISCUSSION:** The differences and changes in the mean measures of maximum-intensity match play have direct implications for design of training and for substitution decisions of professional rugby union players. The low reproducibility of the measures implies that players will have to be monitored across many games to obtain adequate precision for assessing physical performance of individual players.

## EXAMINING THE RELIABILITY OF THE 100 POINT FUNCTIONAL MOVEMENT SCREEN SCORING SYSTEM

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**Introduction** The Functional Movement Screen (FMS) is one of the most widely used movement screens in both research and practical settings. The FMS comprises of seven tests that are traditionally graded from 0 to 3, providing a composite score out of 21. A 100 point scoring system has been developed in order to improve the ability of the FMS to detect variations in movement quality between participants. The reliability of the 100 point system has yet to be fully investigated, with currently no published studies reporting intra-rater reliability and only one study examining the inter-rater reliability of the 100 point scoring system. Therefore, the primary aim of this investigation was to examine both inter- and intra-rater reliability of the 100 point FMS scoring system using two chartered physiotherapists who are both certified and experienced with the FMS (>1000 screens conducted). **Methods** 110 physically active collegiate males (mean ± SD 21.43±3.2 years; body mass= 77.27±8.7kg; height=177.5±6.8cm) were videotaped undertaking the seven FMS tests: Squat, lunge, hurdle, rotary stability, press up, active straight leg raise (ASLR) and shoulder mobility (Shld). Thirty participants were randomly chosen and their videos were re-scored 6 weeks later by the second rater and again by the first rater. Inter- and intra-rater reliability of both the final scores and component tests were analysed using Intra-Class Coefficients (ICC) and kappa statistics with associated 95% Confidence Intervals (CI) respectively. **Results** Inter- and intra-rater ICC values for the total scores were .97 (.95-.98) and .98 (.97-.99) for the 100 point and .98 (.96-.99) and .99 (.96-.99) for the 21 point scoring system, indicating that both scales had almost perfect inter- and intra-rater reliability. All the component tests using both scoring systems had between perfect and substantial agreement for both inter- and intra-rater reliability. For intra-rater reliability, the 100 point scale had seven measures that were perfect or almost perfect (Shld, ASLR, squat,

right rotary stability) and five measures had substantial agreement (lunge, left rotary stability, hurdle). For inter-rater reliability, the 100 point scale had 10 of the tests that were either perfect or near-perfect agreement and 2 (Right Lunge and Hurdle) with substantial agreement. Every measure using the 21 point scale had perfect or almost perfect inter- and intra-rater agreement with the exception of the rotary stability test, which had substantial agreement. Conclusion Both the 100 point and 21 point scoring systems had substantial to excellent levels of inter- and intra-rater reliability for both the total score and component scores. Experienced practitioners should feel confident using the 100 point scoring system, which may help distinguish athletes of different movement abilities more effectively than the 21 point scoring system.

## THE RELATIONSHIP BETWEEN WALKING CAPACITY AND PREVIOUS STOP DURATION IN PATIENTS WITH PERIPHERAL ARTERY DISEASE

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**Introduction** Walking capacity is a key outcome in the management of lower extremity peripheral artery disease (PAD) patients limited by ischemic pain during walking. While the walking pattern of these patients is characterized by repeated walking and stopping bouts due to ischemia, it is likely that walking capacity is not maximized throughout repeated walks/stops. Indeed, during recovery from a maximal walking test (MWT), patients' pain dissipates whereas ischemia is still present (Gardner, 1993). The aim of this study was to prospectively determine how maximal treadmill walking time is influenced by previous stop duration. **Methods** This study presents preliminary results of the CLASH protocol (NCT02041169) for 13 PAD ( $ABI \leq 0.90$ ) patients. The included patients had a maximal walking distance  $< 500$  m with limitations due to lower-limb pain during a treadmill test. Using a Strandness protocol, patients performed 10 "walking blocks" in a random order on 4 different days. A block was composed of: i) a MWT1; ii) a recovery bout of a given duration; iii) a MWT2. Ten recovery durations were tested: from 0.5 to 9.5 min with 1.0-min increments. Maximal walking time was measured during MWT1 and MWT2. Individual linear and logarithmic models were tested for the relationship between change in maximal walking time ( $(MWT2 / MWT1) \times 100$ ) and recovery duration. A general (group-based) linear mixed model was also tested. **Results** Individual linear and logarithmic models were significant ( $p < 0.05$ ) in 9 and 11 patients, respectively.  $R^2$  coefficients ranged from 0.50 to 0.78 (linear models), and from 0.43 to 0.93 (logarithmic models). Greater  $R^2$  values were obtained using logarithmic (vs. linear) models in most patients ( $n = 9$ ). In 2 patients, no model reached statistical significance. The  $R^2$  coefficient for the general mixed model was 0.50 ( $p < 0.05$ ). **Discussion** While the relationship between maximal walking time and previous stop duration seems to mainly be logarithmic, it remains an important inter-individual variability. Further analyses of our data are needed to determine which factors, such as pathophysiological responses to walking, could improve the prediction offered by both individual- and group-based models. Such a prediction could be tested in free-living conditions (Le Faucheur, 2010) and likely be used to optimize walking exercise programs. **References** Gardner A W (1993). *Med Sci Sports Exerc*, 25, 904-910. Le Faucheur A (2010). *J Vasc Surg*, Apr, 51(4), 886-92. Support: University Hospital of Rennes (CORECT 2013 funding).

## Oral presentations

### OP-PM68 Health & Fitness

#### PROLONGED SITTING, POSTURE AND PHYSICAL INACTIVITY - A MODERN EPIDEMIC IN SCHOOL CHILDREN

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During childhood and adolescence growth, the development of bones and muscles should be coordinated, because muscular forces influence the growth and function of bones and joints. The alignment and posture of the spine is related to the length and balance of muscles attached to the spine and pelvis. Despite great care dedicated to proper motor function in children, shortness of muscles is common among them. This may be due to the modern lifestyle related epidemic of inactivity, which is one of the factors of back pain among school children. Adult back pain became to be one of the most important of medical and socio-economic problems today. 437 pupils (225 boys and 212 girls) were randomly selected from 10 primary schools in six different Israeli cities. The research population was divided into three age groups according to age and sex. Straight leg Raising (SLR), Pelvic Rotation (PR), Hip Extension (HE), Lumbar Lordosis (LL), Thoracic Kyphosis angles (TK) and postural deformities were measured. Past complaints of Back pain noted, 'Physical activity parameters' and 'Sitting parameters' were recorded. The average of out-of-school sitting was 3.2 hours/day. The commonest leisure activity was watching television, 12.4 hrs/week in boys and using a computer 10.3 hrs/week. Among the girls watching television occupied 13.7 hrs/week and using a computer 9.6 hours/week. There was a reduction in the range of all motion parameters as the number of sitting hours increased ( $P < 0.05$ ). A significant negative correlation was found between all motion parameters, SLR, PR, HE and the LL angle ( $P < 0.05$ ). With the TK angle only PR and SLR were found significantly correlated ( $P = 0.05$ ). Tight hamstrings were found as a predicting value for Back pain only amongst girls ( $P = 0.05$ ). Better ranges of motion, both with regard to SLR and PR were noted in those involved in physical activity ( $P = 0.06$ ) and here there were also less postural deformities ( $p = 0.00$ ). Both prolonged sitting and excessive physical activity were associated with back pain. Significant differences were found with regard to the frequency of computer use in relation to back pain ( $P = 0.007$ ). Great importance must be attached to revising physical education and sports programs as an inseparable part of our cultural life. This situation, already considered to be one of the most dangerous, chronic epidemics of the modern era, will, probably, become worse, in the future, because the amount of sitting hours and inactivity will increase as modern high technology continues to develop. This research was supported by research foundation of Hadassah Hospital, Orthopedics Dep. By the late Prof. Haim Weinberg until the year of 2012, and it is a continuation of original papers presented in different international conferences.

## RESULTS OF A HEALTH AND FITNESS PROMOTION CAMPAIGN IN A MILITARY SETTING: EXPLORATION OF DIFFERENCES BETWEEN SUCCESSFUL PARTICIPANTS AND DROPOUTS.

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**Introduction** Sustained participation of personnel in workplace health promotion campaigns is even under optimal conditions a challenging problem (Leyk et al. 2014). In order to minimize dropout rates of health and fitness programs, it is important to explore in detail differences between sustaining participants and those who drop out. 203 persons participated in a health and fitness campaign at an international military agency in Strasbourg. Given the physical requirements in a military setting most participants did previously exercise. We hypothesized that low and medium exercisers who dropped out of the program would differ from sustained participants in their perception of the importance of physical performance, motivation, and motives to exercise. **Methods** In order to reduce intercultural, age, and gender related influences only data from German males in the range of 25-50 years of age were analyzed. Of the 123 Germans participating 48 qualified as low and medium exercisers (training frequency < 3 times a week). This sample was split into two groups (31 dropouts and 17 sustainers). Dropouts were defined as persons that participated only at the onset of the six months study period. Data collection included questionnaire data on lifestyle, motives to exercise (Motives for Physical Activity Measure revised) and motivation (Behavioural Regulation in Exercise Questionnaire 2), as well as anthropometric measurements. Analyses were conducted using Chi-Square and t-tests (U-tests). **Results** At the onset of the program the two groups did not differ in respect to their motivation, motives, and importance of physical performance to themselves as individuals. However, sustainers considered physical performance to be less important to their prior assignments. Sustainers were less satisfied with their own body weight and did weigh significantly more than dropouts. At the end of the program sustainers significantly reduced their body weight, BMI, waist circumference, and body fat. **Discussion** Results show that participation in the program was worth the effort. Nevertheless, less than 20% of eligible personnel participated in the health promotion campaign. In addition almost 2/3 of the low and medium exercisers that choose to take part in the health program did not finish it six months later. These findings underscore the urgent need for a better understanding of the individual motives to participate and incentives to stay with health and fitness programs. **References** Leyk D et al (2014). Dtsch Arztl Int: 111: 320-7

## INFLUENCE OF INCREASED PHYSICAL ACTIVITY ON APPETITE AND MOOD STATE IN YOUNG ADULT WOMEN USING VARIOUS PHYSICAL ACTIVITY INDICATORS

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**Introduction** Engaging in regular physical activity (PA) with moderate-to-vigorous PA (MVPA) or PA at or above the lactate threshold intensity (LT) would improve health outcomes. Increasing the daily step count (SC) is often promoted as an alternative indicator for achieving a target PA level. However, our understanding of how such PA indicators influence the quality of PA and how appetite and psychological stress are affected remains limited. This study aimed to assess the effects of acutely increased habitual PA on the quality of PA, appetite and mood state using various PA indicators. **Methods** Twenty-seven healthy young adult women participated in this randomized, crossover study. All subjects completed a 1-day protocol under three different conditions. For the LT trial, subjects were instructed to increase PA to a level that was equivalent to or exceeded LT for at least baseline plus 30 min. For the STEP trial, subjects were instructed to increase their SC by at least baseline plus an equivalent amount of SC, which was estimated as increasing SC during the LT trial. For the MVPA trial, subjects were instructed to increase their MVPA for at least baseline plus 30 min. For each trial, all subjects used the 100-mm VAS to record their subjective feelings regarding hunger, fullness, desire to eat and estimated quantity of food they desired. These assessments were conducted at the following three time-points: on waking up on the morning of the trial, immediately prior to eating evening dinner and on the morning following the trial. Each subject was additionally asked to complete a Profile of Mood States-Brief Form (POMS) at the similar three time-points. **Results** While there were no significant differences in SC when compared across the three different trials, the duration of PA conducted at LT during the LT trial was significantly longer than that in the STEP or MVPA trials. Significant time effects, in which all subjective appetite parameters increased from the morning to a time-point immediately before evening dinner, were found in all trials. However, no significant trial effects or time  $\times$  trial interactions were observed for any of these parameters or with regard to the data provided in the POMS's scales. **Discussion** The present data indicated that the quality of PA can fluctuate according to the PA indicator used when individuals attempt to increase their PA. Moreover, a strenuous PA, such as increasing the duration of PA at or above LT, is not likely to cause deleterious effects on appetite or induce psychological stress. **References** King JA et al.(2010)Med Sci Sports Exer, 42, 485-492. Ekkekakis P et al.(1999)Sports Med, 28, 337-374. Contact kumahara@nakamura-u.ac.jp

## EVALUATION OF A 2-YEAR Pedometer-BASED INTERVENTION PROGRAM USING APPRECIATIVE INQUIRY: STEP INTO HEALTH IN CAMPUSES

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**Introduction:** In Arab countries, physical inactivity among adults fluctuated from 33% to 86%; Qatar shows a prevalence rate of 46% [1]. This study evaluates the effectiveness of a 2-year community intervention based program on increasing the physical activity levels through pedometer measures and appreciative inquiry (AI) within 11 universities in Qatar. **Methods:** SIH in Campuses, Qatar, is a community-based program to increase physical activity levels through walking amongst universities [2]. This study involved 1,299 students and staff (aged 18-64 years), males and females of different nationalities. The intervention was implemented in 2 phases and launched as a 4-month walking competition. The 2nd phase included awareness sessions about physical activity and the program itself. Pedometers are linked to a web-database allowing physical activity level follow up. Daily steps were categorized as:  $\leq 5,000$ , sedentary; 5,000-7,499, low active;  $\geq 7,500$ , physically active [3]. AI evaluation used the 4-D model and involved 30 universities' stakeholders. **Results:** Out of total population: 800 were females (62%) and 499 males (38%); 86% were non-Qataris, 14% Qatari nationals. Mean age was  $31.3 \pm 12.9$  years and BMI averaged  $26.6 \pm 5.1$  kg/m<sup>2</sup>. Daily step count was 5,681 steps. The age groups 18-24 and 25-34 years (n=841; 68%) represent students, while age groups 35-44 (n=201; 15.5%), 45-54 (n=162; 12.5%) and 55-64 (n=95; 7.3%) are staff. Results shows 38% were low active, 37% physically active and 25% sedentary. The AI main themes that engaged stakeholders the most were awareness/ education - 5 points (100%), competition, multi levels of involvement with SIH, sense of community, community-based program, and motivation - 4 points each (80%). The AI points represent themes' repetition accrued within stakeholders' discussions. **Discussion:** This intervention engaged more students, categorized as low active. Participants tend to become more active with age, as staff was categorized as physi-

cally active. Both phases confirm an increase of average steps engaging the community in physical activity. The 2nd phase shows a greater increase due to the awareness session and continuity of the program. All outcomes confirm that this intervention would focus more on spreading physical activity/health awareness and education within universities community. References: [1] Musaiger AO, et. al. Strategy to combat obesity and to promote physical activity in Arab countries. *Diabetes, Metabolic Syndrome and Obesity: Targets and Therapy* 2011; 4:89–97. [2] SIH website: <http://www.stepintohealth.qa> [3] Tudor-Locke C, et. al. A step-defined sedentary lifestyle index: <5000 steps/day. *Applied physiology, nutrition, and metabolism* 2012; 38(2):100-114. Contact [daniela.khidir@aspetar.com](mailto:daniela.khidir@aspetar.com)

## Oral presentations

### OP-SH17 PE in School & other Pedagogical Settings

#### **VOLUNTEER MOVEMENT AS A MEANS OF HEALTHY LIFESTYLE PROMOTION.**

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The issue of establishing a well-organized Physical Education system is one of the most essential problems that modern education faces. Its urgency arises from the fact that only duly organized Physical Education process can contribute to improving schoolchildren's health and encourage children to develop physically and spiritually [1]. The student volunteer movement at Pedagogical University of Physical Culture and Sports is aimed at raising popularity of PE and sports activities among children and teenagers, including children with deviant behavior, at attracting their attention to the idea that healthy living is within their reach and equipping them with all the qualities needed for an active, healthy and achievement-oriented lifestyle. Researchers have concluded that one of the prospective trends in Theory and Methodology of Physical Education is the trend of optimizing the integral process of physical and mental development of schoolchildren. It means that both physical training and auto-training techniques should be integrated into the PE system [2]. The aim of cooperation between students of MSU Pedagogical University of Physical Culture and Sports and the Khimki basketball team is «to raise students' interest in their future professional activity by means of the University extracurricular activities» [3]. MSU students and the Khimki basketball team take part in "One team" project. "One team" is a corporate programme of social responsibility and an integrated marketing program developed by Euroleague in partnership with several sports clubs. MSU students and members of the basketball team arrange sports activities for children in cooperation with secondary school teachers. They arrange meetings with pupils, teach master classes at PE lessons, and organize basketball games to develop team spirit, tolerance and the ability to interact among schoolchildren. During the first year with "One team" MSU students had teaching practice at secondary schools in Khimki. It was a good opportunity for students to get involved into the professional basketball club activities, learn about the latest basketball Euroleague sports and teaching techniques, put their knowledge into practice. Multiple activities were aimed at helping students develop new education programs and manuals for PE teachers and coaches. By the end of the first year students achieved significant results: pupils became much more involved and interested in PE lessons, trainings and master-classes arranged by students, Khimki team players and world class athletes. Children with deviant behavior took part in most of these activities and games. As a result of team work with Khimki basketball club students got a lot of experience that may help them make a long-term plan of actions aimed at bringing PE teaching system up to standard.

#### **SAVORING DANCE IN A LIFE: A CASE STUDY ON THE DANCE EXPERIENCE OF MIDDLE-AGED KOREAN WOMEN PARTICIPATING IN A DANCE EDUCATION PROGRAM**

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**Introduction** This study aims to understand the dance experience of middle-aged Korean women in the context of their lives. In particular, Korean women in middle age experience a time of many changes when they are given free from child-rearing and household chores. They encounter a turning point in their lives re-illuminating their own identities, roles and so on. In this regards, experiencing dance in middle age can make their lives happier. Therefore, this study focused on the stories from middle-aged women, who participate in a dance education program, and explored the way they savor dance and the meaning of dance in their lives. **Methods** Through the case study based on qualitative research method, this study took 2 participants, of whom one participated in a dance education program for 2 years and the other in the same program for 5 years. The program was to provide middle-aged women opportunities of arts education and was supported by a Foundation for Arts and Culture in Seoul. The data were collected through in-depth interview, non-participation observation, researcher's field note, and the materials from the program, and analyzed in the inductive method. **Findings** Three ways of savoring dance experience - physical, cognitive, and affective way - were identified; and each way was all divided into two aspects again - external aspect (EA) and internal aspect (IA). First, the physical way that the participants savored dance included 'doing dance movement and skills' (EA) and 'lived experience during movement' (IA). Second, the cognitive way included 'acquiring information around dance' (EA) and 'cultivating phronesis' (IA). Third, the affective way included 'promoting attitude to dance' (EA) and 'building character through dance experience' (IA). These dance experiences meant to the participants as 'fulfilling their lives', 'communicating with the world', and 'encountering the self as a new existence'. **Conclusion** This study was to explore the meaning of savoring dance in a life of middle-aged women, and identified that the experience of savoring dance had the possibilities to make their lives happier. Based on the findings, the following further researches were suggested. Firstly, it should be discussed how the experience of savoring dance relates to the concepts; lived experience, aesthetic experience, and embodied experience, etc. Secondly, we should study on what and how to teach to make learners savor dance constantly. Contact [homoartex@snu.ac.kr](mailto:homoartex@snu.ac.kr)



## COMMUNICATION ACTIVITIES IN LIFESAVING TEAM RESCUE: FOR DEVELOPING THE METHODOLOGY OF LIFESAVER TRAINING

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**Introduction** Whether someone is struggling at the local pool or has gone overboard out at sea, communication is an indispensable duty for lifesavers. Their day-to-day activities are unique and vary from other sports in terms of communication styles. Unfortunately there are not enough studies about communication skills in the field of lifesaving. This study shows the specific characteristics of communication styles in lifesaving and suggests the effective training in lifesaving skills from an educational perspective. **Method** Data concerning lifesaving communication was taken by observing the R University's lifesaving club's simulation training. As for gathering data, both verbal and non-verbal activities of lifesaving has been recorded by an IC recorder and a videotape. Transcript of recording data was processed by the way of Szatrowski (2010) and analyzed by the method of text linguistics (Brown and Yule 1983). Furthermore subjects were interviewed right after the simulation training to examine the purpose, meaning of their utterance and their emotions during lifesaving activities. **Result** 1. Using a nickname for each member of the team at lifesaving activities is essential to strengthen their sense of unity as a team and form friendships. 2. The leader of the lifesaving team uses at most three simple words at rescue, and manages communications easily and smoothly. 3. Each member of the team can understand and communicate with teammates by minimal words and signs. The communication system in an emergency is naturally formed through their rigorous routine exercise regimens and frequent small talk. **Discussion** Communicating with teammates not only at the lifesaving exercises but on daily basis is paramount. Having everyday conversations and knowing each member's characteristics and habits contribute toward developing the team's communication skills and competence to cope with a problem as a cohesive unit. It is not isolated individual activity but a team working in unison in order to save a life. In addition, active and spontaneous association with other people seems to be crucial for lifesavers to develop an attitude toward saving life in an emergency. **References** Brown, G. & Yule, G. (1983) *Discourse Analysis*. Cambridge: Cambridge University Press. Szatrowski, P. (ed.) (2010) *Storytelling across Japanese Conversational Genre*. Amsterdam: John Benjamins. Contact tachikawa@rku.ac.jp

## TALENT UNDERSTANDING AND TALENT DEVELOPMENT AMONG HANDBALL COACHES IN NORWEGIAN AND DANISH SPORT SCHOOLS

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**Introduction:** There is little consensus among researchers and scholars regarding the term talent (Baker, Schorer & Cobley, 2012), as well as among coaches (Ellingsen & Danielsen). The first aim of this study is to analyse how coaches at sport schools for athletes in the age of 15 to 19 understand the term "talent". The second aim is to determine how male handball players skills are developed at these selected schools. **Methods:** Qualitative in-depth interviews were conducted in autumn 2015. Two sport schools in Norway and two sport schools in Denmark were included in the study. Coaches with daily contact with the students were interviewed, and their working experience ranged from 3.5 to 10 years. They also had experience as coaches at elite-club level. Some were former elite-level players. **Results:** The understanding of talent seems to be different among the coaches. The schools aim for the players seemed to vary between countries. The coaches understanding of talent ranged from finding the "right types", to technical and tactical skills, physical abilities, will to work hard over time and prioritize, handling of adversity and the role of the environment. The findings indicate further that the Norwegian schools have a clear objective to develop a certain number of national and international players. The Danish schools tend to be more directed towards ensuring the students academic career and helping the students reach the objectives they set for themselves. **Discussion:** The Norwegian coaches both stressed "reading of the game" as an important aspect of a talent among physical abilities such as height, speed and size, supporting Howe, Davidson og Sloboda (1998) focus on the inherently characteristics in an athlete. The Danish coaches combination on focusing on both innate abilities and the environments role corresponds with Baker et al. (2012) work regarding talent. Gagnés (2004) model "The Differentiated Model of Giftedness and Talent" and Bronfenbrenners (1979) ecological developmental model will be used to get a further understanding of talent and talent development in the schools. **References:** Baker, J., Schorer, J. & Cobley, S. (2012). Talent identification and development in sport: International perspectives. Bronfenbrenner, U. (1979). The ecology of human development : experiments by nature and design. Cambridge, Mass: Harvard University Press. Ellingsen, J. E. & Danielsen, A. G. (accepted). The Norwegian Children's Rights in Sports and Coaches' Understanding of Talent. *Nordic Journal of Human Rights*. Gagné, F. (2004). Transforming gifts into talents: the DMGT as a developmental theory 1. *High ability studies*, 15(2), 119-147. Howe, M. J., Davidson, J. W. & Sloboda, J. A. (1998). Innate talents: Reality or myth? *Behavioral and brain sciences*, 21(03), 399-407.

## PE LESSONS IN HUNGARIAN SCHOOLS IN THE LIGHT OF THE INTRODUCTION OF DAILY PE LESSONS

HAMAR, P.1, KARSAI, I.2, CSIRKÉS, ZS.1, CSEPELA, Y.1, SOÓS, I.3

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PE lessons in Hungarian schools in the light of the introduction of daily PE lessons Hamar, P.1, Karsai, I.2, Csirkés, Zs.1, Csepela, Y.1, Soós, I.3 **1University of Physical Education, HU, 2University of Pécs, HU, 3University of Sunderland, UK** **Introduction** After the transformation of the political regime, the majority of teachers in Hungary agreed, or at least acknowledged the fact that the essential reform of education must go forward (Halász, 2003). Physical Education and Sport is one of the key areas that play an indispensable role in the cultural domain system (Hamar et al., 2006). From the beginning of the 2012/13 school year, five physical education lessons have to be held in Hungarian primary and secondary schools in the first, fifth and ninth grades and then in other grades in an ascending order, as well. In this presentation the position of physical education and physical education teachers is examined, for example, the status of physical education in relation to other subjects, the position of physical education teachers compared to other teachers, and if there are such central measures that ensure the transition between compulsory physical education and extracurricular sports activities. **Methods** A cross-sectional questionnaire-based survey method was taken place in Hungary. The original version of the questionnaire translated into Hungarian was used by Ken Hardman and Joe Marshall in an international investigation (Hardman & Marshall, 2009). In the interest of the representativeness of the data, the stratified sampling procedure for groups was used (N=1.161). Data collection was carried out in the 2013/14 school year. Besides performing descriptive statistics (frequencies), the Chi-square test was applied to examine the association and independence of nominal variables, and the Fisher Exact test for smaller number of samples. **Results and discussion** About one-third of the teachers questioned believe that physical education has the same status as the other subjects. In the period of the introduction of daily physical education, more than a quarter of the PE teachers said that the PE teachers' position was worse compared to other teach-

ers. This feedback primarily comes from those teachers who are more highly qualified and have a university degree. The main explanation for this can be the different approach and content in terms of teacher training. Although the introduction of five physical education lessons a week is welcomed, at the same time it causes concerns because of the lack of infrastructure and/or sufficient qualified staff.

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## THE PREVALENCE OF UNDERWEIGHT AND OBESITY AMONG HIGH SCHOOL GIRLS AND THE ROLE OF PARENTAL EDUCATION ON THE SPORT PRIORITY OF THEM

RASHIDI ZAFAR, R., GHAFOURI, F.

*organization of education*

Introduction Sport participation in children and adults allow multiple health benefits such as increased physical activity and physical fitness (Sepúlveda & Calado, 2012). Family, school, coaches and society are mainly responsible of the consequences that sport participation would have in physical and psychological development of children (Marcen et al, 2013). In addition, socioeconomic status (SES) can affects intention to participate in physical activity (Eime et al, 2015). This study aimed to discover the prevalence of obesity and underweight among high school girl students and effect of the sport type (individual sport and team sport) in body satisfaction and leisure time physical activity. Also tried to find the role of parental education in sport priorities of their children (individual sport and team sport). Methods Our sample consisted of 8000 high school girl students of Shahryar and according to Morgan table, we recruited 307 students with (age:  $16.36 \pm 2.23$  years, height:  $160 \pm 21.04$  cm, weight:  $58.30 \pm 24.07$  kg). Sampling used in the survey was Cluster sampling. In order to collect data, we prepared an adapted and modified questionnaire based on literatures and standard questionnaire (PAQ-A). Spearman rank correlation was used to compute the relationship between parental education and sport participation in children. Results According to the results, those who participate in team sports had better body satisfaction ( $Z = -2.64$ ,  $P = 0.49$ ). Results revealed that there is a positive significant relationship between father educations with the time spending in leisure time physical activity while there were not significant relationship between mother education and the type of the sport in the students. Discussion Although when we speak about SES, it comes the educational level by itself; researchers didn't find any study conducted the effect of parental education on type of the sport chosen by children. In most cases, education especially in father as a basic part of a family, affect the economic situation of the family. Well educated parents especially father, would be able to get along with their children and encourage them to be more socialize. Maybe children with an educated father are more self-confidence and are more willing to be exposed as a member of team sport and subsequently give more verbal and nonverbal encouragement. References Sepúlveda, A.R & Calado, M. (2012). Westernization: The role of Mass Media on Body Image and Eating Disorders. Spain. doi: 10.5772/31307 Marcen, C. Gimeno, F. Gómez, C. Sáenz, A. Gutiérrez, H. (2013). Socioeconomic Status, Parental Support, Motivation and Self-Confidence in Youth Competitive Sport. Procedia - Social and Behavioral Sciences, 82, 750-754. Eime, R.M. Melanie, M.J. Harvey, J.T. & Payne, W.R (2015). Participation in sport and physical activity: associations with socio-economic status and geographical remoteness. Bio Med Central Public Health. 2015; 15: 434. doi: 10.1186/s12889-015-1796-0 Contact rahelerashidizafar@gmail.com

18:00 - 19:30

## Oral presentations

### OP-PM67 Interval Training

#### MICROPAUSES IMPROVE THE PALATABILITY OF RUNNING.

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Introduction Despite the well-established health benefits accruing from regular exercise such as running. Barriers including lack of time and unpalatability of vigorous effort deter large sections of the population from taking part. This pilot study was conducted, therefore to investigate the palatability of running interspersed with regular micropauses of 30 seconds. Methods Following institutional ethics approval, eight recreationally active male volunteers (age =  $21 \pm 2$  years; body mass =  $70 \pm 8$  kg; height =  $1.72 \pm .03$  m) were tested under controlled laboratory conditions on two occasions, at least one week apart. On day one participants performed continuous running for 18 minutes at 85% of previously determined  $\text{VO}_2$  max. Participants' rate of perceived exertion (RPE) was monitored at regular intervals during the run. Upon completion of the run, participants' blood lactate concentration was assessed as well as their score on the Physical Activity Enjoyment Scale (PACES). On day two, participants performed the same running protocol interspersed at regular intervals with five micropauses of 30s passive rest. All other aspects of the protocol were identical to those of day one. A Shapiro-Wilk test was run to test normality of distribution, following which, paired t-tests were used to compare the measured responses to the exercise. Results The primary finding was that the micropause running protocol was associated with a significantly higher score ( $p < 0.01$ ) on the PACES ( $5.10 \pm 0.23$ ) compared to the continuous running protocol ( $3.24 \pm 0.23$ ). Additionally, the average RPE was significantly lower ( $p < 0.01$ ) for the micropause running ( $12.83 \pm 1.72$ ) compared to continuous running ( $16.97 \pm .69$ ). Maximum heart rate did not differ between the two running protocols, but post-exercise lactate level was significantly higher ( $p < 0.01$ ) following continuous running ( $14.2 \pm 2.52$  mmol/l) compared with the micropause protocol ( $10.6 \pm 2.97$  mmol/l). Discussion The results from this study show that the introduction of short micropauses significantly reduces both subjective and metabolic stress during running. Further research is warranted to explore the practical implications of these findings for physical activity promotion.

## IS SPRINT INTERVAL TRAINING EFFICIENT ALTERNATIVE TO IMPROVE HEALTH AND FITNESS IN SEDENTARY OBESE MEN?

KEBSI, W.1,5, LEMOINE-MOREL, S.1, RAUT LE GALLIC, L.1, ADELA, H.2, HAMBLLI, M.2, BEN ABDERRAHMAN, A.3, AHMAIDI, S.4, AMRI, M.5, ZOUHAL, H.1

1: MSH (Rennes, France), 2: CNMSS (Tunis, Tunisia), 3: ISSEP (Tunis, Tunisia), 4: APERE (Amiens, France), 5: NPPP (Tunis, Tunisia)

**INTRODUCTION** Sprint Interval Training (SIT) has been proposed to be a time-efficient alternative for reducing metabolic disorders in obese people (Gillen and Gibala, 2014). So far, there is no data about its impact on physical fitness. Therefore, we aim to investigate the effect of SIT on metabolic, respiratory and fitness factors in obese sedentary men. **METHODS** Thirteen participants (age,  $24 \pm 0.74$  years; Body mass index (BMI),  $33.38 \pm 4.30$  kg.m<sup>-2</sup>) underwent 10 weeks of SIT (3-4 sessions/wk; 3(3-4 x 8s sprints at 75%-95% peak power (Ppeak)). Body composition, anthropometric, fasting blood markers (glucose, insulin, HbA1c, HDL- and LDL-cholesterol, triglycerides) and fitness measurements: peak oxygen uptake (VO2peak) (from maximal incremental test), Ppeak (from force-velocity test), maximal power (Pmax) and mean power (Pmean) (from cycling sprint test: 7 x 6s of 'all out' sprints interspersed with 90s of recovery) were assessed at baseline and post-intervention. **RESULTS** Our results showed a trend of weight drop (-5.68%,  $p=0.052$ ), a significant reduce in waist circumference (-7%,  $p=0.001$ ) and fat mass (-5.98%,  $p=0.036$ ). Despite no change in fat free mass (FFM), there was an important trend of leg free fatty mass increase (+500g,  $p=0.055$ ) in response to SIT. No changes in metabolic blood markers were observed. No significant changes in VO2peak, breathing frequency, tidal volume and minute ventilation at rest and during cycling stages were observed. However, SIT induced a trend of decrease rest heart rate (-16.58%,  $p=0.06$ ) and a significant increase in aerobic peak power output (170W vs. 210W,  $p<0.05$ ) through increase in cycling loads. Moreover, anaerobic power output was enhanced significantly ( $p<0.05$ ) through increase in cycling loads (+22.25%,  $p<0.05$ ). **DISCUSSION** This study have shown, for the first time, that 10 weeks of SIT induced aerobic and anaerobic power output enhancement in obese sedentary male. These fitness increases showed a growing evidence of better mechanical efficiency which can be explained, at least in part, by muscle structural and neural adaptations (Vincent et al. 2003). Thus, SIT has a positive effect on health and fitness that translated into increased functional capacity and better quality of life in obese people. **REFERENCES** Gillen JB, Gibala MJ. (2014) *Appl Physiol Nutr Metab*, 39, 409-012. Vincent S, Gratas-Delamarche A, Berthon PM, Zouhal H, Jacob C, Bentue-Ferrer D, Delamarche P. (2003). *Can J Appl Physiol*, 28, 685-98.

## BETA-ALANINE SUPPLEMENTATION PROVIDES ADDED BENEFITS TO THE EFFECT OF SPRINT-INTERVAL TRAINING ON CYCLING PERFORMANCE

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**Introduction:** Beta-alanine supplementation and sprint-interval training (SIT) have been independently shown to have positive effects on cycling time trial (TT) performance (Rønnestad et al., 2014; Bellinger et al., 2015). SIT following beta-alanine supplementation may lead to added benefits compared to SIT alone by allowing athletes to train at a higher intensity. The present study investigated the effects of beta-alanine supplementation only, and in combination with SIT, on training capacity, and energy provision and performance during exhaustive supramaximal cycling and a 4-km TT. **Methods** Trained cyclists ( $VO_{2max} = 4.5 \pm 0.6$  L/min) performed a supramaximal cycling test to exhaustion (equivalent to 120%  $VO_{2max}$ ), a 4-km TT and 4 x 1-km sprints at 3 time points: before and after 4 wk of supplementation loading (6.4 g/day) with beta-alanine (BA=7) or a placebo (PL=7), and after 5-wk of supervised SIT (repeated 1-km maximal efforts) performed 2/wk whilst maintaining supplementation (1.2 g/day). Data was compared using a two-way ANOVA and contemporary magnitude-based inferences (Hopkins et al., 2009). **Results** Beta-alanine supplementation alone increased anaerobic capacity ( $4.0 \pm 3.0\%$ ;  $P=0.03$ ), supramaximal cycling TTE ( $8.9 \pm 8.4\%$ ;  $P=0.03$ ), 4-km TT ( $1.7 \pm 1.7\%$ ;  $P=0.05$ ) and sprint 3 and 4 of the 4 x 1-km sprints ( $2.1 \pm 2.0\%$  and  $1.9 \pm 1.2\%$ ;  $P<0.05$ , respectively) with no change in PL. Power output during the 1-km cycling sprints increased from the first to the last training session to a greater extent in BA compared to PL (BA:  $12.9 \pm 6.4\%$ ; PL:  $6.6 \pm 4.2\%$ ;  $P=0.04$ ). Following SIT, there were greater improvements in supramaximal cycling TTE (BA:  $14.9 \pm 7.6\%$ ; PL:  $9.0 \pm 6.9\%$ ;  $P=0.04$ ) and further worthwhile enhancements in 4-km TT performance (BA:  $4.0 \pm 1.5\%$ ; PL:  $2.9 \pm 1.5\%$ ;  $P=0.28$ ) in BA compared to PL, but this did not reach statistical significance. Anaerobic capacity ( $5.5 \pm 4.2\%$ ;  $P=0.04$ ) and  $VO_2$  after 60-s of supramaximal cycling ( $2.9 \pm 1.9\%$ ;  $P=0.05$ ) was higher in BA following training, but remained unchanged in PL, whilst  $VO_{2peak}$  increased similarly in each group (BA:  $3.1 \pm 2.9\%$ ; PL:  $3.5 \pm 2.8\%$ ;  $P=0.48$ ). **Discussion:** These findings indicate that beta-alanine supplementation allowed for better maintenance of cycling performance during repeated bouts of cycling sprint intervals, thereby allowing cyclists to consistently train at a higher intensity during a SIT program. Furthermore, this provided additional worthwhile benefits to exhaustive supramaximal cycling and 4-km TT performance compared to training alone. The additive benefits to performance following beta-alanine supplementation, in combination with SIT, appear to be related to superior aerobic and anaerobic adaptations. **References:** Rønnestad B., et al. (2014) *Scand J Med Sci Sports* 25:143-151 Bellinger P., et al (2015) *Eur J Sports Sci* EPUB Hopkins W., et al. (2009) *Med Sci Sports Exerc*, 41:3-12 Contact: p.bellinger@griffith.edu.au

## HIGH INTENSITY INTERVAL TRAINING DURING WINTER TIME IN SUBJECTS WITH INCREASED CARDIOVASCULAR RISK: IS ALPINE SKIING A SOLUTION?

STÖGGL, T., SCHWARZL, C., MÜLLER, E.E., NAGASAKI, M., STÖGGL, J., SCHÖNFELDER, M., NIEBAUER, J.

*University of Salzburg; Paracelsus Medical University; Aichi Gakuin University, TU Munich*

**Introduction** Physical inactivity is a strong predictor of cardiovascular morbidity and is decreased up to 40% during winter (e.g. Merchant et al., 2007). High intensity interval training (HIIT) revealed great improvements in key variables of endurance performance in both trained and untrained (Laursen & Jenkins, 2002) and was found to be a potent stimulus to induce physiological adaptations similar to traditional endurance training despite lower training time commitment (Gibala et al., 2012). Alpine and Nordic sports have a long standing tradition in alpine and Scandinavian countries with alpine skiing (AS) being seen as the best way to experience nature and freedom in winter (Bachleitner, 1998). It is open to debate whether AS – besides being a popular leisure time activity - might provide sufficient cardiovascular and metabolic response for HIIT. **Methods** Nineteen volunteers proficient in AS and cross-country skiing (XCS) were included in the study and performed a complete medical examination including cycle ergometry ramp protocol and AS, XCS, and indoor cycling (IC) sessions in randomized order on three separate days. During each session after a standardized warm-up a heart rate (HR) (XCS, IC) or skiing technique (AS)-controlled 4-min continuous session at high intensity (HIGH: 90%  $HR_{max}$ ) and a 10-min HIIT (5x1' at  $>90\%$   $HR_{max}$ , with 1' low) were carried out. **Results** In all three exercises subjects were able to attain  $HR>90\%$   $HR_{max}$ , with highest values during XCS (100%) and higher HR during HIIT compared with HIGH (99 vs 94%,  $P<0.05$ ). No difference in  $VO_{2peak}$  was found between the three exercises

(84-97% VO<sub>2</sub>max), while energy expenditure (EE) was lower ( $P<0.05$ ) during AS for both situations compared with XCS and IC. With AS, when using HIIT the estimated EE for 1 hr (including standing and lift) was increased 22% compared with HIGH (314 vs 384 kcal/h). Discussion All three exercise modes induced pronounced physiological response ( $>91\%$  HRmax,  $>84\%$  VO<sub>2</sub>max) and participants were able to maintain continuous 4-min HIGH, or 10-min HIIT. When applying short turn skiing and the terrain allows steady skiing over a longer period, AS might provide sufficient stimulus for the cardiologic and metabolic system to enhance fitness and reduce cardiovascular risk. Consequently, besides a popular leisure activity, AS might serve as a fitness workout including HIIT (e.g. "cardio-skiing"). References Bachleitner R (1998). Innsbruck: Studien Verlag Gibala MJ et al (2012). J phys, 5901077-1084 Laursen PB & Jenkins DG (2002). Sports med, 32, 53-73 Merchant AT et al (2007). Rev Can Sante Pub, 98, 203-208 Ulmer H et al (2004). Wiener Klin Woch, 116, 662-668

## AN ACUTE BOUT OF HIGH INTENSITY INTERVAL TRAINING REDUCES THE AUTOPHAGOSOME CONTENT IN TYPE I AND TYPE II MUSCLE FIBRES

SHAW, C.S., ZACHAREWICZ, E., TREWIN, A.J., PARKER, L., GARNHAM, A., STEPTO, N.K., MURPHY, R.M.

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**Introduction** Autophagy is a dynamic intracellular degradation process which can target old or damaged organelles and provide substrate for cellular regeneration. Activation of autophagy during exercise has been implicated in the improvements in glucose homeostasis with training. The aim of this study was to investigate the muscle fibre type specific autophagy response to an acute bout of moderate intensity continuous (MICT) and high intensity interval training (HIT). **Methods** Eight recreationally active individuals (aged  $25\pm 6$  years, BMI  $24.8\pm 1.0$ , VO<sub>2</sub>max  $48.4\pm 4.0$  ml/min/kg) completed two exercise bouts on a cycle ergometer in a randomised order separated by  $\geq 7$  days. HIT sessions involved 5 x 4 min bouts performed at 75% peak power output whereas MICT was performed at 50% of peak power output, work matched to the HIT session. Muscle biopsies were collected after an overnight fast prior to exercise, immediately post-exercise and 3 h post-exercise. Single muscle fibres were immediately isolated and muscle fibre type was assessed using immunoblotting. Single muscle fibres of the same fibre type were pooled before analysis of the autophagy markers LC3-II/I, GABARAP and p62. **Results** Basal LC3-II abundance ( $P=0.08$ ) and the LC3-II/I ratio ( $P<0.05$ ) was higher in type I muscle fibres, which is indicative of greater autophagosome content. There was no significant change in LC3-II abundance or LC3-II/I ratio in response to MICT immediately or 3 hours post-exercise. In contrast, there was a reduction in the LC3-II abundance in type I ( $P=0.02$ ) and type II muscle fibres ( $P=0.02$ ) immediately post-HIT which returned to baseline values at 3 hours post-exercise. These changes were reflected in the LC3-II/I ratio which were also reduced in both muscle fibre types immediately following HIT ( $P<0.05$ ). There were no significant differences in GABARAP or p62 abundance ( $P>0.05$ ) following either exercise mode ( $P>0.05$ ). **Discussion** These results demonstrate that HIT induces a transient reduction in autophagosome content in both type I and type II muscle fibres which does not occur following a work matched bout of MICT. This enhanced clearance of autophagosomes may contribute to the superior metabolic benefits observed following HIT. Furthermore, these results indicate that type I muscle fibres have a higher autophagosome content in the basal state, therefore fibre type differences should be considered when assessing autophagy in human skeletal muscle. chris.shaw@deakin.edu.au

## Oral presentations

### OP-PM14 Sports Medicine: Exercise & Disability

#### GASTROCNEMIUS CONTRACTILE BEHAVIOR IN CHILDREN WITH CEREBRAL PALSY DURING FLAT, UPHILL AND BACKWARD-DOWNHILL GAIT

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**Introduction** Patients with Cerebral Palsy (CP) develop joint contractures and the ankle is severely affected. For the Gastrocnemius, degenerations in passive morphometrics have been documented [e.g. 1-3] but the contractile behavior during gait is unclear. Especially adaptability of muscle contractions on slopes could be relevant during therapy. Our aim was to compare Gastrocnemius contractions in patients and controls during flat and sloped walking. **Methods** Med. Gastrocnemius contractions were measured during flat, uphill (+12%) and backward-downhill (-12%) treadmill gait in 15 children with bilateral CP and 17 controls (aged: 7-16 years). CP patients displayed passive dorsiflexion of only  $1\pm 8^\circ$  and naturally walked in mild to moderate crouch. They were analyzed using an Echoblaster ultrasound (Telemed) to image fascicles at 60-Hz. Vicon Nexus was used to capture lower limb kinematics. Ultrasound of 6 strides was analyzed and a seated rest measurement was performed. Fascicle length was tracked, muscle-tendon unit and series-elastic element length were calculated. All values were normalized on seated rest length. Additionally, EMG (Noraxon) of the Med. Gastrocnemius, Soleus and Tibialis ant. was collected. **Results** Key findings were that during flat gait, spastic gastrocnemii maximally reached 10% shorter relative fascicle length, 5% shorter series-elastic element length and also showed 37% less fascicle shortening during stance than controls. No difference in fascicle lengthening excursion existed. Uphill gait increased Gastrocnemius fascicle shortening in CP and controls (by 23% and 41%) and Tibialis anterior activity during swing (by 33% in CP and 48% in controls). Backward downhill gait more than doubled (+112%) fascicle strains in CP patients. **Discussion** Having innately shorter fascicles compared to healthy controls, spastic gastrocnemii additionally worked at shorter relative length during gait. Healthy gastrocnemius fascicles usually work near the descending limb of the length-tension curve [4]. Since spastic fascicles worked at shorter length, they may be used more on the ascending limb and thus will provide a lower potential for active force generation. Yet, findings of longer sarcomeres in CP [5] suggest that contractile filament overlap would likely worsen at more extended length. Hence, limited fascicle length during spastic gait could be an adjustment to use short fascicles with long sarcomeres where they produce larger active forces. Uphill gait may be useful to concentrically train push-off skills and foot lift. During backward-downhill gait the spastic gastrocnemius functions as a brake and displays more eccentric excursion which may stimulate sarcomere-genesis in series. **References** [1] Hösl et al. 2015, J child orthop 9, 209-219. [2] Barber et al. 2011. J biomech 44, 2496-2500. [3] Matthiasdottir et al. 2014, Clin biomech 29, 458-62. [4] Hoffmann et al. J appl physiol 116, 1455-1462. [5] Mathewson et al. 2014, J Orthop Res 32, 1667-1674. Contact m.hoesl@bz-aschau.de



**CLASSIFICATION AND COMPETITION LEVEL EFFECTS ON PUSH NUMBER IN WHEELCHAIR SPORT SPRINTING**

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**Introduction** Wheelchair sprinting capacity is best measured in a field test, allowing the athlete to freely choose push strategies adapted to their own wheelchair settings, physical ability, classification and speed changes during a sprint. The key test outcome is sprint duration, but there are various push strategies to accomplish the same sprint time. The effect of classification and competition level on the number of pushes needed for a 12m sprint was investigated by field testing 30 male wheelchair basketball athletes in their own wheelchair. International level athletes were expected to be faster with less pushes, and athletes of higher classification (less impaired) were expected to be faster with an unknown possible effect on the number of pushes. Methods A recently developed method for ambulatory measurement was used to calculate wheelchair kinematics (van der Slikke et al. 2015), providing outcomes on displacement, speed, acceleration and pushes. Additionally maximal isometric push force was recorded and rear seat height was noted. Mutual correlations and competition level differences of sprint characteristics were calculated. Generalized Linear Models (GLM) were drawn to determine the effect of competition level and classification on sprint time and number of pushes. Results Sprint characteristics did not correlate significantly with classification, only if split by competition level there were significant correlations with sprint time ( $r=-0.715$ ,  $p=0.006$ ) and number of pushes ( $r=-0.647$ ,  $p=0.017$ ) in the national level group. Sprint time, number of pushes and isometric push force differed significantly between national and international level wheelchair basketball athletes, with international athletes being faster with fewer pushes. Together, main effects of competition level and classification as factors in GLMs explained 57% of sprint time and 52% of the number of pushes. Discussion As hypothesized, international level athletes were faster with fewer pushes, even though their higher average seat height was less optimal for propulsion (Mason et al. 2013). The expected relationship between classification and sprint time was clear in the national level athletes, but not present in the internationals. Seat height of lowly classified athletes seemed optimized for sprinting, whereas seat height of highly classified athletes with already adequate sprinting capacity was optimized for upward reach. Although more challenging than well controlled experimental research, the field based setting in this research revealed additional information not only describing the relation between wheelchair setting and performance, but also describing its practical applications if other game demands were taken into account. The results of this approach are believed to assist athletes, coaches and wheelchair experts in decision making concerning wheelchair configuration and athlete training References Van Der Slikke et al. (2015). Journal of Biomechanics, 48(12), 3398-3405. Mason, B. S. et al. (2013). Sports Medicine, 43(1), 23-38.

**RELATIONSHIP BETWEEN GROUND REACTION FORCE IMPULSES AND SPRINT VELOCITY IN TRANSFEMORAL AMPUTEES**

MAKIMOTO, A.1,2, HOBARA, H.1, SANO, Y.1,2, HASHIZUME, S.1, KOBAYASHI, Y.1, MURAI, A.1, TAKEMURA, H.2

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**Introduction** Since sprint kinematics in transfemoral amputees (TFAs) are quite different from those of able-bodied sprinters and transtibial amputees, improving sprint performance in this population is very challenging task (Buckley, 1999). According to a previous study (Hunter, 2005), sprint velocity in able-bodied sprinters can be mainly predicted from impulse of propulsive components of ground reaction force (GRF). The purpose of this study was to investigate the relationships between sprint velocity and GRF impulses generated by both intact and prosthetic limb in TFAs. Methods Eight unilateral TFA sprinters (male:female = 5:3, age =  $34.7 \pm 11.0$  years, body height =  $1.61 \pm 0.09$  m, body mass =  $55.5 \pm 9.75$  kg; mean  $\pm$  SD) were recruited. All TFA sprinters used same type of prosthetic knees (3S80, Ottobock) and feet (IE90 Sprinter, Ottobock). Subjects were asked to perform maximal sprinting on over 40 m runway embedded with 7 AMTI force plates (sampled at 2000 Hz) which were located halfway of the runway. Sprint velocity was determined using horizontal velocity of sacral reflective marker. Three-dimensional coordinate data (sacral reflective marker) were captured by a motion capture system (VICON MX+, 200 Hz). Impulses of each component of GRF were calculated. We performed a stepwise multiple linear regression with sprint velocity as the dependent variable and impulses of vertical, braking and propulsive components of the GRF on intact and prosthetic limb as the independent variables ( $p < 0.05$ ). Results On average, sprint velocity was  $5.69 \pm 0.74$  m/s. The stepwise multiple linear regression revealed that propulsive impulse on prosthetic limb being the variable to enter the model, and explained 77% ( $R^2 = 0.77$ ,  $p < 0.01$ ) of the variance in sprint velocity. Braking and vertical impulses on both limbs and propulsive impulse on intact limbs did not explain any further variance in sprint velocity and were not included in the model. Discussion We found that propulsive impulses on prosthetic limb accounted for 77% of the variance in sprint velocity in TFAs. The results of the present study suggest that propulsive impulses generated by prosthetic limb rather than intact limb may be the key parameter to achieve faster sprint velocity in TFAs. References Buckley J.G. (1999). Arch Phys Med Rehabil, 80, 501-508. Hunter J.P. (2005). J Appl Biomech., 21(1), 31-43. Contact makimoto-atsushi@aist.go.jp

**A GENERIC MOBILITY MODEL FOR STANDARDISATION OF MOBILITY-RELATED ASSISTED LIVING SOLUTIONS: A CONTRIBUTION FROM HUMAN MOVEMENT SCIENCE**

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**Problem** Assisted living solutions (AAL) claim to support maintaining independence, one of the most important wishes for ageing or impaired individuals. This includes mobility, i.e. the capability, opportunity and performance of changing body positions and of locomotion. This talk deals with needs and challenges in order to support the development and interoperability of related AAL technology. Methods The DKE, German Commission for Electrical, Electronic & Information Technologies of DIN and VDE, established an AAL standardisation roadmap, and a working group targeting on an application guide to be submitted to DIN and IEC committees. At first, working group members from transportation science and technology, human movement science, telecommunication, building industry, computer science and electrical engineering identified issues the document should deal with: (a) the individual need for support changes on different time scales, due to daily fitness, health or ageing processes, (b) the usage of assisted living (or conventional) utilities itself can modify the user's mobility in a good or harmful way, (c) a barrier (process interruption) between indoor and outdoor mobility can arise when devices and utilities have to be changed. The following steps were conducted: 1. to identify mobility-related aspects in national and in European projects in the field of AAL and in DIN ISO 9999 (a standard including mobility assistant devices) 2. to collect mobility-related user stories 3. to define a common theoretical platform 4. to develop complex user stories, covering different target groups and mobility devices 5. to develop example use cases, using the official UCMR format (Use Case Management Repository) from standardisation procedures 6. to develop a generic mobility model, using UML (unified modelling language) 7. to describe example use cases in UML

Results and perspectives A model combining action theory and a resource-based view is considered useful for identifying and discussing mobility aspects. Its main terms are (a) a situation, which comprises (b) a person with certain internal resources (abilities and skills), facing (c) a task with requirements and affordances, embedded in (d) an environment with external resources. Using this specific language scheme, the terms distinguish mobility as (e) room for action. Consequently, the next step of standardisation in mobility-related AAL should be, that the provider has to state clearly, which options for which target group a product will offer, and which requirements its usage will demand. Example use cases show, that the generic model can easily be adapted to target groups of different age and living conditions in different situations.

## Oral presentations

### OP-BN14 Running Footwear

#### EFFICACY OF ELASTIC SHOE INSOLES IN KINEMATICS, KINETICS, AND MUSCLE ACTIVITY DURING WALKING AND RUNNING

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**Introduction** There has been some, but not conclusive, evidence for the effect of shoe sole elasticity on exercise performance [1, 2]. However, mechanisms of the boosting, if any, effect of adding elasticity onto the foot remain uncovered. The purpose of this study was to investigate the effect of shoe insoles on the mechanical characteristics in the support phase of walking and running. **Methods** Nine male participants (age:  $23.3 \pm 3.3$  years, height:  $171.2 \pm 3.0$  cm, weight:  $55.1 \pm 6.2$  kg) walked at 1.5m/s and as fast as possible, and ran at 2.5m/s, 3.5m/s, 4.5m/s with the elastic (EI) and control (CON) insoles. The angles of 4 lower limb joints (hip, knee, ankle, and metatarsophalangeal), ground reaction force (GRF), and 11 muscles' electromyographic (EMG) data were collected. Two way ANOVA for repeated measures and Shaffer's post hoc test were used to compare the differences between EI and CON conditions. The level of significance was set at  $\alpha=0.05$ . **Results** Both in walking and running, the maximal plantar flexion angle of the ankle in the stance phase and the maximal dorsiflexion angle of the metatarsophalangeal (MTP) joint in the push-off phase were significantly lower in EI compared to CON. The propulsive impulse in the active phase exhibited no significant difference between the insole conditions, while the maximal antero-posterior propulsive force in the active phase was significantly lower and the propulsive impulse in the push-off phase was significantly higher in EI. In addition, EMG root mean square (RMS) values of medial gastrocnemius (MG) over one step cycle during running and the tibialis anterior (TA) in the stance phase at 3.5m/s were significantly lower in EI compared to CON. **Discussion** It was demonstrated both in walking and running that EI enhanced propulsive impulse while decreasing the maximal propulsive force and the ankle and MTP joints' range of motion in the push-off phase. This was associated with lower activity of muscles around the ankle joint during running. It is suggested that the elastic insoles contribute to body propulsion and energy saving in walking and running. **References** 1: Roy J-P. R., and Stefanyshyn D.J. (2006). *Med Sci Sports Exerc*, 38, 562-569 2: Chen C. H., Tu K. H., Liu C., Shiang T. Y. (2014). *Hum Mov Sci*, 38, 163-172. Contact [elpivote@asagi.waseda.jp](mailto:elpivote@asagi.waseda.jp)

#### INFLUENCE OF RUNNING SHOES ON THE NEGATIVE WORKS OF THE LOWER EXTREMITY JOINTS: A PRELIMINARY STUDY

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**Introduction** One of major functions of running shoes is decrease in risks of running-related injuries. The effects of running shoes on risks are sometimes assessed using the ground reaction force (GRF) (Nigg et al., 1987). However, the GRF may not be enough necessarily to interpret risks of running-related injuries. Muscles of lower extremity are common injured parts of running-related injuries. Nosaka and Newton (2002) reported that eccentric muscle contraction induced larger muscle damage than concentric muscle contraction. Negative joint work is thought to be generated by force due to eccentric muscle contraction (Cavagna et al., 1964), suggesting that decrease in the negative works of the lower extremity joints reduce risks of running-related injuries occurring on muscles of lower extremity. The present study, therefore, preliminarily confirmed the influence of different running shoes on the negative works of the lower extremity joints. **Methods** Three young adult males voluntarily participated. Two types of running shoes with different sole design were used in this study: SOR-TIEMAGIC and GT-2000 (ASICS) having thin and thick soles, respectively. Retroreflective markers were attached on to pelvis and lower extremity. Subjects were asked to run on runway at  $3.0 \pm 0.3$  m/s. The three-dimensional coordinates of each marker and the GRF were recorded using motion capture system and force platforms. The joint angles of lower extremity were computed as Cardan angles for each local coordinate system embedded to distal segment relative to that embedded to proximal segment. Inverse dynamics approach was used to calculate the negative works for the hip flex-extension, the knee flex-extension and the ankle plantar-dorsiflexion during stance phase of running. **Results** The negative works of the hip flex-extension were  $17.7 \pm 5.6$  J and  $13.0 \pm 7.9$  J for trials with shoes having thin sole and with shoes having thick sole, respectively. The negative works of the knee flex-extension were  $32.6 \pm 9.0$  J and  $38.7 \pm 4.1$  J for trials with shoes having thin sole and with shoes having thick sole, respectively. The negative works of the ankle plantar-dorsiflexion were  $15.1 \pm 6.1$  J and  $15.3 \pm 6.1$  J for trials with shoes having thin sole and with shoes having thick sole, respectively. **Discussion** The negative works of the hip flex-extension and the ankle plantar-dorsiflexion were similar between trials with two types of shoes, whereas the corresponding values of the knee flex-extension was larger for trials with shoes having thick sole than those with shoes having thin sole. Furthermore, the negative joint work was markedly larger for the knee flex-extension than the other two joint movements. These results suggest that shoes having thin sole may reduce risks of running-related injuries occurring knee flexor and extensor muscles. **References** Nigg B, Bahlsten H, Luethi S, Stokes S (1987). *J Biomech*, 20(10), 951-959. Nosaka K, Newton M (2002). *Med Sci Sports Exerc*, 34(1), 63-69. Cavagna G, Saibene F, Margaria R. *J Appl Physiol*, 19(2), 249-256 Contact [satoru.hashizume@aist.go.jp](mailto:satoru.hashizume@aist.go.jp)

**DEVELOPMENT OF A TEST METHOD TO COMPARE DYNAMIC PARAMETERS OF SPORTS SHOES**

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**INTRODUCTION** Shoe properties like anti-pronation [1] damping and flexibility [2] can play an important role in reducing the risk of running injuries. However it is difficult to evaluate different sport shoe types considering above mentioned parameters. This work belongs to a larger project aiming to develop a test protocol for measuring a number of relevant shoe parameters, independent of shoe size, shoe type and runner, but measured in real running conditions. **METHODS** 55 healthy persons ran 10 times with 5 different running shoes. Ground reaction force and 3D movement of shoe sole and shank were recorded simultaneously with a force plate (Amti) and a motion tracking system (Codamotion) with a 28 markers protocol. According to the manufacturer shoe 1 is an antipronation shoe, shoe 2 is a neutral but very flexible shoe, shoe 3 has good shock absorption properties, shoe 4 is an antipronation shoe and shoe 5 is a reference shoe. Five shoe parameters were calculated: the angle between calcaneus and Achilles tendon and the angle between heel and ground (antipronation), the steepness of the active peak of the ground reaction force (damping) and the sagittal and torsional bending magnitude in the forefoot (flexibility). A paired t-test was done for all parameters between every couple of shoe types. **RESULTS** Both antipronation parameters of shoe 1 are significantly different ( $p < 0.001$ ) than all other shoes. 84% of the test persons has a more controlled unroll of the heel when running with shoe 1 than with shoe 5. Shoe 2 is significantly more flexible ( $p < 0.001$ ) than all other shoes. 72% of the test subjects bent the forefoot at least 10% more when running with shoe 2 compared to shoe 5. Shoe 3 has a significant higher damping than all the other shoes ( $p < 0.001$ ). There is no statistically significant difference of antipronation properties between shoe 4 and the reference shoe. **DISCUSSION** A method to quantify shoe parameters and to compare different shoes was developed. Shoe manufacturers can obtain truthful feedback about shoe properties. Although according to the manufacturer shoe 4 should be antipronating, there is no difference in the chosen anti-pronation parameters. All other distinct shoe features given by the manufacturers were proven by measurements. To make statistical relevant results in a smaller time frame, we are transferring the measurement protocol to our robotic gait simulator. **REFERENCES** [1] Cheung R.T.H., Wong M.Y.M. & NG G.Y.F. (2011). Effect of motion control footwear on running: a systematic review. *Journal of sports sciences*, 29 (12), 1311-1319. [2] Nigg B.M. (2010). *Biomechanics of sport shoes*. University of Calgary, Calgary, Alberta, Canada CONTACT eveline.deraeve@thomasmore.be

**LONG-TERM EFFECT OF THE SHOE DROP ON RUNNING BIOMECHANICS: A RANDOMIZED CONTROLLED TRIAL**

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**Introduction** Among numerous technological features of modern running footwear, heel to toe drop is deemed crucial to modify the running style. So far, only few biomechanical studies have addressed the acute effect of the drop in standard cushioned running shoes, but longitudinal studies are lacking. Therefore, we conducted a randomized controlled trial to investigate if the drop of standard cushioned shoes induces specific long-term adaptations in running technique. **Methods** Leisure-time runners ( $n=59$ ) unexperienced with minimalist shoes were randomly allocated to the three study groups and followed-up for 6 months. Each group was assigned an anonymised version of a conventional running shoe model with strictly identical features except for the drop: either 0 mm (D0,  $n=20$ ), 6 mm (D6,  $n=17$ ) or 10 mm (D10,  $n=22$ ). Running mechanics were tested on a treadmill at the participant's preferred running speed before and after the 6-month period. Systems for three-dimensional motion analysis and optical timing were synchronized to record spatio-temporal and kinematic variables of running trials at 200 Hz. Joint angles were investigated at initial contact (IC) and mid-stance phase (MSP) of  $151 \pm 22$  analysed steps per record. Two-way analysis of variance for repeated measures with the post hoc Bonferroni correction was used and accepted significance was set at  $p < 0.05$ . **Results** Between pre- and post-tests, participants performed on average a total of  $332 \pm 178$  km over  $163 \pm 16$  days. Overall, increased contact time ( $286 \pm 28$  vs.  $292 \pm 30$  ms,  $p < 0.001$ ) and stride frequency ( $82.3 \pm 4.2$  vs.  $82.8 \pm 4.0$  cycles.min<sup>-1</sup>,  $p = 0.030$ ), but decreased stride length ( $2.07 \pm 0.27$  vs.  $2.06 \pm 0.27$  m,  $p = 0.021$ ) were observed. No interaction between shoe drop and time was found for any of the spatio-temporal variables. Kinematic evaluations at IC showed an increased ankle dorsiflexion ( $-0.4 \pm 4.3$  vs.  $0.6 \pm 4.5^\circ$ ,  $p = 0.001$ ) and decreased knee flexion ( $12.9 \pm 4.8$  vs.  $11.3 \pm 4.6^\circ$ ,  $p < 0.001$ ) after the follow-up, while foot/ground angle remained unchanged ( $10.5 \pm 4.9$  vs.  $11.0 \pm 5.4$ ,  $p = 0.072$ ). No interaction between shoe drop and time was found for any angles at IC. At MSP, a significant shoe drop by time interaction was found for knee abduction angle ( $p = 0.032$ ). For D0, knee abduction decreased ( $-0.3 \pm 3.1$  vs.  $-1.3 \pm 2.6^\circ$ ) in contrast to D6 and D10 groups ( $0.3 \pm 2.7$  vs.  $1.3 \pm 3.1^\circ$  and  $-0.2 \pm 3.2$  vs.  $0.5 \pm 3.1^\circ$ , respectively). **Discussion** This is the first randomised controlled trial to investigate the long-term effect of shoe drop in cushioned shoe on running biomechanics. After the follow-up of six months, there was no difference between the three shoe versions except for decreased knee abduction at mid stance phase. However, given the effect size, this may not be clinically relevant.

**Oral presentations****OP-BN19 Motor Learning & Development****EVALUATION OF THE BRAKING STRENGTH PRODUCTION AND CONTROL ON A BICYCLE WITH A NEWLY DESIGNED BRAKE LEVER IN 5- TO 7-YEAR OLD CHILDREN**

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**Introduction** A new bicycle brake lever (StopEasy, BTwin™) has been recently designed to facilitate the braking in young children. This new brake lever was based on (i) a shorter course of displacement adapted for the children's hand size (Norris & Wilson 1999), and (ii) a reduced moment arm. It was hypothesized that children would produce more force during maximal voluntary contraction with the StopEasy compared to a classical brake lever. Furthermore, the force steadiness could be improved during sustained submaximal braking tasks with the StopEasy. **Methods** Twenty-nine children (17 girls, 12 boys) aged 5- to 7-year old participated in the present study. All of them performed on a stationary bicycle three maximal voluntary contractions (MVC) and three submaximal contractions at 30%, 50% and 70% of MVC using either the StopEasy or a classical brake lever. Electromyographic activity (EMG) of the extensor carpi radialis (ECR) and flexor digitorum superficialis (FDS) muscles and the force signals were simultaneously recorded during MVC and submaximal conditions.

The sample entropy (SampEn) of the force signal was calculated during submaximal contractions and considered as a task complexity index (Richman & Moorman 2000). Paired Student t-tests were used to compare the variables obtained during MVC. Two-way (2 brake levers x 3 force levels) ANOVA with repeated measures were performed to test the variables during submaximal conditions. Results During MVC, no significant difference of force and EMG activity of the ECR and FDS muscles was observed between the StopEasy and the classical brake lever. During submaximal conditions, the EMG activity of the FDS was similar between the two brake levers. However, the ECR showed a lower EMG activity with the StopEasy for the same force level ( $p < 0.01$ ). Finally, the SampEn increased with the force level when the classical brake lever was used ( $p < 0.01$ ), whereas it remained unchanged with the StopEasy whatever the force output. Discussion Interestingly, the EMG activity of the ECR was lower with the StopEasy during submaximal contractions, hence suggesting that less wrist stabilization was required with the StopEasy compared to the classical brake lever. The SampEn results also suggest that the motor control during submaximal braking was more effective with the StopEasy, even at high force levels. From a practical point of view, the StopEasy could facilitate the control of the braking, even in emergency situations where high braking forces need to be finely tuned. To conclude, the newly designed StopEasy lever is likely to improve the effectiveness of braking on bicycle in 5- to 7-year old children compared to a traditional brake lever. References Norris B, Wilson JR. (1999). Childdata: The handbook of child measurements and capabilities. Richman JS, Moorman JR. (2000). *Am J Physiol Heart Circ Physiol*, 278, H2039-H2049.

## VARIABILITY AND SPACING – DO THEY INTERFERE WITH EACH OTHER?

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Introduction: Research evidence shows better learning results if people practice skills in larger numbers of shorter practice session compared to a massed practice schedule (Magill & Anderson, 2014). But the relationship between spacing and learning effort is still unclear. Beckmann et al. (2014) showed an optimal spacing of 48 hours between sessions when novices learn a field hockey task by the differential learning approach (DL; Schöllhorn, 2000). While Shea et al. (2000) identified spacing as a confounding factor in motor learning studies the following study examines if the optimal spacing depends on the practice protocol. Methods: Therefore the hockey dribbling performance of 32 novices (physical education students, M age = 21.6 years, SD = 2.1) was calculated from the dribbling and sprint performance in a 15 m slalom parcours (Lemmink et al., 2004). After the pretest participants were separated into three groups. Each group performed five practice sessions for the hockey dribbling according to a high contextual interference (CI) schedule. Only the spacing between the practice sessions was different for each group (24, 48 and 72 hours). After the third practice session all participants completed an intermediate test and at the end of the last session the posttest. One week after the posttest all participants returned for a retention test. Results: The results of the repeated measurement ANOVA show a significant effect for the factor time ( $F(1.6; 46.4) = 94.525$ ;  $p < .001$ ; partial eta-square = .765) but no group or interaction effects. Discussion: In two aspects these results (CI) differ from the results Beckmann et al. (2014) showed for the DL. Firstly, the trend of the learning curves in the CI condition do not show a continuous increase in dribbling performance and secondly, there are no differences between the three groups. This confirms the annotation from Shea et al. (2000) that the spacing of the practice sessions might be a confounding factor when results of CI-studies under laboratory circumstances are transferred to the field. Also the results refer to the possibility that the amount and structure of variation during practice interfere with the spacing of the practice sessions. This might be an unnoticed aspect in the development of practice schedules. References: Beckmann H, Schöllhorn WI (2014). 19th annual congress of the ECSS. Book of abstracts, 515. Lemmink KAPM, Elferink-Gemser MT, Visscher C (2004). *Br J Sports Med*, 38(2), 138–142. Magill RA, Anderson DI (2014). *Motor learning and control*. McGraw-Hill. Schöllhorn, WI (2000). *Acta Academiae Olympicae Estoniae*, (8), 67–85. Shea CH, Lai Q, Black C, Park JH (2000). *Hum Mov Sci*, 19, 737–760. Contact: beckmannh@uni-mainz.de

## ASSOCIATION BETWEEN THE DEVELOPMENT OF MOTOR PERFORMANCE AND SELF-RATED HEALTH IN CHILDHOOD AND ADOLESCENCE

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Introduction In adulthood motor performance (MP) is considered one of the most important health markers, as well as a predictor of morbidity and mortality for cardiovascular disease (Ortega, 2008). However, there are only few studies that examine the association between MP with health outcomes (a) in children and (b) longitudinally. The purpose of this longitudinal analysis is to investigate, whether there is an association between changes in MP in childhood and adolescence over a period of 6 years (t0-t1) and self-rated health (SRH) after this period (t1). Methods To examine the association between development of MP and health, MP and SRH were assessed within the framework of the longitudinal German Health Interview and Examination Survey for Children and Adolescents (KIGGS) and the Motorik-Modul (MoMo). In this nationwide sample of children/ adolescents in Germany (age: 4-23 y.; n=2,167) MP was assessed by means of the MoMo test profile covering four dimensions of MP (strength, endurance, coordination, flexibility) (Wagner et al., 2013). SRH was measured with a single item which is a valid measure for general health (Lunberg & Manderbacka, 1996). For statistical analyses bivariate correlations (Spearman) were conducted. Results There were significant positive correlations between MP development (t0- t1) and SRH at t1 for the MP tasks bicycle ergometer (PWC 170) ( $r=.11$ ;  $p=.00$ ;  $n=1,148$ ) and standing long jump ( $r=.11$ ;  $p=.00$ ;  $n=1,851$ ), but not for jumping sideways ( $r=.05$ ;  $p=.05$ ;  $n=1,838$ ), static stand ( $r=.04$ ;  $p=.11$ ;  $n=1,859$ ), and stand & reach ( $r=.04$ ;  $p=.10$ ;  $n=1,863$ ). To conclude: the analyses revealed significant positive correlations in MP development (t0- t1) and SRH at t1 for MP tasks which are predominantly determined by physical condition but not for tasks testing coordination and flexibility. Children/ adolescents with a higher increase in MP from t0 to t1 show a higher SRH value at t1. Discussion Our results emphasize that elevating the MP is a marker for health already in childhood. The enhancement of MP, for example by increasing time spent in vigorous physical activity, should be emphasized in public health promotion policies. On account of the fact that different MP tasks relate in different ways to other different (objective) health outcomes more in-depth analyses will be conducted. References Lundberg, O, Manderbacka, K (1996). *Scand. J. Soc. Med.*, 24:218–224. Ortega, FB, Ruiz, JR, Castillo, MJ & Sjöström, M (2008). *Int. J. obes.*, 32(1), 1–11. Wagner, M, Bös, K, Jekauc, D, Karger, C, Mewes, N., Oberger, J, Reimers, AK, Schlenker, L, Worth, A, Woll, A (2013). *Int. J. Epidemiol.* doi: 10.1093/ije/dyt098 [JIF 2012: 6.982] Contact claudia.albrecht@kit.edu



**TRAINABILITY OF POSTURAL CONTROL IN CHILDREN**

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**Introduction** In contrast to the benefits of balance training on postural control in healthy young adults (Lesinski et al., 2015), no clear evidence have been found in children. Previous studies in children have revealed divergent results concerning the trainability of balance skills. Children aged from 11-14 y displayed improvements whereas younger children did not - at least in transfer tasks. The question therefore is, whether the young age of the children prevents postural adaptations or the implemented training regimes have not been suited to improve these skills. Hence, the present study applied for the first time an identical, children specific training regimen in three different age groups (old: 14-15 y; middle: 11-12 y; young: 6-7 y) to shed light on the abilities to improve postural control in response to balance training in childhood. **Method** 77 children (10.7±3.4 years, 1.46±0.20 m, 42.5±17.4 kg; 38 f and 39 m) were distributed to three age specific intervention (INT) and control groups, respectively. The training was arranged holistically and playfully and took place during physical education lessons (5 weeks with 2 sessions per week of 45 minutes). Postural control was assessed by different static and dynamic (among others: single leg stance on spinning top (STIL) and single leg stance on Posturomed (POSIL)) postural control tests. In addition, jump height of countermovement jumps and rate of force development (RFD) in a plantar flexion motion task were measured. **Results** No statistical differences in static balance tasks could be found. A three-way mixed design ANOVA with repeated measures revealed a significant GROUP\*TIME interaction for one dynamic test (STIL;  $F_{1,66} = 6.652$ ;  $p = .012$ ;  $n2p = 0.092$ ) and for RFD ( $F_{1,68} = 4.375$ ;  $p = .040$ ;  $n2p = 0.060$ ). Age specific adaptations were observed by GROUP\*TIME\*AGE interaction in STIL ( $F_{2,66} = 3.217$ ;  $p = .046$ ;  $n2p = 0.089$ ) and POSIL ( $F_{2,69} = 4.069$ ;  $p = .021$ ;  $n2p = 0.106$ ). **Discussion** The present study shows evidence that dynamic postural control and explosive strength in children can be improved by holistic balance training. Age specific adaptations revealed greatest gains in the youngest group. This is the first study demonstrating that postural control can be trained already at the age of 6 years onwards in healthy children. Furthermore, the kind of balance training seems to be essential to improve balance in children. **Literature** Lesinski, M., Hortobagyi, T., Muehlbauer, T., Gollhofer, A., & Granacher, U. (2015). Dose-response relationships of balance training in healthy young adults: a systematic review and meta-analysis. *Sports Medicine*, 45(4), 557-576.

**OBJECTIVE PROFILING OF CHILDREN'S ACTIVITY USING MOTION MAPPING AND MACHINE LEARNING**

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**Introduction** In children's activity programmes the challenge is to obtain information on their physical motion using techniques that do not hinder natural motion and that can be implemented in ecological settings. Accelerometers are widely used to study exercise and activity [1] and have been shown to be informative of motion mechanics [2]. We present a novel analysis framework for activity assessment that uses accelerometry to create sophisticated motion maps and demonstrate their utility in profiling and categorising movement mechanics in a diverse range of activities. **Methods** Acceleration data were collected from ankle and wrist mounted sensors. Children aged 9 - 11 years were assessed in a multi-stage fitness test (increasing run speed) and a fundamental motor skill (FMS) challenge (9 exercises testing agility, balance and coordination). Radial acceleration data from the ankle was used to construct spectrograms and phase maps of running motion. Ankle and wrist acceleration traces were used to create motion maps of the activities. Whole-activity profiling of the cohorts (ranking and sub-group identification) was completed using multi-dimensional scaling of correlation matrices obtained from pairwise cross-correlation of spectrograms and activity maps. Specific activity components were analysed through pattern recognition using machine learning. **Results** Analysis of the first stage of the fitness test yielded cross-correlation indices in the range  $0.5 < p < 0.7$ . Dimensional scaling of this data provided an accurate description of child-to-child variation in a 2D space. Motion maps of ankle and wrist acceleration within the FMS challenge, displayed patterns clearly linked to specific activities such as throwing, jumping and body roll. These were sufficient to classify performance into activity categories using pattern recognition and a training set from expert observer scores. **Discussion** We have shown that detailed mapping of children's mechanical motion patterns can be achieved, in a range of activity settings using light weight, low cost wearable sensors. These motion maps can be predictive of performance based on limited sampling allowing population profiling with sub-maximal fitness testing and FMS profiling. The recording of position and acceleration of wrist and ankle provides detailed information on dynamic system behaviour which when allied to computerised pattern recognition and classification gives an objective scoring of complex motion, normally requiring subjective assessment by expert human observers. **References** 1. Mathie MJ et. al. *Physiol. Meas.* 2004; 25:R1-20 2. Mannini A et. al. *Med. Sci. Sports Exerc.* 2013; 45:2193-2203

**Oral presentations****OP-PM62 Risks & Injury: Screening, Prevention & Treatment****CONTEMPORARY MODELS OF PRE-EXERCISE SCREENING AND RISK STRATIFICATION**

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**Introduction** Each year in Australia approximately 40% of the adult population report beginning or upgrading an exercise program [PA]. A national adult pre-exercise screening system [APSS] was developed jointly by three professional groups to refine the way risk stratification is undertaken [FA 2010]. The superseded system was based on a strict cut-off of common risk factors [RF] whereby 2 or more RF resulted in a medical [GP] referral. In recent years this conservative thinking about RF, risk stratification and physical activity promotion has changed. The APSS identifies people at moderate risk (>2RF) but does not automatically involve GP referral. The APSS has not been applied to a normative population. **Methods** Individual record data from the Australian Health Survey 2011-12 was processed through the APSS. The adult proportion [ $\geq 18$ yr] with  $\geq 2$ RF was determined using both self-report [SR;  $n=20,762$ ; age $\geq 45$  or 55yr (F), smoking, PA<150min/wk, BMI $\geq 30$ , high BP, cholesterol or glucose] and measured variables [ME;  $n=6,923$ ; BMI $\geq 30$ , SBP $\geq 140$  or DBP $\geq 90$ mmHg, waist girth $\geq 94$  or 80cm (F), cholesterol $\geq 5.2$ mmol/L, glucose $\geq 5.5$ mmol/L]. **Results** Using SR, there were 41.3% with 2 or more RF. This approximately doubled when variables were ME. The three most common SR RF were insufficient PA [46.3%], age [40.8%] and BMI [27.5%], while ME RF were waist girth [58.9%], high lipids [53.4%] and BMI [25.1%]. **Discussion** The APSS was developed to reduce the

burden of excessive referrals to the medical system, minimise unnecessary barriers to exercise adoption, and encourage more people to become habitually physically active. It was also based on the notion that fitness professionals working with people new to PA should assume more responsibility to prescribe appropriate intensity tailored for individuals and progress cautiously, especially for those at moderate risk. There is substantial evidence that light-moderate PA is safe for most people. The results of this study show there is a very large proportion of adults who have multiple risk factors. Previous conservative approaches would have recommended this population seek medical guidance before beginning a PA program. The APSS, and the more recent ACSM recommendations (Riebe et al., 2015), reflect a new approach to RF management and PA promotion. When more than half the population is not sufficiently active, and are obese with large waist girths, the most important advice we can give as health professionals is to be more active. References Fitness Australia (2010). Adult pre-exercise screening system. <http://fitness.org.au/articles/policies-guidelines/adult-pre-exercise-screening-system/4/18/20>. Riebe D, Franklin BA, Thompson PD, Garber CE, Whitfield GP, Magal M, Pescatello LS. (2015). Med Sci Sp Ex, 47(11):2473-9.

## INJURY TRENDS AT A SELECTIVE-ENTRY YOUTH SPORTS ACADEMY: IMPLICATIONS FOR LOAD MONITORING AND PROGRAM DESIGN FOR STUDENT-ATHLETES

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**AIM** To investigate the incidence, timing and type of injuries to student-athletes, with the applied aim to identify strategies to mitigate the risk of injury within a talent-identified youth student-athlete cohort. Maribyrnong Sports Academy (MSA) is a the specialist sport school of the Victorian Government now supporting over 500 student-athletes. In 2015, over 200 MSA student-athletes achieved selection to state and/or national representative squads. **METHODS** Injury data was collated on all student-athletes this information includes and is not limited to diagnosis, injury mechanism, injury type and training location where the injury occurred. **RESULTS** Data for the period of January to November 2015 show that out of the six highest monthly injury tallies, four of these months coincided with the start of a new school term. Higher incidences of sudden onset acute injuries as opposed to chronic injuries occurred at the start of each school term. MSA student-athletes obtained 56% of all injuries outside of structured MSA training (i.e., local club & talent pathway sport). Further 19% of all injuries were attributed to activities at MSA including technical sport training, school sport/competition, Athlete Development Program (ADP) and Physical Education. The other 25% of injuries to the student-athletes were attributed and classified as overuse aetiologies which highlights a potential disconnect of what training is taking place outside of MSA. Most common type of injuries were strains (15.6%) of all injuries, ligaments (14.4%), bone injuries (13.6%), teninopathies (9.2%) and contusion (8.1%). It was found that the more common overuse injuries in adolescent athletes (Anderson, 2005; Soprano et al., 2007) accounted for 22.9% of all injuries. These included ATFL sprain (6%), Hamstring strain (4.1%), Facet Joint (3.7%), Patello femoral joint pain (PFJ) (3.5%), Osgood Schlatters disease (3.5%) and severs disease (2.1%). **CONCLUSIONS** Implementation of more systematic load monitoring procedures for both MSA sport programs and for external sport activities will provide an evidence-based approach to drive new strategies to reduce the risk of injury. Program design changes that have been influenced by the data presented herein and plans for increased load monitoring will be discussed. This includes the reduction of load at peak times of identified risk (i.e., start of each term) and the on-going identification of external load points such as the commencement of club and pathway sport competitions. **REFERENCES** Anderson, SJ. (2005). Current Problems in Paediatric and Adolescent Health Care, 35(4), April 2005, 110-164. Soprano, JV. Fuchs, SM. (2007). Clinical Paediatric Emergency Medicine, 8(1), March, 7-14. **CONTACT** Calvin Pane - pane.calvin.l@edumail.vic.gov.au

## SAARLAND INJURY MOVEMENT SCREEN : CONCEPTION AND INTRA-/INTER-RATER RELIABILITY

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**Introduction** Assessment of movement quality is widely used within applied practice. One goal is to highlight athletes with an increased likelihood of injury (McCunn et al., 2015). A number of movement screens exist within the scientific literature; however, few have been specifically designed to serve one particular sport. The newly developed Saarland Injury Movement Screen (SIMS) was designed for use within soccer. It comprises five movements: the anterior reach portion of the Y-balance test (AR), single-leg deadlift (SDDL), in-line lunge (ILL), single-leg hop for distance (SLHD) and the tuck jump assessment (TJ). Scoring criteria relate to both objective (e.g. distance achieved) and subjective (rating of movement quality) criteria. The aim of the present study was to establish the intra- and inter-rater reliability of the test. **Methods** Twenty-five (male=11, female=14) recreationally active university students (age 25.5±4.0 years, height 170.9±8.9 cm, weight 64.7±12.6 kg) were assessed using the SIMS on three separate occasions separated by an average of 3.5 days. Two raters (Raters 1 and 2) assessed all participants on each occasion. An additional third rater (Rater 3) scored 15 of the 25. Raters scored two of the five movements (AR and SLHD) in real-time. The remaining three movements (SDDL, ILL and the TJ) were filmed from both the frontal and sagittal planes using Apple iPhone 4S devices and retrospectively scored. Two-way mixed model intraclass correlation coefficients (ICC; 3,k) were calculated as a measure of intra- and inter-rater reliability. **Results** The average intra-rater ICC values for the composite score (across all three testing occasions) for Raters 1, 2 and 3 were 0.72 (95% CI: 0.56-0.84), 0.70 (95% CI: 0.52-0.83) and 0.65 (95% CI: 0.39-0.83) respectively. In addition, average inter-rater ICC values for occasions 1, 2 and 3 (n=15) were 0.92 (95% CI: 0.81-0.97), 0.95 (95% CI: 0.87-0.98) and 0.92 (95% CI: 0.80-0.97) respectively. **Conclusion** Various qualitative interpretations of ICC values exist and these are largely subjective (Atkinson and Nevill, 1998). A reasonable consensus of what constitutes 'good' reliability based on other studies investigating movement screens is an ICC value ≥0.70. This initial study reveals the SIMS appears to possess moderate to good intra-rater and good inter-rater reliability. Future research using the SIMS will seek to assess its usefulness in applied practice within soccer. **References** McCunn R, aus der Fünten K, Fullagar HHK, McKeown I, Meyer T. (2015). Sports Med, [Epub]. Atkinson G, Nevill AM. (1998). Sports Med, 26(4), 217-238.

## THE EFFECT OF A CONTROLLED MANDIBLE POSITION MOUTHGUARD ON STRENGTH AND POWER IN TRAINED ATHLETES

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**INTRODUCTION** The use of mouthguards is widely accepted on sports for injury protection. Research has suggested that they might also enhance athlete's muscle strength, but this is still a controversial issue. Thus, the aim of this study was to objectively determine if the use

of a controlled mandible position mouthguard may influence athlete's strength and power. **METHODS** Ten rugby players ( $25.3 \pm 3.29$  yrs;  $1.85 \pm 0.1$  m;  $97 \pm 11.1$  kg) volunteered for the research. Each subject performed a 1RM bench press test to ascertain their maximal load. Test protocol applied was a bench throw at 40% of the 1RM results, in the following randomized conditions: a) no mouthguard; b) controlled mouthguard (jaw in centric relation); c) over-the-counter mouthguard (placebo) d) Occlusal splint. All tests were applied on a smith machine, with 48h between them. **RESULTS** The results revealed that from the several parameters scrutinized, acceleration, peak acceleration, peak force, time to peak velocity and time to peak acceleration were improved when using the controlled mouthguard ( $p < 0.05$ ). No placebo effects were found. **DISCUSSION** The findings in this study suggest that the use of a controlled mouthguard may improve athlete's strength in power exercises. To the best of our knowledge, this was the first study that assessed strength while using a mouthguard that placed the mandible in centric relation, which is the most orthopaedic musculoskeletal stable position of the mandible (Okeson, 2008). Involuntary teeth clenching occur during physical exercise (Yokohama, 1998) and may optimize performance (Ebben et al., 2008), as it was previously demonstrated during countermovement jump. Therefore, it might be speculated that this controlled mouthguard optimizes the relation between mandibles, providing better stability for the mandible while clenching, which in turn allowed for an improvement in strength related skills. Since the position of the mandible is anatomically determined and therefore reproducible, this mouthguards provide a different and novel approach. They enable the comparison between participants using similar mouthguards, with controlled anatomical positions. This controlled mandible mouthguard is in contrast with similar studies on this subject, that perform random teeth fitting for manufacturing the mouthguard and did not control (clinically) the position of the mandibles. **REFERENCES** Okeson, J. (2008). Management of temporomandibular disorders and occlusion, 6th edition. Elsevier editions, Missouri Yokoyama, Y. (1998). Involuntary Teeth Clenching during Physical Exercise. Journal of the Japan Prosthodontic Society, 42, 90-101 Ebben, W.; Flanagan, E.; Jensen, R. (2008). Jaw clenching results in concurrent activation potentiation during the countermovement jump. Journal of strength and conditioning research, 22(6), 1850-1854

### PREDICTION OF KNEE VALGUS MOMENT DURING A HOP-AND-SIDESTEP TEST SIMULATED SIDESTEP CUTTING IN RUGBY PLAYERS

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**Introduction** Many non-contact anterior cruciate ligament (ACL) injuries have been reported to occur during sidestep cutting in rugby players. There is no screening tool of ACL injuries caused by sidestep cutting. Knee valgus moment is recognized as an important predictor of non-contact ACL injury risk. Since actual sidestep cutting are complicated to be tested, we have suggested to use hop-and-sidestep as simple and easy clinical screening test. Hop-and-sidestep is associated with sidestep cutting in knee valgus moment. The purpose of this study is to investigate lower extremity and trunk motion which predicts knee valgus moment during hop-and-sidestep in male rugby players. **Methods** Twenty one male rugby players ( $20.9 \pm 2.8$  years,  $171.6 \pm 4.0$  cm,  $75.4 \pm 7.1$  kg) participated in this study. We performed hop-and-sidestep test as follows; single leg hop forward, landing with the same leg, and cutting to the opposite direction of the standing leg. The testing procedures were repeated three times and the average data was recorded. A three dimensional motion analysis system featuring ground reaction force was used to determine kinematics and kinetics of both legs. We calculated Peak knee valgus moment, lower extremity and trunk angle (lower leg medial tilt, knee flexion, hip abduction, trunk flexion and trunk lateral flexion) during the test. Peak knee valgus moment was normalized to weight. Kinematic data was recorded at peak knee valgus moment. Multiple regression analysis was used to correlate knee valgus moment with lower extremity and trunk angle. **Results** Lower leg medial tilt, hip abduction and trunk lateral tilt angle explained knee valgus moment ( $p < 0.01$ ), while knee flex and trunk forward tilt angle were not significant predictors of knee valgus moment. Multiple regression revealed that 74% ( $r = 0.86$ ) of knee valgus moment was explained by the combination of the three predictors. **Conclusion** We reveal that lower leg, hip and trunk angle predict knee valgus moment during hop-and-sidestep. Hop-and-sidestep might be an effective clinical screening test predicting knee valgus moment. The three predictors should be frontal plane motions. To prevent ACL injuries during sidestep cutting, athletes are required the ability to coordinate their body in side-to-side motion. Contact E-mail: wtr0804@hotmail.co.jp

### ASSOCIATION BETWEEN THE USE OF ANALGESICS AND DOPING - A SURVEY IN 2,997 TRIATHLETES

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1: University of Graz, (Austria), 2: University Medical Center Schleswig-Holstein (Luebeck, Germany), 3: University Medical Center (Mainz, Germany), 4: University of Tuebingen (Germany), 5: University of Mainz (Germany) **Introduction** According to several epidemiological studies, the use of doping substances has been reported to be common practice among competitive athletes (Dietz et al., 2013; Striegel et al., 2010). Further studies showed that non-prohibited physical performance-enhancing substances, such as nutritional supplements (NS), provide a gateway for using doping substances (Backhouse et al., 2013). Additionally, the use of non-steroidal anti-inflammatory drugs (NSAIDs), including over-the-counter (OTC) analgesics, directly before a competition, has also been reported to be common use among endurance athletes such as marathon runners (Kuster et al., 2013) and triathletes (Gorski et al., 2011). The objective of this study was to test whether the use of analgesics is associated with the use of doping and therefore provides a gateway to doping as discussed for NS. **Methods** A questionnaire primarily addressing the use of analgesics and doping was distributed among 2,997 triathletes. The randomized response technique (RRT) was used to estimate the 12-month prevalence of doping in order to assess whether users of analgesics have a higher potential risk for doping than non-users. Statistical power analyses were performed to determine sample size. The bootstrap method was used to assess the statistical significance of the prevalence difference for doping between users and non-users of analgesics. **Results** The 12-month prevalence estimate for the use of doping substances (overall estimate 13.0%) was significantly higher in athletes that used analgesics (20.4%) than in those athletes who did not use analgesics (12.4%). **Discussion** The results of this study revealed that athletes who use analgesics prior to competition may be especially prone to using doping substances. As a practical implication of the present findings, we recommend athletes and coaches to handle the consumption of analgesics with care, and only use them for therapeutic reasons instead of pain prevention. **References** Backhouse SH, Whitaker L, Petroczi A. (2013). Gateway to doping? Supplement use in the context of preferred competitive situations, doping attitude, beliefs, and norms. Scand J Med Sci Sports, 23, 244-252. Dietz P, Ulrich R, Dalaker R, Striegel H, Franke AG, Lieb K, Simon P. (2013b). Associations between physical and cognitive doping - A cross-sectional study in 2,997 triathletes. PLoS One, 8, e78702. Gorski T, Cadore EL, Pinto SS, da Silva EM, Correa CS, Beltrami FG, Krusel LF. (2011). Use of NSAIDs in triathletes: prevalence, level of awareness and reasons for use. Br J Sports Med, 45, 85-90. Kuster M, Renner B, Oppel P, Niederweis U, Brune K. (2013). Consumption of analgesics before a marathon and the incidence of cardiovascular, gastrointestinal and renal problems: a cohort study. BMJ Open, 4, e002090.

## Oral presentations

### OP-SH12 Sociology: Gender

#### CREATING ORGANISATIONAL CULTURES TO SUPPORT THE PROGRESSION OF WOMEN COACHES AND COACH EDUCATORS

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**Introduction** The aim of this study was to understand the experiences of women coaches and coach educators in progressing through the licensed coaching and tutoring system within an English National Sporting Governing Body, The English Football Association. Statistics show that there is an average 75% drop-off in the number of women at each stage of the coaching pathway and an average 97% drop-off in the number of women progressing through the coach education (tutor) pathway from level 1 to 4. The focus of this paper centres specifically on examining the organisational structures and practices that influenced women's careers at critical points of their coaching development. Personal experiences were considered as an interplay of not only individual choices and circumstances, but also related to organisational contexts and relations with others within the system. Method 26 semi-structured interviews were conducted with a sample of licensed women coaches and tutors, at different points of the respective pathways, within the English Football Association. Interviews focused on the participants' entry and progression into coaching and coach education, experiences of initial training and professional development, motivations for leadership / to progress, their experiences as a woman within their sport, and their experiences of the organisational context in which they work. Results For women to thrive and progress as coaches and coach educators, particular organisational values are key in supporting their career. Creating a culture that values and nurtures the contribution that women can make to the coaching and tutoring professions, creating a culture that accepts women in and associates women with, leadership, retaining frequent and meaningful relationships between organisations and staff, and rewarding and recognising women's experiences and achievements all serve to create organisational cultures that are welcoming and inclusive of diversity. Discussion Gender needs to be understood as a complex set of social relations enacted across a range of social practices, rather than merely as a biological status. An interrogation of the social order of sport is required, that is how structures, practices, relations and values maintain and enforce particular ways of relating and being, and result in unequal social relations. Addressing the types of gendered social practices that exist within sporting organisations and ideologically reframing gender equality are avenues for change to the current status quo within sport. The challenge then, is to redefine this coaching culture rather than simply to operate within the constraints of the existing system. Contact L.J.Norman@leedsbeckett.ac.uk

#### GENDER POSITIONS IN SCHOOL SPORT: FLOORBALL AND SOCCER

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In Sweden, organized team sports performed during leisure time are mainly separated for boys and girls. As Messner (2002) argues, this often reproduces traditional gender hierarchies within sport, in which boys are favored and girls undervalued. In sport schools, however, mixed-sex training groups are as common as separated groups. Anderson (2009) discusses that mixed-sex team sports may effectively reduce gender stereotypes, because men and women need to cooperate. Therefore, it is of interest to study mixed-sex and separated team sport groups at a sport school. The aim of this study was to explore and discuss young people's construction and display of gender in floorball and soccer groups at a sport school, and in what way gendered power relations were exercised. Methodology and theory An ethnographic approach was used to access voices, attitudes and actions on and off the floorball and soccer lessons (cf. Ennis & Chen 2012). Young teenagers attending floorball and soccer lessons at a sport school (7th to 9th grade) were observed and 21 one of them interviewed. Lorber's (1994) theory of gender as a social institution was used to analyze and interpret their expressions and actions, attitudes and notions of sport. Results "Boys are better than girls" was the hegemonic discourse in the training groups. The mixed-sex floorball setting seemed to actualize an unquestioned need to dichotomize and construct distinct groups of boys and girls. However, the floorball girls emphasized that they empowered themselves by improving their athletic skills together with boys. Though being recognized by the boys, they were also patronized in various ways. The floorball boys reproduced an orthodox masculinity and similarly challenged this masculinity by most often appreciating the girls as skilled training peers. The soccer girls experienced a verbal patronizing as the soccer boys frequently told them that "girls are rotten soccer players", though never having trained together. The soccer boys weren't as reflective as the floorball boys, instead maintaining that "boys are better than girls" and that a mixed-sex setting was evidently unacceptable. Conclusion Although the boys and girls constantly emphasized differences due to gender, they strove towards a uniform level of skills and ideal way of play—to be fast, tough, strong and technical. Gender seemed to lose significance in this common strive for similarity, still they continued to compare each other with boys as the norm. Therefore, gendered power relations set an agenda based in a notion underlining that "boys' way to play" is the ideal. References Anderson, E. 2009. Inclusive masculinities: The changing nature of masculinities. New York: Routledge. Ennis, C. and S. Chen. 2012. Interviews and focus groups. In Research methods in physical education and youth sport. Edited by: K. Armour and D. Macdonald. New York: Routledge. Lorber, J. 1994. Paradoxes of gender. New York: Yale university press. Messner, M. 2002. Taking the field: women and men in sports. Minneapolis: University of Minnesota Press.

#### GENDER MARKING IN MEDIA COVERAGE OF SPORT - LONGITUDINAL ANALYSES ON THE VISUAL REPRESENTATION OF FEMALE AND MALE ATHLETES IN GERMAN PRINT MEDIA

HARTMANN-TEWS, I.

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**Introduction** The visual representation of athletes via sports photographs is one of the most powerful medium for the social construction of gender relations in sport. Research in the anglo-american countries has revealed a continuous gender marking, denoting female athletes' otherness and their sport as something less valuable than that of men. The respective gender markings in media communication include 'compulsory heterosexuality', 'appropriate femininity', 'infantilization', 'emphasis on non-sport related aspects', 'sexualisation' and 'ambivalence' in reports. To sum it up, it is the discourses through which media construct knowledge that leads to shared under-



standings and practices that reinforce rather than challenge the existing gender order and relations of power (Bruce 2013). During the last three decades social change has affected the gender order, management of sport events and marketing of athletes. However, there is only little research on the relevance and impact of social change to gendered print media coverage and discourses and no respective research in Germany. Research questions and methods The question to put forward is, whether media discourses on sport have changed towards a more gender-neutral presentation of athletes. In order to get answers to these questions, we designed two follow-up studies. The first one refers to daily newspaper coverage and the original study of Klein (1986) on print media coverage in Germany in 1979. The longitudinal study is based on a systematic content analysis of four national newspapers in Germany in 2000 and 2010 in order to compare data over a period of 30 years. The sample consists of a total number of 852 texts and 352 photographs 2000/2010. The second longitudinal study is based on a systematic content analysis of the visual representation of athletes during the Olympic Games 2004, 2008 and 2012 and a total sample of 2424 photographs in two national newspapers [777 photographs in 2004, 876 photographs in 2008 and 771 photographs in 2012]. Results are presented and discussed against the background of theoretical assumptions about social construction of gender and gender order in sport. References Klein, M (1986) *Frauensport in der Tagespresse*. Bochum: Universitätsverlag Dr. N. Brockmeyer. Bruce, T (2013) *Reflections on Communication and Sport: On Women and Femininities*. Communication & Sport, Vol. 1, No 1-2, p. 125-137

## **'TWO GIRLS; THAT MUST BE OKAY, RIGHT': SEXUAL CONSENT AND ABUSE IN KARIN'S COACH-ATHLETE LESBIAN RELATIONSHIP**

JOHANSSON, S.

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**Introduction** Female elite-athlete Karin\* was 17 years old when the considerably older, team coach Selma\* became her girlfriend. Five years later Karin contacted me, offering to share her story. To date there are no studies on coach-athlete lesbian or gay relationships and literature on legal coach-athlete sexual relationships is sparse. Although sexual consent is often the defining characteristic of sexual abuse, the meanings of consent are rarely explicitly defined, problematized or comprehensively investigated (Beres, 2007). The current study investigates how Karin makes sense of her coach-athlete lesbian relationship and what can be learnt about sexual consent from this story. **Methodology** Drawing on qualitative methodology, the study uses a narrative case study design. First, a loosely-structured interview was performed, inductively analysed within-case, and presented in form of a literary short story. Second, the story was analysed and discussed in reference to literature on sexual consent, abuse, gender, and sexuality. Findings and discussion Karin's story gives a rare insight to a lesbian coach-athlete sexual relationship that unfolded in a consent and abuse grey-area. Social and sexual conventions, normative notions, and corresponding regulations to protect athletes can (unintentionally) result in stigmatisation and isolation that facilitate abusive, harmful coach-athlete relationships. For example, heteronormativity and predominant male perpetrator – female victim stereotypes (Johansson & Larsson, 2016). Karin's story moreover illustrates that socially and relationally, consent is not necessarily amenable to a mutually exclusive yes or no answer to sexual relations (Beres, 2007). Sometimes consent is alternately absent and present during events and phases; before, during and after a coach-athlete sexual relationship. This negotiation and renegotiation depends on contextual factors both within and outside of the relationship. Karin's negotiation of consent circled primarily around her need for friendship. Sharing stories like Karin's breaks the prevailing silence and marginalisation. Further research into the contextual, complex, and sometimes contradictory negotiations of sexual consent, that intersect both structure and agency, and needs to regard gender, sexuality, athlete empowerment, and preventing sexual abuse among sexual majorities and minorities is proposed. \* Pseudonyms **References** Beres M (2007). Spontaneous sexual consent: An analysis of sexual consent literature. *Feminism and Psychology*, 17(1), 93-108. Johansson S & Larsson H (2016). 'This might be him; the guy I'm gonna marry': Love and sexual relationships between female elite-athletes and male coaches. *International Review for the Sociology of Sport*, DOI: 10.1177/1012690215626593. Contact su-sanne.johansson@jih.se

## **ACTION FOR MEN – PERCEIVED REASONS FOR AND BARRIERS TO PARTICIPATING IN PHYSICAL ACTIVITY IN MEN AGED 50 PLUS**

STROBL, H.1, TITTLBACH, S.1, LOSS, J.2, WARRELMANN, B.2

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**Introduction** Men at and over the age of 50 represent a special target group for physical activity promotion trials: In general, men experience higher mortality rates due to chronic diseases than women, but health promotion offers are more frequently utilized by women than men. Even so, there is little published evidence in how to promote men's engagement in physical activity (Robertson et al., 2008). Literature suggests that programs effective in increasing physical activity respond specifically to local needs and barriers by being regionally grounded and multi-sectoral (Cordier and Wilson, 2014). This is the key strategy of the project Action for men, granted by Germany's Federal Ministry of Education and Research. In two rural communities (5.000 to 10.000 inhabitants each), key stakeholders from a variety of sectors (e. g. local health authority, adult education centers and sports associations) are participating in a task force that will develop and implement programs to promote physical activity among men aged 50 plus. To inform the development of interventions, a needs assessment and barrier analysis was carried out. **Methods** A standardized quantitative questionnaire was sent to 2.500 men at and over the age of 50, including questions about perceived reasons for and barriers to partaking in physical activity and about stages of behavioral change of the participants. **Results** In total, 431 men between the ages of 50 and 92 answered the questionnaire. Exemplary, two significant results concerning barriers to physical activity are illustrated: Perceived lack of time as well as perceived uncertainty with physical ability decrease continuously across stages of change. There are significant differences between the stages for both types of barriers, but more variance can be explained by uncertainty (lack of time:  $F=8,39$ ;  $p<0,01$ ;  $\eta^2=0,13$ ; uncertainty:  $F=35,30$ ;  $p<0,01$ ;  $\eta^2=0,38$ ). **Discussion** Contrary to middle-aged persons (e. g. Duan et. al, 2013), men aged 50 plus perceive uncertainty with their own physical ability as a greater barrier to physical activity when compared to lack of time. This has to be considered in developing activity promotion trials for older men. **References** Duan Y, Brehm W, Strobl H, Tittlbach S, Huang Z, Si G. (2013). *J Exerc Sci Fit*, 11(2), 63-77. Cordier R, Wilson, N. (2014). *Health Promot Int*, 29(3), 483-493. Robertson L M, Douglas F, Ludbrook A, Reid G, Teijlingen E (2008). *BMC Health Serv Res*, 8, 1-9.

## Oral presentations

### OP-PM40 Kayak & Rowing

#### OXFORD AND CAMBRIDGE BOAT RACE: PACING AND TACTICS BETWEEN 1890 AND 2014.

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1: University of Essex, Colchester, UK 2: University of St Mark & St John, Plymouth, UK Introduction: The Oxford and Cambridge Boat Race is one of the oldest, continuing sporting events in the world. Historically as well as scientifically, the race is of unique value, as performance data have been collected in the same event over 125 years. The purpose of this study was to investigate the pacing and tactics employed by crews of the Oxford and Cambridge head-to-head race between 1890 and 2014. Methods: To examine pacing profiles, 4 intra-race checkpoints were used (1: Mile Post, 2: Hammersmith Bridge, 3: Chiswick Steps, 4: Barnes Bridge and the Finish). In addition, the pacing strategy in terms of section times of the crews was considered in accordance with 1) the overall profile across checkpoints and 2) the degree to which all crews sought to gain tactical advantage during the race. This was investigated by assessing each crew's average boat speed (m/s) across the full course (6.8km) and comparing the crew's average speed between checkpoints. To evaluate categorical data and the impact of factors such as starting station and the extent of fast start strategy, Chi Squared analyses were performed. Results: There was no tactical advantage from commencing on either Surrey (55% of victories) or Middlesex (45% of victories); however, all crews (n=228) adopted a fast start strategy, with 81% of victories achieved by the crew leading the race at the first intra-race checkpoint at 24% of the total race distance. Crews leading the race at the final checkpoint (83% of total distance; 1143m) achieved victory on 94% of occasions. Discussion: Tactically gaining the early lead position with a fast start strategy seems particularly meaningful to success in the Boat Race, and is of greater importance to race outcome than factors such as starting station. An early lead is associated with taking the preferential racing line from the opposition, while also giving the trailing crew disturbed (wake) water which disrupts balance, aerodynamics and consequent pace of the boat (Garland, 2005). This is opposite to the finding that the final stages of the race are crucial to performance in other head-to-head competitive sports such as short-track speed skating, where the trailing rider has a clear aerodynamic advantage of drafting in the slipstream of the preceding competitors (Konings et al 2016). As previously found when comparing cycling with skating (Stoter et al in press), pacing strategies might differ related to the specific nature and characteristics of the different sports. References: Garland SW. BJSM 2005;39:39-42. Konings MJ et al. USPP 2016; 11(1), 122-129. Stoter IK et al. USPP DOI: 10.1123/ijspp.2014-0603. Contact: fjhett@essex.ac.uk & aedwards@marjon.ac.uk

#### PHYSIOLOGICAL AND BIOMECHANICAL CHARACTERISTICS OF SIMULATED OLYMPIC KAYAK DISTANCES WITH A KAYAK ERGOMETER.

PAIZIS, C.1,2,3, LEPERS, R.1,2, HILT, P.1,2, GARNIER, Y.1,2

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Introduction The physiological characteristics in Olympic flat water kayaking races are well known today (1) and the latest studies are turning more to the kinematic (2) and neuromuscular parameters (3) of the activity. However, no studies have assessed the specificity of these characteristics in relation to the duration of the effort. The purpose of this study was to investigate modifications that occur in the paddling technique using a paddling ergometer during different maximal effort trials (40 seconds and 4 minutes). Methods Nine experienced kayak paddlers who have competed at the French national level (female = 2, 18.6 ± 3.5 years) participated in this study. Athletes performed two maximum-effort trials of 40 seconds and 4 minutes, simulating an Olympic distance sprint (respectively 200m and 1000m). Physiological (Grip strength, blood lactate and muscle activity), biomechanical (power output, stroke rate) and kinematics data were recorded throughout the experiment. Results The average maximum power output values were higher for 40 seconds over 4 minutes (p < 0.01). Moreover maximum power output values were higher during the first 25% of the exercise compared to the 50%, 75%, 100% of the total exercise duration for both exercises (p < 0.05). Muscular EMG activities were more important during the 40 sec exercises compared to the 4 min. Moreover the left triceps showed more activity changes over the two exercises. In addition the latissimus dorsi (during the 40s) and the right biceps (over 4 min) also show EMG activity changes. A grip strength loss (8.5% ± 4.67) was observed only after the 40 sec exercise for the right forearm. Post exercise blood lactate levels were significantly higher (p < 0.01) for both types of maximal effort trials Discussion Our results show that anaerobic qualities are a very important factor for middle distance races such as a 1000 m in kayak. Muscle fatigue associated with the reduction of the maximum grip strength of the right hand after an exercise of 40 seconds could result from the different roles of the hands on the paddle. The orientation of the blades in water is ensured only with the right hand which requires continuous muscle contraction throughout the paddling while the left hand is contracted only during the left traction phases. Further work would be needed to confirm this hypothesis by comparing other kayakers using their left hand in the orientation of the blades in water. References 1. Bishop D. (2000). Eur J Appl Physiol, 82 (1-2), 91-97. 2. López López C, Ribas Serna, J. (2011). Rev Andal Med Deporte, 4(3), 91-95. 3. Trevithick BA, Ginn KA, Halaki M, Balnave R. (2007). J Electromyogr Kinesiol, 17(1), 74-9.

#### FOUR WEEKS OF INTENSIFIED TRAINING DECREASES RESTING METABOLIC RATE IN ELITE ROWERS.

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Introduction: Elite rowers must complete a high volume of training across a number of exercise modalities to build aerobic endurance, anaerobic power, strength and technical ability. Periods of heavy training may influence energy expenditure and subsequently, resting metabolic rate (RMR). Appropriate periodization of training is important to ensure consistent preparation and adaptation to the work prescribed, and to minimize illness and injury risk. Methods: Seventeen national-level rowers undertook a four-week period of intensified training. A block periodization approach was employed, emphasizing endurance capacity. RMR, body composition (DXA) and rowing performance were assessed PRE and POST the four-week period. Wellness was evaluated weekly using the Multicomponent Training Distress Scale (MTDS). Key on-water and ergometer sessions were monitored for physiological parameters. Results: Significant decreases were observed in: (mean ± SD of difference, p-value): absolute RMR (-466 ± 488 kJ.day<sup>-1</sup>, p = 0.01) and relative RMR (-1.91 ± 1.95

cal.kg.FFM-1,  $p = 0.01$ ) in the ten athletes who completed the training block. Significant reductions in body mass ( $-1.64 \pm 1.28$  kg,  $p = 0.003$ ) and fat mass ( $-2.20 \pm 1.22$  kg,  $p = 0.0001$ ) were also observed, while energy intake was unchanged. Rowing performance did not improve. Fatigue and total mood disturbance were significantly increased across the training period (Tests of Within-Subjects Effects: F(5, 45) = 5.413,  $p = 0.001$ ; F(5, 45) = 3.180,  $p = 0.02$ ), but post-hoc analysis did not determine the time point of change. Discussion: Four weeks of heavy training decreased RMR and body composition in elite rowers, likely due to an imbalance between training load and energy intake. Future training cycles of this nature should ensure energy needs are met to enhance physiological adaptation and performance.

### PREDICTION OF SIMULATED 1000 M KAYAK ERGOMETER PERFORMANCE IN YOUNG ATHLETES.

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**Introduction** The competitive distance of 1000m-kayak effort is characterized by a large requirement of aerobic cardio-circulatory and respiratory system, and at the same time, a great ability to produce work through anaerobic lactic metabolic pathway. The performance of young athletes is also modulated by morphological and maturation status. This study aimed to evaluate the predictive value of cardio-respiratory fitness, anthropometric, maturation and biomechanical indicators to the performance in 1000 meters in kayak ergometer in young athletes. **Methods** 12 young kayak athletes of Portuguese national level ( $16.0 \pm 1.1$  years old;  $63.8 \pm 7.2$ kg body mass;  $174.9 \pm 7.2$ cm; with  $100.1 \pm 5.7\%$  of mature height predicted; mean weekly training is  $10.5 \pm 2.4$  hours, were submitted to two protocols in kayak ergometer (Dansprint,UK) with 48 hours apart. In the first visit to the laboratory, they accomplished a specific warm-up to familiarize with the ergometer (15'). After resting (10') they underwent an incremental protocol starting 8 km.h<sup>-1</sup> with increments of 1 km/h each 2 minutes, until exhaustion. In the second visit to the laboratory at the same time of the day, they accomplished the same warm-up and rest interval and then they underwent a simulated maximal 1000m assuming the same approach as they use in competition. **Results** In the incremental protocol a VO<sub>2</sub> max of  $3.4 \pm 0.6$  (L.min<sup>-1</sup>), a mechanical power of  $138.5 \pm 24.5$  watts (MAP) at a speed of  $13 \pm 0.5$  km/h (MAS) were reached. The first ventilatory threshold was held at  $57.4 \pm 8.8\%$  and the respiratory compensation point at  $79.2 \pm 7.1\%$  of VO<sub>2</sub>max. At the 1000m simulating the race  $292.25 \pm 15$  seconds was spend, maintaining a mean speed of  $97 \pm 2.8\%$  of MAS and  $90 \pm 6.5\%$  and  $95.7 \pm 16.6$  of the VO<sub>2</sub>max and PAM respectively. **Discussion** Important correlations were found between the performance in the 1000m and chronologically age, VO<sub>2</sub>max MAP, MAS, stroke frequency at VO<sub>2</sub>max, velocity at first ventilatory threshold and compensation respiratory point, and HR at LV1. The final lactate accumulation confirmed the important contribution of lactic anaerobic ( $12.4 \pm 2.4$  mmol.L<sup>-1</sup>). The variation of results in 1000 meters in kayak ergometer was strongly associated to maximal aerobic power (MAP) and with stroke frequency at VO<sub>2</sub>max. An estimated explanation regression model for performance (s) of 1000 meters in kayak ergometer was found to the performance on 1000m with the PAM and stroke frequency at VO<sub>2</sub>max speed. Time 1000m (s) =  $413,378 - 0,433$  (PAM) -  $0,554$  (SF at VO<sub>2</sub>max);  $R^2 = 84.5\%$ . The maximal aerobic power and the stroke frequency at this intensity seems to be an important strategy to monitor training adaptation, namely to predict performance in young kayakers. Contact [luisrama@fcdef.uc.pt](mailto:luisrama@fcdef.uc.pt)

### ACUTE EFFECTS OF CONCURRENT STRENGTH AND ENDURANCE TRAINING ON PHYSIOLOGICAL AND SPECIFIC PERFORMANCE PARAMETERS IN WELL-TRAINED KAYAKERS.

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**Introduction** The sport of Olympic sprint kayaking depends on both high aerobic and strength capabilities. Concurrent development of these components is a common training aim. However, concurrent training (CT) appears to have a negative impact on strength development, with no detrimental effects on endurance performance. García-Pallarés et al. (2010) proposed strategies to minimize these detrimental effects, one of which includes sequencing strength training before endurance workouts. Based on this recommendation, the aim of this study was to analyse whether hypertrophy strength training (HST) has negative effects on physiological performance parameters on a subsequent aerobic endurance bout in elite kayakers. **Methods** Eleven well-trained youth kayakers had to perform two different training sequences in a randomized crossover design. One consisted of a HST performed before an aerobic endurance training (AET) that lasted 40 minutes at a velocity equal to 55% of VO<sub>2</sub>peak on an air-braked kayak ergometer with 20 minutes rest in-between. The second session included the AET without a preceding HST. Relative and absolute oxygen consumption, respiratory exchange ratio (RER), blood-lactate and stroke-rate data were collected every 10-minute interval during AET. **Results** Wilcoxon test demonstrated no significant differences between training sequences for relative and absolute oxygen consumption, blood-lactate and stroke-rate during each interval and the entire endurance bout ( $P < 0.05$ ). RER differed between sequences in each of the four intervals with significantly ( $P < 0.05$ ) lower RER values in the AET bout that was subsequent to the HST session (HST+AET: 10' = 0,85; 20' = 0,0,87; 30' = 0,86; 40' = 0,85 / AET only: 10' = 0,88; 20' = 0,9; 30' = 0,89; 40' = 0,88). **Discussion** Sequencing HST prior to AET may be a possible strategy to optimize concurrent training of strength and endurance. Especially, in the general preparation phase of sprint kayakers, where muscle growth and aerobic endurance capacity are major training aims, this sequencing may enable the athlete to produce favourable strength gains compared to an opposite sequencing. Lower RER after HST may even show a positive side effect of this order: Because of depleted glycogen storages consumption of fatty acids seems to be augmented. Future research should focus on long-term adaptations to this approach to examine this order effect on performance. **References** García-Pallarés, J., García-Fernández, M., Sánchez-Medina, L., & Izquierdo, M. (2010). Performance changes in world-class kayakers following two different training periodization models. *European Journal of Applied Physiology*, 110(1), 99–107.

### ROWERS' ON-WATER POWER OUTPUT IS COMMONLY UNDERESTIMATED

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**Introduction** In rowing, mechanical power output is a key parameter for biophysical analyses and monitoring of performance and should therefore be measured accurately [1,2]. It is common practice to estimate a rower's on-water power output as the time average of the dot product of the moment of the handle force relative to the oar pin (MFh,r) and the oar angular velocity ( $\omega_o$ ) [3,4]. In a theoretical analysis we have shown that this measure differs from the true power output (P<sub>rower</sub>) by an amount that equals the mean of the rower's mass (Mr) multiplied by the rower's center of mass acceleration (Arcom) and the velocity of the boat (Vb) (Presidual). The purpose of this study was to quantify Presidual for different rowers under different rowing conditions. **Methods** Nine rowers participated in an on-water exper-

iment consisting of 7 trials in a single scull. Stroke rate, technique and forces applied to the oar were varied between trials. Inertial sensors (Xsens MVN motion capture suit; 60Hz), a GPS (LOCOSYS, Taiwan; 10Hz) and a pre-calibrated conventional digital scale obtain Arcom, Vb and Mr. Forces applied to the oar and oar angle were determined using instrumented oarlocks (Peach Innovations, UK; 100Hz). The average ratio of Presidual to Prower per trial was calculated as a measure of the difference between true power output and power output estimated while using the common proxy. Results On average, the ratio of Presidual to true power output was 0.123 with only small variations between rowers and rowing conditions (SD = 0.011). A multilevel analysis revealed an effect of stroke rate: an increase in stroke rate from 18 to 32 strokes per minute resulted in an increase of the ratio of Presidual to true power output from 0.120 to 0.133 ( $p < .001$ ). Discussion The results of this study indicate that a rower's mechanical power output is underestimated by 12.3% on average when calculated according to the common proxy. In order to accurately analyze and monitor rowing performance, a correction of the determination of rowers' on-water power output is, therefore, required. References [1] Hofmijster, M. J. (2010). Mechanics and Energetics of Rowing. Faculty of Human Movement Sciences. VU University Amsterdam, Amsterdam. [2] Smith, T. B., & Hopkins, W. G. (2012). Measures of Rowing Performance. Sports Medicine, 42, 16. [3] Baudouin, A., & Hawkins, D. (2004). Investigation of biomechanical factors affecting rowing performance. J Biomech, 37(7), 969–976. [4] Zatsiorsky, V. M., & Yakunin, N. (1991). Mechanics and Biomechanics of Rowing : A Review. International Journal of Sport Biomechanics, 7, 229–281.

## Oral presentations

### OP-PM48 Fatigue

#### ARE REACTION TIME AND ACCURACY INFLUENCED BY MENTAL OR PHYSICAL EFFORT?

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Purpose: The present study was designed to examine the individual and combined effects of a mentally fatiguing task and subsequent exercise, both performed in 30°C, on accuracy and reaction time during a short cognitive task (Flanker test). Methods: Ten endurance-trained male athletes (Age: 22±3y; Wmax: 332±41W) completed two experimental trials in a single blind, randomized, cross-over design in 30°C (30% RH). The trial started with subjects completing a 5min Flanker task (FL1). Next, either 45min of Stroop (mentally fatiguing task) were performed or a documentary (control) was watched. Upon completion the second Flanker task (FL2) was performed. Then subjects cycled for 45min at a fixed pace equal to 60% Wmax, immediately followed by a self-paced time-trial in which they had to produce a fixed amount of energy (equal to cycling 15min at 80% Wmax) as fast as possible. To conclude subjects performed the third Flanker test (FL3). Reaction time and accuracy were measured during each 5min Flanker task and during the Stroop task. Thermal sensation, ratings of perceived exertion, the NASA-Task Load Index (NASA-TLX) and a mental fatigue-VAS-scale (M-VAS) were assessed throughout the entire trial. Results: The NASA-TLX scale showed that the Stroop task was more mentally demanding than the documentary ( $p < 0.05$ ). This was supported by the M-VAS that indicated that subjective mental fatigue was significantly higher during and after the Stroop compared to the control condition ( $p < 0.05$ ). During the Stroop task mean reaction time and accuracy did not significantly change. Accuracy during the Flanker task decreased over time in both conditions, but no effect of the intervention was observed. In the mental fatigue condition reaction time only improved significantly for FL2 vs FL3 (% performance change compared to FL1: FL2 97% and FL3 86.5%;  $p = 0.001$ ), while in the placebo condition reaction time was improved at all time points (FL1 vs FL2; FL2 vs FL3;  $p < 0.015$ ). Conclusion: Subjective measures (M-VAS & NASA-TLX) indicated that the mental task was more mentally demanding and that MF was successfully induced in the heat. MF induced a decrease in accuracy while reaction time did not significantly change. Subsequent exercise further decreased accuracy and improved reaction time. In contrast, after the documentary accuracy also decreased, but there was a significant improvement in reaction time. Exercise resulted in a further aggravation of accuracy and improvement of reaction time. We conclude that heat stress potentially overruled the effects of MF on cognitive parameters.

#### THE EFFECTS OF MENTAL FATIGUE ON LONG-TERM ENDURANCE PERFORMANCE

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INTRODUCTION Mental fatigue is a psychobiological state caused by prolonged and demanding cognitive activity (Boksem et al. 2008). It has been previously demonstrated that mental fatigue has negative effects on perception of effort and endurance performance during laboratory tests lasting between 4 and 25 minutes (Marcora et al. 2009; Pageaux et al. 2013; Brownsberger et al. 2013). However, the effects of mental fatigue on longer term endurance performance and on the field have never been tested. Therefore, the main aim of the current study was to investigate the effects of mental fatigue on perception of effort, heart rate, pacing and performance during a simulated half-marathon race in amateur runners. METHODS Sixteen amateur marathon runners (means ± SD: age 41.9 ± 9.1 yr, body mass 75.1 ± 7.8 kg, height 1.76 ± 0.06 m) were randomly allocated to either a group performing a 50-min mentally-fatiguing task before the half-marathon, or a control group (reading magazines for 50 min before the half-marathon). All subjects completed psychological questionnaires and fatigue visual analogue scales before and after experimental treatment, and after the half-marathon. Performance time, speed, heart rate and rating of perceived exertion (RPE) were measured during the simulated race. RESULTS Runners who performed the mentally-fatiguing task completed the half-marathon approximately five minutes slower (6,664 ± 860 s) than the control group (6,358 ± 634 s) (Cohen's  $d = 0.41$ ;  $p = 0.432$ ). Practically, the true effect size at the population level is possibly harmful (65.6% probability), unlikely trivial (22.1% probability) and unlikely beneficial (12.3% probability). DISCUSSION In conclusion, because of low statistical power, the data collected so far do not provide reliable evidence that mental fatigue reduces long-term endurance performance. However, magnitude-based inference suggests that mental fatigue is possibly harmful to half-marathon performance in amateur runners. Additional data will be collected to draw a firmer conclusion on the null hypothesis and provide more precise estimates of the effects of mental fatigue on long-term endurance performance. REFERENCES Boksem MA, Tops M. Mental fatigue: costs and benefits. Brain Res Rev 59: 125-139, 2008. Brownsberger J, Edwards A, Crowther R, Cottrell D. Impact of mental fatigue on self-paced exercise. Int J Sports Med 34: 1029–1036, 2013. Marcora SM, Staiano W, Manning V. Mental fatigue impairs physical performance in humans. J Appl Physiol 106: 857-864,



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### MENTAL FATIGUE DOES NOT IMPAIR ALL-OUT SPRINT IN ELITE TRACK CYCLISTS BUT IT ALTERS PERCEPTUAL RESPONSES DURING CONTINUOUS SUBMAXIMAL EXERCISE

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**INTRODUCTION** Mental fatigue (MF) has a detrimental effect on endurance performance by altering perceptual responses of effort despite no changes in physiological parameters (Marcora et al., 2009). Moreover, recent studies have proven that MF does not alter anaerobic capacity in a 3 min all out cycling exercise (Martin et al., 2014). The present study had two aims. Firstly, to assess the impact of a cognitive demanding task (Stroop) on anaerobic capacity of elite cyclists during an all-out cycling sprint test (AOS). The second objective was to elucidate the negative effect of MF during a submaximal cycling step test. **METHODS** 10 internationally competitive track cyclists completed 30 min of an incongruent Stroop colour-word test, or the equivalent time in a control condition in a cross-over study. Participants completed a submaximal 3-step cycling test (5 min for each step) at a constant power increasing at each step and afterwards they completed a 15 sec AOS. Physiological and perceptual measures of heart rate (HR), cadence (RPM), lactate and rating of perceived exertion (RPE) were collected during the submaximal test and the AOS. Psychological questionnaires were used to assess fatigue and mental demand of the Stroop. **RESULTS** The Stroop test was rated as more fatiguing ( $p < 0.001$ ) and mentally demanding ( $p < 0.001$ ) than the control task. There was no significant difference between conditions during the AOS for peak power ( $p = 0.67$ ), mean power ( $p = 0.69$ ) and fatigue index ( $p = 0.96$ ). During the submaximal step test, there were no significant differences between condition for HR ( $p = 0.23$ ), RPM ( $p = 0.88$ ) and lactate ( $p = 0.13$ ). However, a significant interaction time (step)  $\times$  condition has been reported for RPE ( $p < 0.05$ ). **DISCUSSION** No difference in performance between Stroop and control condition suggests that cognitive processes do not regulate maximal anaerobic exercise in AOS for elite cyclists. Anaerobic capacity during AOS seems to be mainly regulated by peripheral parameters. Whereas, 30 min of mentally demanding test negatively impact submaximal endurance exercise during the step test. In line with previous studies, it appears that RPE, is the main variable affected by MF. This is the first study assessing the influence of MF in AOS performance and submaximal exercise in an elite group of track cyclists. **REFERENCES** Marcora SM, Staiano W, Manning V. Mental fatigue impairs physical performance in humans. *J Appl Physiol.* 2009; 106:857-64. Martin, K, Thompson, KG, Keegan, R, Ball, N, & Rattray, B. Mental fatigue does not affect maximal anaerobic exercise performance. *Eur J Appl Physiol.* 2015; 115 (4), 715–725.

### EFFECTS OF VOLUNTARY AND EVOKED LOCOMOTOR MUSCLE FATIGUE ON RESPIRATORY RESPONSES TO A HIGH INTENSITY INTERVAL TRAINING SESSION

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**Introduction** High intensity interval training (HIIT) is a time-efficient training method to improve aerobic capacities. In the present study, we tested the impact of pre-fatiguing the locomotor muscles on respiratory responses to a HIIT session. As muscle fatigue can be induced by evoked (electromyostimulation, EMS) or voluntary (VOL) contractions, we also tested whether EMS fatigue and VOL fatigue could differently impact respiratory responses to a HIIT session. As EMS contractions involve a different muscle fibers recruitment pattern and higher respiratory responses than VOL contraction (Maffiuletti 2010), we hypothesised that EMS fatigue would have the greater impact on respiratory responses to a HIIT session. **Methods** Fifteen subjects completed a control session, an EMS fatigue session and a VOL fatigue session. Each session consisted in the completion of a running intermittent time to exhaustion test (30-30, 30s run interspaced by 30s rest) performed at the speed eliciting  $\dot{V}O_{2max}$ . Subjects were pre-fatigued with EMS or VOL contractions. The EMS fatigue protocol consisted in 30 bilateral intermittent isometric evoked contractions of the knee extensors. In the VOL session, subjects performed as many bilateral intermittent maximal isometric voluntary contractions (MVC) of the knee extensors as necessary to induce the same decrease in force experienced following the EMS fatigue protocol. Respiratory parameters were collected during the 30-30. **Results** Time to exhaustion decreased in both fatigue conditions with a greater decrease following the EMS fatigue compared to the VOL fatigue. This decrease in time to exhaustion was associated with a decrease in absolute time spent above 90%  $\dot{V}O_{2max}$  (t90). When normalised by the performance of each respective session, the relative t90 decreased only during the VOL fatigue session. Both fatigue protocols induced an increase in respiratory responses to the exercise. Interestingly, higher  $\dot{V}O_2$ , respiratory frequency and ventilation was observed during the EMS fatigue session compared to the control and VOL fatigue session. **Discussion** Both pre fatigue protocols induced an increase in respiratory responses to the exercise, leading to a decrease in time to exhaustion. Interestingly, due to the greater respiratory responses, only the absolute t90 and not the relative t90 was altered by the EMS fatigue. Future research should aim to investigate whether integrating pre-fatigue of the locomotor muscles induced by EMS before completion of a HIIT session could have beneficial long term effects for athletes and patients. **References** Maffiuletti NA (2010) Physiological and methodological considerations for the use of neuromuscular electrical stimulation. *Eur J Appl Physiol* 110 (2):223-234.

### FATIGUE DOES NOT ALTER FLUCTUATIONS OF STRIDE INTERVAL IN GAIT

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**Introduction** Plenty of studies have reported long-range correlations in stride interval fluctuations under different conditions for healthy subjects, while it has been shown that this structure breaks down with aging and several pathologies [1-8]. A decrease in strength has been proposed to explain the reduction in stability [6]. Therefore, we induced fatigue to check if this alters the structure in the fluctuations of healthy subjects. **Methods** 30 healthy individuals (20 f, 10 m) (h: 165cm  $\pm$  9,3, w: 65,5kg  $\pm$  1,4, age: 25,3 years  $\pm$  1,4) that had no acute or chronic lesions or diseases of the lower extremities wore pressure-sensitive insoles (T&T, Schönefeld, Germany) when walking on a treadmill (Woodway, Weil a. R., Germany) in their preferred walking speed (=PWS) [determined as in 9]. Measurements (pre and post fatigue) were performed with a sampling frequency of 300 Hz for consecutive 237 s. To induce fatigue, participants were asked to run on the treadmill starting with 8 km/h. Treadmill speed was increased by 1 km/h every two minutes until subjects reported a value of 13 on Borg-Scale. Subsequently, they had to continue in that particular speed until a value of 17 was reached. Immediately after, the post-fatigue measurement was performed at the earlier determined PWS [10-11]. **Results** Detrended fluctuation analysis (=DFA) was performed.

DFA pre resulted in  $\alpha=0.67$  and post in  $\alpha=0.64$ , while both varied significantly from their surrogates. Discussion The results show each condition to resemble persistent long-range correlations [12]. Fatigue did not alter the structure of the fluctuations in this study. References [1]. Ashkenazy Y, Hausdorff JM, Ivanov, PC, Stanley HE (2002). *Physica A*, 316:662-670 [2]. Bollens B, Crevecoeur F, Nguyen V, Detrembleur C, Lejeune T (2010), *Gait & Posture* 32(3):369-373 [3]. Goldberger AL, Peng C-K, Lipsitz LA (2002), *Neurobiol Aging* 23(1):23-26 [4]. Hausdorff JM, Peng C-K, Ladin CK, Wei JY, Goldberger AL (1995), *J Appl Physiol* 78:349-358 [5]. Jordan K, Newell, KM (2008), *Exerc Spo Sci Rev* 36(4):200-204 [6]. Kang HG, Dingwell JB (2008), *Gait & Posture* 27(4):572-577 [8]. Terrier P, Dériaz O (2012), *Hum Mov Sci* 31(6):1585-1597 [9]. Jordan K, Challis JH, Newell KM (2007), *Gait & Posture* 26(1):128-134 [10]. Dierks TA, Davis IS, Hamill J (2010), *J Biomech* 43(15):2993-2998 [11]. Koblbauer IF, van Schooten KS, Verhagen EA, van Dieën JH (2014), *J Sci Med Sport* 17(4):419-424 [12]. Bohnsack-McLagan NK, Cusumano JP, Dingwell JB (2015), *J Biomech* in press

## GRADED DEEP WATER RUNNING IN WARM WATER ACCELERATES FATIGUE AND PEAK HEART RATE RESPONSES

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UNIVERSITY OF ATHENS

Introduction Deep water running (DWR), is an alternative mode of enhancing cardiorespiratory fitness in healthy athletes, and is used extensively in rehabilitation. Heart rate and perceived exertion in the water change significantly in DWR, compared to land running (Svendsen and Seger, 1992), but the effect of temperature still needs to be determined. This study was undertaken, to observe the effect of warm water temperature on heart rate (HR) responses, perceived exertion (RPE), and time to exhaustion during graded DWR. Methods Nine active men (22.2±3.1 years), wearing a flotation belt, performed two incremental deep water tests to exhaustion (at 24°C and 31°C), by increasing the stride frequency and/or the load in 3-min stages, in a cross-over design. Heart rate (HR), and ratings of perceived exertion (RPE), were continuously monitored throughout the stages. Blood pressure and lactate, were also measured before and after the tests. Data were analysed via a two-way repeated measures ANOVA test and paired t-tests, with post-hoc Bonferroni test when needed, at a  $p < 0.05$  level of significance. Results The length of time to exhaustion was significantly lower in warm versus cool water reaching stage 5.99±0.58 in warm, versus 7.13±0.72 in cool water ( $p = 0.007$ ). Peak HR occurred earlier in warm versus cool water, and was manifested at stage 5.56±0.53 in warm water versus 6.78±0.68, in cool water ( $p = 0.005$ ). Peak HRs were not different between the two conditions (175±4.5 vs. 174±3.4 bpm) in warm and cool water respectively ( $p = 0.88$ ). The RPE data showed no significant differences, and there was no indication that warm water was perceived to be more difficult than cold at any stage. Discussion Studies performed on DWR demonstrate suppressed maximal and sub-maximal cardiorespiratory responses when compared to land running (Dowzer et al., 1999). The effect of cool and warm temperature hasn't yet been seriously addressed in DWR target heart rate estimation (Barbosa et al., 2009; Frangolias and Rhodes, 1996). The accelerated manifestation of peak HRs in response to graded DWR, with no changes in RPE, coupled with the natural drop in heart rate (of up to 17 beats/min), when immersed in water, appear to underestimate exercise intensity during DWR, in warm water of 31°C. References Barbosa MT, Marinho DA, Victor M, Reis VM, Silva AJ, and José A. Bragada JA. (2009). *JSSM* 8, 179-189. Dowzer CN, Reilly T, Cable NT, Nevill A. (1999). *Ergonomics*. Feb;42(2):275-81. Frangolias DD, and Rhodes EC. (1996). *Med Sci Sports Exerc*. Sports Med Jul;22(1):38-53. Svendsen J, Seger J. (1992). *Med Sci Sports Exerc*. Oct;24(10):1155-60. Contact elenisoul@hotmail.com; esultan@phed.uoa.gr; niki.nikita70@yahoo.com

## Oral presentations

### OP-BN07 Training & Testing Technology

#### GOLF SWING ANALYSIS - THE CENTER OF MASS AS A VALUABLE DIAGNOSTIC PARAMETER

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Introduction There are several swinging techniques in golf which result in different movement sequences. Weight transfer can therefore be a very useful diagnostic parameter to measure differences between skill levels. Top coaches on the PGA Tour stated that the weight transfer is the most important factor within the golf swing [1]. This indicates a relevance for figuring out parameters which can be used by practitioners. So the objective of this study was to distinguish between experts and intermediate players by the variability of their golf swing. Methods The sequence of interest (SOI) of the golf swing was from take away to impact. Eight experts ( $n=4$  professionals and  $n=4$  with a HCP of  $-1.25 \pm 1.9$ ) and five intermediate players (HCP =  $-28.3 \pm 15.0$ ) were included. Outcome parameters were the traveled distance of the COP, the period of the SOI and the area of variation of the COP (AOV) around the address position during the SOI. The AOV is calculated as an ellipse. The axes of the ellipse are built by the standard deviation of the COP around the medio lateral axis and the anterior posterior axis during the movement. The analysis took place on a pressure distribution platform (4096 sensors with 300Hz; RScan International®). All subjects performed a neutral swing on the platform with a pitching wedge. For group comparison the Mann-Whitney U test was used. For correlation analysis the Spearman-Rho correlation coefficient was calculated. The level for statistical significance was set to  $p < 0.05$ . Results The period of the SOI was statistically significant shorter in the expert group ( $848.6 \pm 208.6$  ms) than in the intermediate group ( $1166.0 \pm 176.4$  ms) ( $p < .05$ ). The traveled path of the COP (expert group:  $211.2 \pm 49.6$  mm; intermediate group:  $227.4 \pm 44.0$  mm ( $p = .56$ )) and the AOV (expert group:  $11.9 \pm 9.5$  cm<sup>2</sup>; intermediate group:  $14.5 \pm 6.4$  cm<sup>2</sup> ( $p = .60$ )) did not show any statistical significant differences. Correlation analysis showed a statistical significant relationship between the HCP and the period of SOI ( $r = 0.64$ ,  $p < .05$ ). There is no correlation between the AOV and the HCP nor for the traveled distance of the COP and the HCP. Discussion Wrobel et al. 2012 [2] found out in the contrary that stated that good players have a decreased COP displacement in comparison to novice players. The reason why we found no difference was because our subjects were more skillful. The higher the quality of the players is the more complex it is to find differences between the skill level. The data show a shorter period of SOI which claims that this might be a relevant performance parameter for better players. References 1. Jenkins, S., *International Journal of Sports Science and Coaching*, 2008. 3, 29-51. 2. Wrobel, J.S. et al, *J Sports Sci Med*, 2012. 11(3): p. 452-8. Contact Florian Kreuzpointner, PhD kf@tum.de

## VALIDATION OF TWO BASED ACCELEROMETRY DEVICES FOR ESTIMATING ENERGY EXPENDITURE OF WALKING IN DIABETIC PATIENTS

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**Introduction** Nowadays, physical activity (PA) is recognised as non-therapeutic treatment for the prevention of diabetes mellitus (DM) and its complications. Basic recommendations are to practice a daily PA such as walking to improve or maintain health (Sigal et al, 2004). To optimise the effect of exercise, patients need to have an accurate estimation of PA dose by using daily energy expenditure or activity energy expenditure (AEE). Currently, it exists several commercially actimeters to estimate daily energy expenditure or AEE, such as the RT6. To the best of our knowledge, the validity and reliability of these sensors have never been evaluated in diabetic people. The aim of this study was to compare two methods for assessing the AEE in diabetic people with indirect calorimetry measurement. **Methods** Thirteen diabetic patients (3 males, 10 females; age =  $56.9 \pm 9.6$  years, BMI =  $27.9 \pm 2.4$ ) participated at the study. The subjects were asked to walk on a treadmill at various speeds (0.5, 0.75, 1, 1.25, and 1.5 m.s<sup>-1</sup>) in a randomized order with a 5 min rest period between two consecutive trials. One inertial sensor (MTW, Xsens, Culver City, USA) was placed at the hip and recorded the accelerations along three-axis at a sampling frequency of 75Hz. AEE was determined with a formulae proposed by Bouten et al. (1994) but with a customised gravitational component processing (method 1). The RT6 was placed at the contralateral hip (method 2). **Results** Method 1 presented no significant difference with the reference method for each speed of walking. Method 2 underestimated net EE at the lower speed of walking (0.5 m/s) ( $p < 0.05$ ). Inversely, it overestimated net EE during walking at fast speed (1.5 m/s) ( $p > 0.001$ ). When all trials were pooled, the two sensors gave accurate estimation of AEE with standard error of measurement of 0.85 and 0.63 kcal/min for the method 1 and method 2, respectively. **Discussion** Although, method 2 showed a good overall standard error of measurement, method 1 presented a better agreement for each walking speed. Thus, further studies could be conducted to test validity and usefulness of this methods to estimate AEE in diabetic everyday life under free-living conditions. **References** : - Bouten CV, Westerterp KR, Verduin M, Janssen JD. (1994). *Med Sci Sports Exerc*, 12, 1516-1523. - Sigal RJ, Kenny GP, Wasserman DH, Castaneda-Sceppa C. (2004). *Diabetes care*. 27(10):2518-2539. Contact Nathan.caron@univ-reunion.fr

## ACCURACY OF ANKLE AND KNEE ANGLE MEASUREMENTS WITH THIN FLEX SENSORS

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**Introduction** The accurate determination of joint angles is an important tool for biomechanical research. Electronical goniometers are cheap and easy to use but, in some situations, their application is complicated. For instance, in alpine skiing, the thickness of goniometers precludes mounting within ski boots, impeding the reliable acquisition of ankle joint angles. Externally fixed goniometers are also prone to damage, e.g. through impacts with external objects such as flex poles. Flex sensors feature a thickness of 0.4 mm only and may, therefore, represent an alternative when the use of conventional goniometers is not feasible. The aim of this study was to determine the accuracy of knee and ankle joint angles as measured by flex sensors during deep squats. **Methods** Three subjects (age  $21.3 \pm 1.6$  yrs, height  $1.72 \pm 0.09$  m, mass  $68.1 \pm 3.1$  kg) performed 6x15 repetitions of deep squats. After completion of 2 series, movement speed was gradually increased from 15-45 repetitions per minute. Movement speed was controlled through the use of an electronic metronome. The 11.4 cm long flex sensors (Spectra Symbol, SEN-08606, Salt Lake City, UT) were attached on both legs, across (i) the tibiotalar joint (from the navicular bone to the distal end of the tibia) and (ii) the knee joint (along the popliteal fossa). The attachment sites were chosen to allow longitudinal motion of the sensors. Data were sampled at 1500 Hz and transmitted wirelessly to a recording system (Telemyo 2400T G2, Noraxon, USA). Reference measures were acquired with an active three camera motion capturing system sampling at 100 Hz (AS 200, LUKOtronic, Austria). Optical data of the right and left leg were separately recorded and manually synchronized with the flex sensor recordings. The maximum and standard deviation (SD) of differences between the data obtained with both systems were calculated as measure of accuracy of the flex sensors. **Results** Across the six deep squat series, the mean ranges of movement in ankle and knee joint were  $39^\circ$  and  $94^\circ$ , respectively. For the ankle and knee joint, the mean of the maximum differences between the measures obtained by flex sensors and motion analysis were  $9.1^\circ$  (23.6%) and  $13.1^\circ$  (14.0%), respectively. The mean of the SDs of differences were  $2.9^\circ$  (7.5%) and  $4.0^\circ$  (4.3%). Measurement accuracy was independent of movement speed. **Discussion** The flex sensors yielded a satisfactory accuracy for measurements of ankle and knee angles. Therefore, they may be used as low-cost system for angle measurements that may be applied where usage of electronic goniometers is not feasible due to space constraints or risk of damage. However, it should be noted that conventional goniometers feature superior accuracy and should be used when high measurement precision is required. Contact kurt.schindelwig@uibka.c.at

## IMU-BASED FIELD DIAGNOSIS FOR JUMPING AND SPRINTING IN TRACK AND FIELD EVENTS

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**Introduction** In highly dynamical sports, such as track and field, athletes must be able to generate high forces within a very short time. Temporal parameters like stance and flight durations during jumping and sprinting represent main indicators of performance (Slawinski et al., 2010). Objective feedback of these parameters is crucial to ensure a high quality of training as sprinting and jumping performance cannot be assessed precisely enough by pure observation or over longer distances. In this study, we present an IMU-based wearable measurement system for field-based performance analysis and online monitoring for a group of athletes, that allows an accurate in-field detection of temporal parameters in track and field events. **Methods** For the group monitoring of stance durations (tS) in field-based conditions a wearable measurement system including inertial sensors (IMU), a microcontroller unit, a detection algorithm and an Android™ application was developed. Evaluation studies included 18 participants for Dropjumps (DJ) as well as 12 participants for sprints (SP). Reference measures were a force plate, a contact mat and the Optojump™ system (OJ), respectively. For statistical analyses, absolute differences and Bland-Altman-Plots (BAP) of tS between IMU and reference measurements were calculated. **Results** Throughout the DJ protocol participants executed an overall of 204 jumps including 194 correct detections (95%). Mean absolute difference for tS was  $4.7 \pm 3.5$  ms and BAP 95% limits of agreement (LoA) ranges from 13 to -7.3 ms. Out of 380 contacts during sprinting, 364 were detected correctly (96%). tS showed a mean absolute difference of  $4.3 \pm 3.2$  ms between OJ and IMU. BAP derive LoA in the range from 6.8 to -11.8 ms. **Discussion** The IMU device provides reliable and accurate measurements of stance and flight durations and can be considered as a suitable tool for jump and sprint diagnostics. The accuracy of the system is higher compared to previous studies (e.g. Bergamini et al.,

2012). Overall, the system enables providing objective real-time feedback for a group of athletes during a training session or competition and can overcome restrictions in measurement range as it offers precise results over an entire competition distance (e.g. 400m). Therefore it supports expanding opportunities to analyze human performance in field-based settings that may offer a considerable contribution to enhance the quality of training and lead to a deeper understanding of performance in track and field events. References Bergamini, E., Picerno, P., Pillet, H., Natta, F., Thoreux, P., & Camomilla, V. (2012). *J. Biom.*, 45(6), 1123-1126. Slawinski, J., Bonnefoy, A., Leveque, J. M., Ontanon, G., Riquet, A., Dumas, R. (2010). *J Strength Cond Res*, 24(4), 896-905.

## THE VALIDITY AND INTER-DEVICE VARIABILITY OF THE APPLE WATCH FOR MEASURING MAXIMAL HEART RATE

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**Introduction** Maximal heart rate (HR<sub>max</sub>) is a fundamental measure used in exercise prescription (Achten and Jeukendrup, 2003), yet its measurement during free-living conditions using a chest strap telemonitoring device is not always feasible. The Apple Watch can measure heart rate using an optical sensor. However, the validity and inter-device variability of the Apple Watch heart rate sensor are unknown. **Methods** Fifteen participants aged 32(10) y completed an incremental maximal oxygen uptake test (0.5 km.h<sup>-1</sup> every 30 s) on a motorised treadmill while wearing a first generation Apple Watch (OS 2.0.1) on each wrist. Heart rate data were recorded every 5 s on each watch using the 'Workout' app. Heart rates and sampling times were retrieved via a bespoke iPhone app written in Xcode 7.2.1 using the Apple HealthKit framework (Apple, Inc). Criterion HR<sub>max</sub> was measured using a Polar chest strap interfaced to a Cortex Metalyzer 3B metabolic cart. The highest 30 s mean heart rate was used as the criterion value. All data were log-transformed. Apple Watch validity (N = 13) is reported as a Pearson correlation (r), standardised mean bias, and standardised typical error. Inter-device variability is reported as the typical error (%CV) and intra-class correlation (ICC). Uncertainty is reported as 90% confidence intervals. All data were analysed using custom-designed Microsoft Excel spreadsheets (Hopkins, 2015). **Results** Mean (SD) HR<sub>max</sub> were 183(12) and 182(12) beats.min<sup>-1</sup> for the left and right watches, respectively (mean difference -1 [90%CI: -4 to 2]). Mean (SD) HR<sub>max</sub> as measured by the Polar chest strap was 180(12) beats.min<sup>-1</sup>. There were very large to nearly perfect correlations between the watches and criterion (left: r = 0.87 [90%CI: 0.67 to 0.95]; right: r = 0.98 [90%CI: 0.94 to 0.99]). Standardised mean bias for the left and right watches compared to the criterion were 0.14 (90%CI: -0.12 to 0.39; trivial) and 0.04 (90%CI: -0.07 to 0.15; trivial). Standardised typical error for the left and right watches compared to the criterion were 0.51 (90%CI: 0.38 to 0.80; small) and 0.22 (90%CI: 0.16 to 0.34; small). Inter-device typical error was 2.9% (90%CI: 2.2 to 4.2), ICC = 0.84 (90%CI: 0.65 to 0.93). **Discussion** The Apple Watch displays high criterion validity for measuring HR<sub>max</sub> compared to the widely accepted Polar chest heart rate monitor. The mean bias and typical errors are trivial and small, respectively. Inter-device variability in HR<sub>max</sub> measured by the Apple watch is low, when worn simultaneously on different arms. References Hopkins, W. G. (2015). *Sportscience*, 19, 36-42 ([sportsci.org/2015/ValidRely.html](http://sportsci.org/2015/ValidRely.html)). Achten, J. and Jeukendrup, A. E. (2003). *Sports Medicine*, 33(7), 517-538. Contact [g.abt@hull.ac.uk](mailto:g.abt@hull.ac.uk); [amanda.benson@rmit.edu.au](mailto:amanda.benson@rmit.edu.au)

## COMBINED DIFFUSION TENSOR AND MAGNETIC RESONANCE IMAGING FOR IN VIVO ASSESSMENT OF HUMAN MUSCLE FUNCTION

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**Introduction** Muscle fiber direction strain provides invaluable information for characterizing muscle function. Methods that allow its assessment in human muscles in vivo are scarce. Combining magnetic resonance (MR) imaging based deformation analyses (Yaman et al., 2013) with diffusion tensor (DT) imaging based tractography, we aimed at assessing muscle fiber direction local tissue deformations within the human medial gastrocnemius (GM) muscle caused by (A) passive knee extension and (B) submaximal isometric contraction. **Methods** Healthy female subjects (n=5) were positioned prone within the MR scanner using a custom-made test apparatus with the ankle angle fixed at 90°. Sets of 3D high resolution MR, and DT images were acquired in three subsequent conditions: (1) in relaxed state, when the knee was brought to flexion (140.8±3.0°) and (2) after it was extended (177.0±1.0°). (3) During sustained isometric plantarflexion at 15% of maximum voluntary contraction. Tractography and Demons nonrigid registration algorithm were utilized to calculate local deformations along GM muscle fascicles comparing (2) to (1), and (3) to (2). Therefore, effects of imposed passive knee extension and submaximal isometric contraction were assessed, respectively. For each experimental condition separately, the reference image sets were also transformed by a synthetic rigid body motion to quantify algorithm artifacts. **Results** Mean artifacts were significantly smaller than mean fiber direction strains (for passive knee extension, lengthening: 0.2±0.1% vs. 8.7±8.5%, shortening: 3.3±0.9% vs. 7.5±4.6%; for submaximal isometric contraction, lengthening: 1.9±1.0% vs. 16.0±9.3%, shortening: 1.8±0.9% vs. 4.0±3.7%). Passive knee extension caused shortening and lengthening (up to 23.3% and 116.7%, respectively) to occur simultaneously along individual fascicles despite imposed GM lengthening. Similarly, submaximal isometric contraction, caused shortening and lengthening (up to 108.9% and 23.6% respectively) to occur simultaneously along individual GM fascicles. Mean fiber direction strains of different tracts also show heterogeneity. **Discussion** MR and DT imaging analyses combined presents a powerful tool for quantifying deformation along human muscle fibers in vivo. Non-uniformity of fiber strain indicates sarcomere length heterogeneity and can be explained by epimuscular myofascial force transmission (Yucesoi, 2010). Sarcomere is the key functional element. Therefore, the methodology developed is relevant for assessment of normal and pathological muscle function, mechanisms of treatment techniques and ergonomics. TUBITAK grant (111E084) is acknowledged. References Yaman, A., et al. 2013. *J Biomech Eng* 135(9): 91003. Yucesoi, C. A. 2010. *Exerc Sport Sci Rev* 38(3): 128-134. Contact [agahkarakuzu@gmail.com](mailto:agahkarakuzu@gmail.com)



## Oral presentations

### OP-PM20 Soccer Training

#### RESISTANCE TRAINING STATUS AND EFFECTIVENESS OF LOW FREQUENCY RESISTANCE TRAINING ON UPPER-BODY STRENGTH AND POWER IN SOCCER PLAYERS.

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ASPETAR

1: ASPETAR (Doha, Qatar), 2: AUT University (Auckland, New Zealand) Introduction Soccer is classified as a contact/collision sport with many player-to-player duels. Winning these duels, shielding the ball or fending off an opponent requires upper-body strength and power. Therefore, the purpose of the study was, a) to examine upper-body strength and power changes in elite soccer players with different resistance-training (RT) status, b) to investigate if the RT status influences performances throughout an entire competitive season. Methods Twenty-eight elite young male soccer players (age  $18 \pm 1$  years, height  $178 \pm 5$  cm, body mass  $71 \pm 7$  kg) participated in this study and were divided into a trained (TG;  $n=14$ ) and a novice (NG;  $n=14$ ) group, according to their RT status (Rhea et al., 2003). Both groups performed the same upper-body RT once a week besides the soccer-specific team training over 30 weeks. Maximal strength was assessed via one repetition maximum (1RM) for bench press (BP) and bench row (BR) before (T1), after 10 weeks (T2) and the competitive season (T3). Maximal power (MP) was assessed in the BP exercise only. Results At T1, TG presented significant and moderately greater 1RM in BP ( $+9.9 \pm 10.2\%$ ; effect size,  $ES=1.0$ ) and MP ( $+14.0 \pm 13.1\%$ ;  $ES=1.1$ ) than NG. There was no between-groups difference in 1RM for BR. At T2 and T3, both groups showed significant improvements in the 1RM. The magnitude of changes was small (TG;  $+5.9 \pm 2.6\%$ ;  $ES=0.3-0.4$ ) and large (NG;  $+11.7 \pm 3.2\%$ ;  $ES=0.9-1.3$ ) at T2 and increased to moderate (TG;  $+13.4 \pm 3.1\%$ ;  $ES=0.7-0.9$ ) and very large (NG;  $+20.6 \pm 3.8\%$ ;  $ES=1.8-2.1$ ) at T3. There is no change in MP at T2 and moderate improvement at T3 ( $+13.0 \pm 5.8\%$ ;  $ES=1.1$ ) for NG. TG presented a significantly small decrement at T2 ( $-11.6 \pm 3.9\%$ ;  $ES=0.4$ ) and small improvement at T3 ( $+7.7 \pm 4.9\%$ ;  $ES=0.3$ ). At T2 and T3, there was no between-groups difference in 1RM while MP remained moderately greater for TG. Discussion The players with less RT experience presented a greater rate of improvement in maximal strength after 10 weeks only (Kraemer et al., 2004), notwithstanding a low RT frequency; while maximal power was not affected positively over the same time. One RT session per week is considered as an effective frequency for muscular strength and power maintenance (ACSM, 2009), however our results show that RT throughout a competitive season may elicit substantial improvement in upper-body maximal strength and power regardless of players' RT status. References Rhea, MR, Alvar, BA, Burkett, LN, Ball, SD. (2003). Med. Sci. Sports Exerc. 35(3): 456-64. Kraemer, WJ, Ratamess, NA. (2004). Med. Sci. Sports Exerc. 36(4): 674-88. American college of sports medicine. (2009). Med. Sci. Sports Exerc. 41(3):687-708. Contact maxime.hertzog@aspetar.com

#### ISOKINETIC STRENGTH QUALITIES THAT DIFFERENTIATE RAPID DECELERATION PERFORMANCE IN ACADEMY MALE YOUTH SOCCER PLAYERS

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Introduction Decelerating (DEC) is just as frequent as accelerating in contemporary soccer match play (Russell et al., 2014). Recent evidence suggests that lower body eccentric strength directly improves the ability of a player to produce and tolerate braking forces (Spiteri et al., 2014). The aim of the present study was to identify if measures of isokinetic strength can differentiate performance of a rapid DEC maneuver. Methods Nineteen ( $n=19$ ) academy youth soccer players (age:  $16.7 \pm 1$  yrs; height:  $175 \pm 8.4$  cm; body mass:  $69.1 \pm 7.5$  kg; body fat:  $9.5 \pm 3.9\%$ ) participated in the study. Tests included: isokinetic dynamometer (Cybex International Inc., New York, USA) strength profiling of quadriceps (Q) and hamstring (H) peak concentric (con) and eccentric (ecc) torque (both dominant [kicking leg] and non-dominant legs) assessed at slow ( $60^\circ/\text{s}$ ) and fast ( $180^\circ/\text{s}$ ) angular velocities. Functional H:Q ratios representative of knee flexion (Hcon:Qecc) and extension (Hecc:Qcon) was also calculated; 30m linear sprint time (with 5m, 10m and 20m splits) was recorded using a single beam timing system (Witty, Microgate, Italy) and rapid DEC quantified using time to stop (TTS) and distance to stop (DTS) determined following a 20m maximal acceleration (within 5% threshold of best 20m linear sprint time) using video analysis (Dartfish, Fribourg, Switzerland) captured from a 50Hz video camera (Panasonic HDC-HS900, Japan). Results 10, 20 and 30m sprint times had moderate to large correlations with fast con peak Q and H torque. Slow velocity con peak H torque in dom leg had moderate to large correlations with 10, 20 and 30m sprint times. No significant correlations were found for peak con strength in either Q or H for DEC performance (TTS and DTS). Slow velocity ecc peak Q torque and time to peak torque was significantly correlated to DEC TTS. No significant correlations were found for fast ecc strength parameters in Q or H for either sprint or DEC performance. Sprint and DEC performance had no significant correlations. Discussion Players with superior sprint speed can produce high peak con forces in both Q and H at fast velocities. DEC seems to be a unique movement skill requiring specific ecc strength qualities. Interestingly, in this study slow velocity ecc strength of the Q seems to be critical for production of braking forces and reducing the time spent DEC. In conclusion this study highlights the need for careful consideration to developing specific strength qualities needed for DEC alongside those more commonly known for sprinting and accelerating. References Russell, M., Sparkes, W., Northeast, J., Cook, C. J., Love, T. D., Bracken, R. M., & Kilduff, L. P. (2014). J of Strength & Cond. Research, in press. Spiteri, T., Nimphius, S., Hart, N. H., Specos, C., Sheppard, J. M., & Newton, R. U. (2014). J of Strength & Cond. Research, 28(9), 2415-23.

#### THE RELATIONSHIP BETWEEN PRE-SEASON WORKLOAD INDICATORS AND CHANGES IN THE YO-YO INTERMITTENT RECOVERY TEST IN PROFESSIONAL SOCCER

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Aim In pre-season, a main objective is to develop aerobic fitness to prepare for the competitive season. Workload monitoring can aid in maximizing training adaptations. However, it remains unclear which workload indicators best relate to changes in fitness in professional soccer [1]. Therefore, the aim was to examine the association between workload indicators and changes in the Yo-Yo intermittent recovery test. Methods During the first 2 weeks of pre-season, both external (total distance, distance covered in velocity zones (15-20 km/h, 20-25 km/h and >25 km/h) and PlayerLoad™) and internal (sRPE multiplied by duration) training and match load were collected in 15 professional soccer players (mean age  $\pm$  SD:  $22.2 \pm 3.6$  years). A submaximal Yo-Yo intermittent recovery test level 1 (sYYIRT1; a duration of 8

minutes and 58 seconds, up to 8 repetitions at 15 km/h) was performed at baseline and 2 weeks thereafter. Cumulative workloads over 2 weeks as well as in the week preceding the second sYIRT1 were related to relative changes in average heart rate over the last 60 second (HReX) of sYIRT1. Pearson correlations were used to assess relations. Results A significant lower average heart rate ( $p < 0.01$ ) was observed during the second sYIRT1 ( $167,9 \pm 7,7$  beats/min) compared to the first test ( $179,8 \pm 8,2$  beats/min). More distance covered in velocity zone 15-20 km/h in the week preceding the second sYIRT1 was related to a negative percentage change in HReX ( $r = -0.64$ ,  $p < 0.05$ ). Other indicators were not significantly related to changes in HReX. Conclusion Distance covered in velocity zone 15-20 km/h in the week preceding the second sYIRT1 is related to improvements in fitness during pre-season. The Yo-Yo test performance is positively related to distance covered above 15 km/h in professional matches [2]. A similar type of workload (15-20 km/h) in turn appears to result in a beneficial stimulus for the physical capacity in intermittent exercise. Careful planning of distance covered in the 15-20km/h velocity zone should be considered to optimize training regimes during pre-season. References 1. Akubat, I., et al., Methods of monitoring the training and match load and their relationship to changes in fitness in professional youth soccer players. *J Sports Sci*, 2012. 30(14): p. 1473-80. 2. Bangsbo, J., F.M. Iaia, and P. Krstrup, The Yo-Yo intermittent recovery test : a useful tool for evaluation of physical performance in intermittent sports. *Sports Med*, 2008. 38(1): p. 37-51.

## CHANGES IN TRAINING LOAD, FITNESS, POWER AND BIOCHEMICAL CHARACTERISTICS THROUGHOUT PROFESSIONAL RUGBY UNION SEASON IN BACK PLAYERS.

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Introduction Elite rugby game induces acute fatigue (inflammatory, catabolic states and muscle damages) which requires between 2 and 5 days to return to baseline level (McLellan, 2010). Furthermore, the game frequency and the duration of the competitive period may result in chronic fatigue illustrated by biochemical disturbances as well as a predominance of catabolic process (Banfi et al., 2006). Consequently, it appears essential to monitor and manage training load (TL) throughout a professional rugby season in order to optimize physical performance and reduce injury risk. Therefore, the aims of this study were quantifying TL throughout a professional rugby season and observed, in parallel, changes in physical performance and biochemical characteristics. Methods Eight professional rugby union back players participated in this study. Weekly TL was assessed through 2 methods: S-RPE (Foster et al., 2001) and GPS technology (minimax S4, Catapult). Physical performances were evaluated by 5 YoYo recovery test level 2 (YYRT2) and 27 drop jump tests (DJ). Biochemical characteristics were assessed through three blood samplings were carried out in the first, the middle and the last part of the season. Results - Weekly TL (S-RPE) progressively decreased ( $p < 0.001$ ), especially due to a decrease ( $p < 0.001$ ) in training volume throughout the season. - External TL parameters (GPS) revealed a progressive reduction in total distance travelled ( $p < 0.001$ ). However, no significant change was observed for the high-speed running (HSR) distances, but the average speed of HSR significantly increased ( $p < 0.001$ ) over the season. - YYRT2 performances were not significantly changed during the season. - Negative significant correlations were found between training volume parameters and  $\Delta DJ$  ( $r = -0.49$ ,  $p < 0.001$ ), whereas intensity parameters showed positive correlation ( $r = 0.38$ ;  $p < 0.01$ ). - The blood cell and reticulocyte concentrations significantly increased during the last part of the season ( $p < 0.05$ ). The cortisol concentration was also significantly increased ( $p < 0.05$ ). However, the testosterone/cortisol ratio was not significantly changed. Discussion The TL decrease does not seem to affect fitness level, conversely, it may permit to optimize power production. Furthermore, this decrease may permit to avoid overreaching states (related to the biochemical state) likely to be induced by the accumulation of matches and training stress. It may also contribute to the final victory of the team studied. Références Banfi G, Fabbro MD, Mauri C, Corsi MM, Melegati G. (2006). *Clin Lab Haem* 28(3):183–8. Foster C, Florhaug, Franklin. (2001) *JSCR* 15(1) 109-15. McLellan CP, Lovell DI, and Gass GC. (2001) *JSCR* 25(4):1030-39.

## A COMPARISON OF SLEEP CHARACTERISTICS DURING WEEKLY IN-SEASON COMPETITION VS PRE-SEASON TRAINING IN AUSTRALIAN RULES FOOTBALLERS

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Introduction: Team-sport athletes experience impaired sleep on the night of matches (Fullagar et al., 2016) and during periods of high training stress (Killer et al., 2015). However, the period observed is either isolated to training or competition and is short in duration. Thus, the aim of this study was to compare sleep habits of Australian Rules Footballers (ARF) across the season incorporating pre-season training and weekly competition. Methods: Eight professional ARF had sleep assessed during in-season (IS) competition (11±4 4-day periods) and pre-season (PS) training (8-days). Time in bed (TIB), total sleep time (TST), sleep efficiency (SE; TIB/TST), sleep onset latency (SOL) and wake after sleep onset (WASO) was measured by wristwatch actigraphy. Paired t-tests were conducted to compare PS to IS sleep and one-way repeated measures ANOVA ( $P < 0.05$ ) to compare IS nights' sleep between the night before a match (MN-1), match night (MN) and two recovery nights (RN1 and RN2). Tukey post-hoc analysis was run to identify true differences. In addition, Cohen's effects sizes (d) were used to interpret the magnitude of difference. Results: Although TIB was similar (IS:  $507 \pm 83$  min, PS:  $494 \pm 63$  min,  $P = 0.277$ , ES 0.12), TST was greater during IS ( $458 \pm 77$  min vs.  $432 \pm 57$  min,  $P = 0.017$ , ES 0.26), resulting in higher SE ( $90.2 \pm 3.2\%$ , vs.  $87.7 \pm 6.3\%$ ;  $P < 0.001$ , ES 0.39). During IS, MN-1 TIB was longer than MN (30%), RN1 (6%) and RN2 (8%). Further, TIB was longer during RN1 (18%) and RN2 (17%) vs. MN. Similarly, MN-1 TST was longer vs. MN (32%), RN1 (8%) and RN2 (10%). Additionally, TST was longer during RN1 (18%) and RN2 (17%) vs. MN. SE was higher for MN-1 vs. RN1 (1.5%) and RN2 (1.6%), while, WASO was shorter during MN vs. RN1 (-19%) and RN2 (-19%), and SOL only shorter for MN-1 vs. RN2 (-36%). Conclusion: While ARF sleep longer IS compared to PS it appears they also increase TST by ~2h the night before games, incur reduced sleep on match nights and subsequently repay this sleep loss in the following recovery nights. The presence of reduced sleep during PS and following MN may allow practitioners to target specific seasonal periods so as to maximise sleep opportunities. References: Fullagar, H. H., Skorski, S., Duffield, R., Julian, R., Bartlett, J. & Meyer, T. 2016. *J Sports Sci*, 1-7. Killer, S. C., Svendsen, I. S., Jeukendrup, A. E. & Gleeson, M. 2015. *J Sports Sci*, 1-9.

## Oral presentations

### OP-SH09 Psychology: Behavior & Social Support

#### DOES THE PHYSICAL ENVIRONMENT MODERATE THE EFFECTS OF HIGH INTENSITY EXERCISE ON AFFECTIVE STATES?

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**Introduction** The physical environment and moderate intensity physical activity can independently (Thompson Coon et al., 2011) and collectively (Kinnafick & Thøgersen-Ntoumani, 2014) improve affective states. High intensity or supra-threshold exercise has been shown to provide physiological benefits in previously inactive adults (Shepherd et al., 2015). However, it has been argued, using the Dual Mode Theory, that negative changes to affect occur at supra-threshold intensities (Ekkekakis, Parfitt, & Petruzzello, 2011). However, it is unknown if the physical environment moderate the effects of high intensity exercise on affective states. The current study investigated the effects of two opposing environments (urban versus natural) and 2 types of high intensity activity (continuous and High Intensity Interval Training) on affective states within a laboratory setting compared to a control condition (sitting). **Methods** Using an experimental within subject design, 24 (9 females, 15 males; BMI: 21.34 kg/m<sup>2</sup>, SD = 2.91; age: 22.25 years, SD = 4.28) physically inactive participants, completed all 6 counter balanced conditions in a laboratory setting over a 4 week period. Participants were asked to cycle at >90% HRmax, on a Wattbike, for either 4 minutes of continuous exercise or for 8 repeated 30 second sprints, interspersed with 30 seconds of active recovery whilst watching video clips of either a natural or urban environment. Participants also watched each clip whilst sitting for 4 minutes as a control condition. Measures of affect (Feeling Scale, Felt Arousal Scale, Rate of Perceived Exertion (RPE) and perceived pain) were administered pre, mid, post and following 10 minutes of recovery after each condition. Positive and negative affect (PANAS) were also assessed pre, post and following a 10 minute recovery period. A 3 way (Environment x 2, Time x 3, intensity x 3) repeated MANOVA was used to analyse the data. **Results** Preliminary findings indicate that exercising at high intensity, regardless of whether it is continuous or HIT increases negative affect ( $p < 0.01$ ), reduces positive affect ( $p < 0.01$ ) and reduces positive feelings (FS;  $p < 0.05$ ) compared to sitting. However, results show that being exposed to a natural, as opposed to an urban, environment lessens the negative impact of HIT on negative affect and RPE ( $p < 0.05$ ). **Discussion** High intensity exercise can lead to increases in negative affect, thus supporting propositions of the Dual Mode Theory. However, when physically inactive adults choose to engage in HIT, it is important to consider the role of the physical environment, specifically natural open space, in an attempt to reduce the magnitude of negative affect.

#### ESSENTIAL COMPETENCIES IN CONTEMPORARY APPLIED SPORT PSYCHOLOGY: SOUTH AFRICAN AND UNITED KINGDOM PERSPECTIVES

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Investigation of essential competencies in present-day sport psychology practice is critical to keeping the training, education and regulation standards of applied sport psychology (ASP) practitioners at the forefront of research (Fletcher & Maher, 2013) as well as to offering a new rationale for promoting academic inquiry in developed and developing contexts (Edwards & Barker, 2015). This study focused on identifying essential competencies in contemporary sport psychology practice and exploring the comparative views of a purposefully selected sample ( $n=9$ ) of expert ASP practitioners/psychologists. Data were gathered by means of semi-structured interviews with stakeholders in South Africa (SA) and the United Kingdom (UK). Interview data were analyzed using thematic content analyses. Main findings suggested that a relational and dependable character, a client-centered focus, an all-encompassing counselling skills-set (facilitative and restorative), and explicit expertise in the domains of psychology, sport and sport science are indispensable to current sport psychology practice. Views generated by both stakeholders were remarkably similar and overlapped extensively, which indicated the advanced levels of sport psychology praxis in both contexts. The recommendation arising from the results is that behavioural indicators (personal character) and certain skills prerequisites merit special consideration for candidates entering ASP training and practice. An interdisciplinary training model in ASP with acquired competency in both kinesiology/sport science and psychology-based training should become the accepted standard in the training and development of practitioners for the purpose of garnering an inclusive capacity to render client-centred services. **REFERENCES** Edwards, D., & Barker, J. (2015). Practitioners' perceptions of sport and exercise psychology in South Africa and the United Kingdom. *African Journal for Physical Health Education, Recreation and Dance*, 21(2), 619-637. Fletcher, D., & Maher, J. (2013). Toward a competency-based understanding of the training and development of applied sport psychologists. *Sport, Exercise, and Performance Psychology*, 2(4), 265-280. doi:10.1037/a0031976

#### DEVELOPMENT AND VALIDATION OF THE EXERCISE SOCIAL SUPPORT QUESTIONNAIRE

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**Development and Validation of the Exercise Social Support Questionnaire** **Introduction** Social support plays an important role in understanding exercise behavior. The measurement of social support should be specific in different research domain. However, exercise specific social support measurement is not available in Chinese, which creates a critical barrier to an accurate understanding of this topic in Chinese population. The purpose of the current study was to develop and validate an exercise social support questionnaire (ESSQ) for Chinese adults. **Methods** Qualitative research (semi-structured interviews, experts' consultation, etc.) was firstly conducted to establish the item pool of the initial scale. Questionnaire administration consisted of 2 phases. During phase 1, 378 valid responses were obtained (participants age=25.13±7.63, 56% male and 44% female). The factorial structure of the measure was explored using exploratory factor analysis (EFA). Moreover, internal consistency as well as test-retest reliability was examined. In phase 2, 419 valid responses were acquired (participants age=33.50±10.78, 44.3% male and 55.7% female). Confirmatory factor analysis (CFA) was employed to validate the structure of the ESSQ. Additionally, criteria validity tests (with general social support, physical exercise, etc.) were also adopted for assessment of the sensitivity of the ESSQ. **Results** Following the procedure of qualitative research as abovementioned, 36 items were generated for subsequent quantitative study. The quantitative research results indicated: (1) According to the outcome of EFA, the ESSQ consisted of 4 dimensions, namely emotion, information, instrument and companion support, with 6 items for each dimension. Moreover, the

test-retest reliability ( $r=0.74-0.89$ ) and internal consistency ( $r=0.75-0.94$ ) were all fairly good. (2) Based on the model fit indices of CFA, its construct was further validated (e.g., NNFI=0.943, CFI=0.949, NFI=0.938, RMSEA=0.078, SRMR=0.086). In terms of its criteria validity, exercise social support was significantly correlated with general social support ( $r=0.29$ ,  $p<0.01$ ); moreover, it was more specific in the exercise domain which correlated higher with exercise behavior ( $r=0.28$ ,  $p<0.01$ ). Discussion In present study, the ESSQ was preliminarily developed and validated. Moreover, compared with general social support scale, the newly developed questionnaire had its unique merit for application under the context of exercise in the Chinese population. Future studies should examine the validity of this ESSQ across different Chinese populations and establish normalized standard, as well as explore the role (e.g. serving as moderating or mediating variable) of social support in understanding exercise behavior among Chinese people. Contact: 15484874@life.hkbu.edu.hk

## THE PREDICTION OF PROACTIVE PERSONALITY AND SOCIAL SUPPORT ON TAIWAN FEMALE PROFESSIONAL GOLFERS' CAREER SATISFACTION

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**Introduction** Proactive personality is considered a "stable disposition to take personal initiative in a broad range of activities and situations" (Bateman & Grant, 1993). Previous studies have highlighted the importance of proactive personality in fostering individual's career satisfaction in the workplace (Seibert, Crant, & Kraimer, 1999). However, only a few studies explored athletes' career satisfaction in professional sports. In addition to personality, environmental factors also play an important role on career satisfaction. Therefore the purpose of this study was to examine the predictive utility of proactive personality and social support on Taiwan ladies professional golfers' career satisfaction. **Methods** Forty-five female professional golfers (Mage = 32.36, SD = 12.96) were requested to complete inventories that assess proactive personality (Seibert et al., 1999), social support, and career satisfaction (Greenhaus, Parasuraman, & Wormley, 1990). Research data were analyzed by Pearson's correlation and multiple stepwise regression. **Results** Proactive personality ( $r = .35$ ,  $p < .05$ ) and social support ( $r = .31$ ,  $p < .05$ ) was positively associated with career satisfaction. Multiple regression analyses indicated that proactive personality ( $R^2=12.2\%$ ) and social support ( $R^2=9.4\%$ ) positively predicted career satisfaction. **Discussion** The finding of the study shown that proactive personality positively predicted female golfers' career satisfaction, which is consistent with the results of Li, Wang, Gao, & You (2015) that used school teachers as participants. In other words, female professional golfers who had higher proactive tend to reported greater career satisfaction. In addition, social support positively predicted career satisfaction. Therefore based on the results of the study, cultivate proactive attitude could help professional golfers having greater career satisfaction. Moreover, giving professional golfers more encourage and support to enhance career satisfaction is recommended in the future. **References** Bateman, T. S., & Crant, J. M. (1993). The proactive component of organizational behavior: A measure and correlates. *Journal of organizational behavior*, 14(2), 103-118. Greenhaus, J. H., Parasuraman, S., & Wormley, W. M. (1990). Effects of race on organizational experiences, job performance evaluations, and career outcomes. *Academy of management Journal*, 33(1), 64-86. Li, M., Wang, Z., Gao, J., & You, X. (2015). Proactive Personality and Job Satisfaction: the Mediating Effects of Self-Efficacy and Work Engagement in Teachers. *Current Psychology*, 1-8. Seibert, S. E., Crant, J. M., & Kraimer, M. L. (1999). Proactive personality and career success. *Journal of applied psychology*, 84(3), 416.

## FACTORS THAT INFLUENCED THE EFFECTIVENESS OF RECEIVED SUPPORT IN SPORT

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**Introduction** The presence of supportive relationships is crucial in health and sporting contexts. Paradoxically, the actual receipt of supportive behaviours from these relationships is sometimes ineffective or even detrimental. One explanation for this is that the amount of support individuals receive should meet what they want. Therefore, the aim of this study was to examine whether the interaction of wanted and received support influenced psychological and performance outcomes. **Methods** A convenience sample of 226 university students who were novice golfers completed a questionnaire assessing how much support they would want prior to a golf-putting task. Participants who wanted high levels of support ( $n = 44$ ) and those who wanted low levels of support ( $n = 44$ ) were randomly assigned to receive either a support manipulation or control group, before completing measures of self-confidence and affect, and executing 10 golf putts. **Results** A 2 (wanted support: high, low) by 2 (manipulation: support, control) between-subjects ANCOVA (controlling for gender) was conducted. Significant interactions of wanted support and received support were only found on psychological outcomes (self-confidence:  $F(1, 83) = 39.15$ ,  $p < .001$ ,  $\eta^2 = .32$ ; positive affect:  $F(1, 83) = 1542.02$ ,  $p < .001$ ,  $\eta^2 = .35$ ; negative affect:  $F(1, 83) = 10.60$ ,  $p < .005$ ,  $\eta^2 = .11$ ), but not performance (mean distance:  $F(1, 83) = .80$ ,  $p = .38$ ,  $\eta^2 = .01$ ). Following the significant interactions on psychological outcomes, simple contrasts were conducted using the low wanted, control group as the reference condition. Participants in the low wanted, support condition reported similar confidence and affect to those in the reference condition. In contrast, participants in the high wanted, control condition reported less favourable confidence and affect than those in the reference condition. Finally, participants in the high wanted, support group reported higher confidence and positive affect (not negative affect) than those in the reference condition. **Discussion** The findings highlight that the effects on psychological outcomes of received support are contingent on the support athletes' actually want. Individuals who wanted but did not receive support experienced poorer psychological outcomes. In contrast, individuals who wanted and received support experienced more favourable psychological outcomes. Overall the findings emphasise that the effectiveness of received support was particularly salient for those who wanted high levels of support, and athletes' support networks should be mindful to meet athletes' support needs. Contact Di Fu: dfua@essex.ac.uk



## Oral presentations

### OP-PM25 Balance

#### THE RELATION OF ASYMMETRY IN POWER AND BALANCE IN THE LOWER EXTREMITIES

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**Introduction** Asymmetry in the lower extremities can affect performance (Portegijs et al., 2005) and increase injury risk (Smith et al., 2015). Common ways to identification asymmetry are single legged measures of power or balance. However, there is little understanding about the relation between asymmetries in these capacities (Overmoyer et al., 2013). This study aims to explore the relation between asymmetry in power and balance in the lower extremity in a young athletic population. **Methods** A total of 196 subjects participated in this study. All participants were first year physical education students with a mean age of 19.5 ( $\pm 2.4$ ) years for men (N=132) and 18.3 ( $\pm 2.6$ ) years for woman (N=60). Balance was determined by anterior reach of the Starr Excursion Balance Test (Hertel et al., 2006). Jump height of single legged counter movement jumps were used to calculate power for each leg with the Sayers formula and normalized for body weight. Results Anterior reach was on average 66.5% ( $\pm 5.6$ ) of leg length for men and 68.9% ( $\pm 4.0$ ) of leg length for woman. Anterior reach asymmetry was on average 2.4% (median: 1.7; range: 0.0-20.2) for men and 2.5% (median: 1.8; range: 0.0-17.0) for woman. Average power was 29.9 W/Kg ( $\pm 2.8$ ) for men and 24.4 W/Kg ( $\pm 2.4$ ) for woman. Power asymmetry was 1.6 W/Kg (median: 1.4; range 0.1-6.2) for men and 1.6 W/Kg (median: 1.1; range: 0.1-7.1) for women. Values for power and anterior reach did not correlate ( $p=0.078$ - $0.636$ ). Asymmetry in power and anterior reach significantly correlated for women ( $r=0.393$ ,  $p=0.004$ ). This relation was not significant for men ( $r=0.162$ ,  $p=0.083$ ). **Discussion** Small asymmetries in balance and power are common in a healthy and active population. In few cases asymmetry was found to be large. Values for power and balance did not correlate. Asymmetries in power and balance have a weak relation for woman. This implies that asymmetry in balance or power are to a large extent independent of each other. Asymmetry in power and balance should therefore be identified complementary. **References** Portegijs, E., Sipilä, S., Alen, M., Kaprio, J., Koskenvuo, M., Tiainen, K., Rantanen, T. (2005). Extension Power Asymmetry and Mobility Limitation in Healthy Older Women. *Arch Phys Med Rehabil*. 86:1838-42. Smith C.A., Chimera N.J., Warren M. (2015). Association of y balance test reach asymmetry and injury in division I athletes. *Medicine and Science in Sports and Exercise*. 47(1):136-141. Overmoyer, G.V., Reiser, R.F. (2013). Relations between asymmetries in functional movements and the star excursion balance test. *Journal of Strength and Conditioning Research*. 27(7):2013-2024. Hertel, J., Braham, R.A., Hale, S.A., Olmsted-Kramer, L.C., (2006). Simplifying the Star Excursion Balance Test: Analyses of Subjects With and Without Chronic Ankle Instability. *J Orthop Sports Phys Ther*. 36(3):131-137.

#### DIFFERENT DIFFICULTY LEVELS OF BALANCE TASK INDUCED SPINAL EXCITABILITY ALTERATION

SMAJLA, D., STROJNIK, V., TOMAŽIN, K.

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**Introduction** In balance training, there are no scientific guidelines concerning the optimal duration and intensity of these exercises (Taube, Gruber and Gollhofer, 2008). Therefore, the aim of this study was to determine mechanical differences between different difficulty levels of balance task and their acute influence on H-reflex amplitude. **Methods** The research included 13 participants. Each of them performed balance task of three difficulties in random order (20 s, 7 repetition, 150 s rest). The rest time between each intensity was one week. Balance task was performed on balance board with motion in sagittal plane. We measured soleus H-reflex in standing position, active time of establishing balance control, number of hand supports because of losing balance, distance and speed of balance board. Normal distributed variables were analyzed with Shapiro-Wilk test. Differences between dependent variables were analyzed with repeated measures ANOVA procedure. In case of statistical significance, we used Tuckey-Post-hoc test. For abnormal distributed variables, we used Friedman test (in case of sig., Wilcoxon rank sum test). Spearman correlation coefficients were calculated to analyze dependence of chosen variables. Results Active time of establishing balance, number of hand supports because of losing balance and speed of balance board are statistically different between difficulties (all:  $p<0.001$ ). Mean values of wave H amplitude measured standing after whole balance task were significantly lower than before ( $p<0.01$ ). Although we did not find significant differences between difficulties, H-reflex amplitude was significantly reduced already after the second repetition ( $p<0.05$ ) in the most difficult and after the fifth repetition ( $p<0.05$ ) after the easiest balance task. **Discussion** We assume that the most difficult balance task induces greater alteration in excitability of alpha motoneurons and/or presynaptic inhibition of Ia afferents due to the need for more precise control of movement. The advantage of reduced spinal reflexes in balancing tasks was assumed to rely on the prevention of reflex-mediated joint oscillations and on a shift in movement control to higher centres (Llewellyn et al., 1990; Kocaja and Mynark, 2000; Solopova et al., 2003; Taube et al., 2008). It would be useful to research chronic adaptations induced by different difficulties of balance task on spinal and higher centres. **References** Kocaja DM, Mynark RG. (2000). *Int J Neurosci*, 103(1-4), 1-17. Llewellyn M, Yang JF, Prochazka A. (1990). *Exp Brain Res*, 83(1), 22-28. Solopova IA, Kazennikov OV, Deniskina NB, Levik YS, Ivanenko YP. (2003). *Neurosci Lett*, 337(1), 25-28. Taube W, Gruber M, Gollhofer A. (2008). *Acta Physiol*, 193(2), 101-116. Contact darjan.smajla@fsp.uni-lj.si

#### MAXIMUM MUSCLE STRENGTH AND BALANCE PERFORMANCE AFTER THE HIGH INTENSITY STRENGTH AND AGILITY EXERCISE OF THE FOOT AND LEG MUSCLES

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**[Introduction]** Physical exercises cause to muscle fatigue, which is a decrease in the ability of muscles to produce force (Bigland and Woods, 1984) and a decrease in the ability of nerves to transmit signals (Hagg, 1992). Muscle strength of the foot and leg is important essentials for physical performance in standing. We showed that the foot strength was significantly correlated with dynamic lower-limb physical performances such as sprinting and jumping in children (Morita et al. 2015) and adolescent (Otsuka et al. 2015). Also, we showed that limitation of ankle joint movement decreased vertical jump performance (Koyama et al. 2014) and the foot strength (Yamauchi and Koyama, 2015). The foot muscles are a unit that produces force for postural control during the locomotion. However, there are no studies how physical exercises affect to the force generating capacity of the foot and leg muscles as well as the postural balance ability.

[Purpose] The purpose of this study was to investigate the effects of high intensity strength and agility exercise on maximum muscle strength of the foot and leg and static balance. [Methods] Eighteen healthy men performed the high intensity strength and agility exercise with barefoot for an hour, and their toe flexor strength (TFS), ankle plantar flexor strength (PFS) and postural ability were measured before and after the exercise. The exercise program consisted of muscle strength of the foot and the leg and balance exercises such as calf-raise, balance ball, ladder training and mini hurdle exercises. Static balance was evaluated from the path of the center of pressure (COP) during three balance tasks (bipedal standing with open eyes, bipedal standing with closed eyes, and one-legged standing with open eyes) for 40s. Total length (TL), mean velocity (MV), total area (TA), rectangular area (RA), effective area (EA) and TL per unit area (TL/A) were calculated from COP data. [Results] After the exercise, TFS at both feet with standing and sitting were significantly decreased. PFS at both feet were significantly decreased. TL, MV, TA, RA, EA and TL/A of COP variables in the bipedal standing with open and closed eyes conditions were not significantly different. TA, RA, EA and TL/A of COP variables in the one-legged standing with open eyes were not significantly different; however TL and MV of COP were significantly decreased. [Conclusion] This study suggested that muscle fatigue of the foot and leg after the high intensity strength and agility exercise with barefoot might improve some variables of the standing balance ability in one-legged standing with open eyes. [References] Bigland-Ritchie B, Woods JJ. (1984). Muscle Nerve, 7(9), 691-699. Hagg GM. (1992). J Appl Physiol, 73(4), 1211-1217. Koyama K, Kato T, Yamauchi J. (2014). J Strength Cond Res, 28(5), 1411-1417. Morita N, Yamauchi J, Kurihara T, Fukuoka R, Otsuka M, Okuda T, Ishizawa N, Nakajima T, Nakamichi R, Matsuno S, Kamiie S, Shide N, Kambayashi I, Shinkaiya H. (2015). Med Sci Sports Exerc, 47(2), 350-356.

## POSTURAL CONTROL PROFILE OF AMATEUR RUGBY PLAYERS

CHOW, G.C.C., CHUNG, J.W.Y., FONG, S.S.M., MA, A.W.W., MACFARLANE, D.J.

*The Hong Kong Institute of Education*

Introduction Injuries during rugby training or competitions might disrupt the sensory and motor systems that affect postural control. However, no study has explored the sensory organisation and reactive balance control of rugby players. This study compared (1) the sensory organisation of balance control and (2) reactive balance control, of amateur rugby players and active individuals. Methods Forty-one amateur rugby players (22 males and 19 females; mean age  $\pm$  SD: 21.4  $\pm$  2.1 years) and thirty-one young active individuals (22 males and 9 females; mean age  $\pm$  SD: 20.6  $\pm$  0.9 years) completed the measurements in the study. Their sensory organisation and bipedal standing balance performance were evaluated using a sensory organisation test (SOT), and their reactive balance performance was assessed using a motor control test (MCT). The major outcome measures were the SOT equilibrium scores (ES) and sensory ratios and the MCT motor response latencies. Results Rugby players had lower SOT ESs under different sensory environments (all  $P < 0.001$ ) and prolonged reactive motor response times in the MCT ( $P < 0.001$ ) compared to the active controls. The SOT vestibular and visual ratios were also lower in the rugby group ( $P = 0.005$ ). However, no significant between-group difference was found in the somatosensory ratio ( $P = 0.853$ ). Discussion Rugby players demonstrated inferior standing balance performance compared to their non-trained counterparts. They relied less heavily on vestibular and visual information to maintain standing balance under sensorial challenging environments. Additionally, they reacted more slowly to postural threat, reflecting their suboptimal reactive balance ability in upright standing.

## HOW DOES THE GYMNASTIC APPARATUS INFLUENCE THE MUSCLE ACTIVITY OF A GYMNAST IN A HANDSTAND?

NIESPODZIŃSKI, B.1, KOCHANOWICZ, A.2, MIESZKOWSKI, J.1, ZASADA, M.2, SAWCZYN, S.2

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Introduction Gymnasts perform handstands on various apparatus, both in stable and unstable conditions. Such a balance task requires specific muscle activation which should differ depending on the wrist joint position and the specificity of the apparatus. Therefore, the aim of the study was to show differences in surface electromyography activity (sEMG) of gymnasts' muscles during a handstand on various apparatus. Methods 10 elite male gymnasts participated in the study. Their mean age was 25  $\pm$  3.94 years. In the study, gymnasts performed a 5-second handstand in three conditions: on the floor, on parallel bars and on still rings. During performance, sEMG of 13 muscles was recorded. Mean values of three proper handstands on each apparatus were taken into analysis. Each value was normalized to maximal voluntary isometric contraction (MVIC) performed on Biodex System 4. Results In comparison to a handstand on the floor (60  $\pm$  28%), gymnasts' wrist flexors muscles on parallel bars (42  $\pm$  25%) and still rings (43  $\pm$  32%) exhibited decreased mean percentage activity of the MVIC. On parallel bars it was associated with an increase in rectus femoris activity by about 76% in comparison to that on the floor. Most of the muscles (biceps brachii, deltoids, pectoralis major, latissimus dorsi, trapezius descendens) showed increased activity in unstable conditions of still rings. The activity of triceps brachii (15% MVIC) did not differ between each condition. Discussion The reason for such results may lie in different positions of wrist joints, where on the floor the wrist flexors are the most active muscle group, which determines balance in an inverted position (Hedbávný et al., 2008). Parallel bars enforce a specific hand grip, which shows more balanced sEMG activity of wrist flexors and extensors. As this provides less mobility in the wrist joint due to a lesser range of abduction/adduction motions in it as well as its lower torque production capabilities in such motions (Delp et al., 1996), it may facilitate the use of the two other (shoulder and hip) strategies (Yeadon and Trewartha, 2003), manifested by an increase in the lateral deltoid and the rectus femoris activity. Conclusions The obtained results showed that unstable conditions of still rings increase the sEMG activity of all gymnasts. A different handgrip position between a handstand on the floor and on parallel bars can change the activity of not only forearm muscles but also distal muscles. References Hedbávný P, Sklenářková J, Hupka D, Kalichová M. (2008). Science of Gymnastics Journal, 5(3), 69-80. Delp SL, Grierson AE, Buchanan TS. (1996). J Biomech, 29(10), 1371-1375. Yeadon MR, Trewartha G. (2003). Motor Control, 7(4), 411-430. Contact [Barnie@ukw.edu.pl](mailto:Barnie@ukw.edu.pl)

## Oral presentations

### OP-PM69 Physical Activity & Inactivity

#### FACTORS INFLUENCING QATARI WOMEN TO ADOPT PHYSICALLY ACTIVE LIFESTYLE

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**BACKGROUND:** There is no doubt that physical activity (PA) has numerous health benefits (1). Despite this fact, data show that 60% of Qatari females do not engage in regular PA (2). The high prevalence of physical inactivity in Qatar has contributed to a rise in obesity and chronic diseases (3). To modify PA behavior successfully among Qatari women, it is necessary to understand the factors that influence this behavior. **PURPOSE:** This study aimed to understand the factors that influence Qatari adult women to adopt a physically active lifestyle. **METHODS:** This is an ethnographic study involving three data collection methods: observation, interview and photovoice. The observation sessions were conducted in public areas; such as gyms, malls, parks, and workplaces, in order to report the Qatari women interaction with their environment. A total of eight Qatari women aged 18-44 years, from different backgrounds (education, occupation, and tribal affiliations) were involved in interviews and/or photovoice activities. Participants were recruited through an opportunistic sampling technique. This study is framed by Islamic feminism and guided by a socioecological model. Thematic analysis was used to identify key themes and subthemes across all transcripts. **RESULTS:** Eight themes emerged within this study: limited PA domains in Qatar; Qatari culture does not support women PA; the desert environment as a barrier; practicing PA requires visiting specific locations; adopted luxurious lifestyle fosters sedentary behavior; perceived low motivation for PA; positive perception about PA with some misconceptions; and other individual factors such as health status and eating habits were found to affect PA. **CONCLUSION:** Results suggest that various cultural, environmental, and economic factors play a key role in Qatari women's physical activity. The facilitators and barriers identified from this study provide important insights on how Qatari women might change their physical activity behavior. **REFERENCES:** 1. US Department of Health and Human Services. 2008 Physical Activity Guidelines for Americans. Washington DC: USDHHS, 2008 2. Qatar National Health Strategy. Nutrition and Physical Activity 2011-2016. Available from: <http://www.nhsq.info/strategy-goals-and-projects/preventative-healthcare/nutrition-and-physical-activity/project-in-detail>. 3. Haj Bakri A, Al-Thani A. Chronic Disease Risk Factor Surveillance: Qatar STEPwise Report 2012. The Supreme Council of Health. Qatar: 2013 **CONTACT:** Lena.Zimmo@aspetar.com

#### BENEFITS OF ADAPTED PHYSICAL ACTIVITY IN WOMEN AFTER TREATMENT FOR BREAST CANCER.

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The main aim of the research is evaluate the physical benefits of a program of Adapted Physical Activity (APA) for cancer survivor (CS) after adjuvant therapy made with lower costs for users, out of the health care system. Methods A "natural experiment" was adopted. Sixteen patients with breast cancer, BMI > 25 or who have increased their weight by 5% during the adjuvant therapy, have agreed to undergo a APA program for 6 months, 2 lessons/week of 60 minutes following this protocol: 10' dynamic stretching, 20-30' aerobic exercise, 10-15' strength exercises, 10' static and passive stretching. The assessment of training effectiveness was carried out three time: initial (M1), at three months (M3), final (M6). Measures adopted was: back scratch test (right and left), sit and reach test, arm curl test for limb of the mastectomy, 30" chair stand test, neck pain with NRS scale (0-10) in best and worst condition within the last 24 hours, RPE Borg Scale for fatigue on two flights of stairs, MMRC Dyspnea Scale, arm abduction test right and left. Results All parameters improved at three or at six month (\*= $p < 0.001$  M6 vs M1; °= $p < 0.001$  M3 vs M1; ^= $p < 0.001$  M6 vs M3). Flexibility is improved in all tests: Back Scratch test right (M1=-7.25±9.10; M3=-4.00±7.24; M6=-3.38±7.42\*;  $p < 0.001$ ), Back Scratch test left (M1=-10.81±10.88; M3=-7.34±8.65°; M6=-5.84±7.81\*;  $p < 0.001$ ) with greater improvements limb of the mastectomy 62,50% cancer survivor after 3 month, 75% after six month; Sit and Reach test (M1=-3.63±5.35; M3=-1.25±4.37°; M6=-0.44±3.89\*;  $p < 0.001$ ); the two subjects that at M1 does not get the maximum values of arm abduction test (right and left) have reached them at M3. Strength is improved in both test: Arm Curl test (M1=1.81±7.01; M3=30.34±4.85°; M6=32.97±4.73\*^;  $p < 0.001$ ); 30"Chair Stand test (M1=12.75±2.89; M3=16.88±2.99°; M6=19.69±2.89\*^). RPE Borg Scale for fatigue on two flights of stairs decreased (M1=9.44±3.08; M3=7.38±1.86; M6=6.25±0.45\*;  $p < 0.001$ ). MMRC Dyspnea Scale overall decreased (M1=0.75±0.86; M3=0.31±0.48; M6=0.19±0.40;  $p = 0.002$ ). Neck pain NRS improved both in worst condition (M1=6.00±3.08; M3=3.75±2.77°; M6=1.75±2.02\*;  $p < 0.001$ ) and in best condition (M1=1.00±1.21; M3=0.63±1.31; M6=0.25±1.00;  $p < 0.001$ ). Discussion The cancer survivors, after 6 months of APA, have significantly improved their physical fitness and this will allow them to undertake the physical activity of their choice and consolidate an active lifestyle. It seems reasonable to assume, therefore, that an low cost APA program is able to contribute to winning the sedentary lifestyle that these people adopt since the first diagnosis. This can be an important step toward an active lifestyle that can reduce or delay recurrence or a second primary cancer and to reduce, attenuate and prevent long-term and late effects of cancer treatment.

#### ACCUMULATION OF RECOMMENDED PHYSICAL ACTIVITY IN OLDER ICELANDIC ADULTS

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**Introduction** In many European countries, published guidelines recommend older adults to conduct at least 150 min/week of physical activity (PA) of moderate or vigorous intensity (MVPA). Generally, the guidelines state that aerobic PA should be performed in episodes of at least 10 min bouts. However, studies have shown that health benefits might also be gained with bouts of lower intensity and activity that last less than 10 min. The aim of this study was to objectively assess the proportion of older Icelanders accumulation recommended PA using two different definition of a minimum bout of PA, in a sample of older community-dwelling Icelanders from the Age, Gene/Environment Susceptibility Reykjavik study (AGESIL study). **Methods** Free living PA was measured by a waist-worn accelerometer in 138 older adults (61.1% women, 80.3±4.9 yrs) during both summer and winter months. One-week assessment period was used each season for each participant. A bout of MVPA was defined as at least ten consecutive minutes of activity counts above the moderate

threshold (2020 counts/min), allowing for one minute outside of the threshold. A bout of life style PA (LSPA) was defined as at least five consecutive minutes of activity counts above the LSPA threshold (760 counts/min), allowing for one minute outside of the threshold. Results Sedentary behaviour (SB) was high, or about 75% of registered wear time. More PA were accumulated in LSPA bouts during summer than winter. The number of bouts, counts and minutes accumulated in LSPA bouts were higher during the summer compared with winter. For accumulated PA in MVPA bouts there was no significant difference between the seasons. Only 1.5% reached the recommendation of accumulating 150 min per week of PA in MVPA bouts during the summer, and 4.4% during the winter. When LSPA bouts were used as a minimum of continuous PA, 26.8% accumulated at least 150 min per week of PA during the summer and 17.4% during the winter. Discussion The results support the notion, that the minimum of 10 min bouts of MVPA when accumulating PA, may be too ambitious for many older adults. By reducing the intensity and time of the minimum bout to 5 min of LSPA, it seems to be more achievable and realistic for larger part of older adults to reach the recommendations. Thus, it may be more realistic to use LSPA in 5 min bouts as a minimum when accumulating the recommended 150 min per week of PA for older adults. Contact thorasve@hi.is

## PATTERNS OF ACTIVITY BEHAVIOR IN OLDER AFRICAN AMERICAN: PRELIMINARY FINDINGS

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**Introduction** The way in which daily activity is accrued in older African American women (OAAW) is not well understood. This study explored amounts and patterns of physical activity (PA) and sedentary behavior (SB) (i.e., activity behavior) in both sufficiently active (SA) and insufficiently active (IA) OAAW. **Methods** Twenty OAAW were recruited to take part in this study. Activity behavior was objectively measured through accelerometry over the course of 7 consecutive days. Individual accelerometer data was processed using the ActiLife 6 software. Information regarding accelerometer use (i.e., wear time and valid days), PA volume (i.e., sedentary, light intensity and MVPA, steps/day) (Freedson et al., 1998), and PA patterns (i.e., breaks in sedentary time, maximum length of sedentary bouts, average length of sedentary bout, number of sedentary bouts large than 30 minutes) was assessed. Participants were categorized into SA (n = 9) or IA groups (n = 11) based on national PA recommendations (DHHS, 2008). **Results** The average age of participants was 68.3 (6.1) years. As expected, IA women spent significantly less time in light activity and MVPA per day compared with the SA group; (82.9 (16.5) vs. 121.5 (38.7),  $p < 0.01$ ; and 17.4 (2.8) vs. 42.9 (5.3),  $p < 0.01$ , respectively. The average length of sedentary bouts and the average number of sedentary bouts longer than 30 min were both significantly greater in the IA group compared with the SA group; (24.3 (1.4) vs. 17.1 (2.4),  $p < 0.01$ ; and 7.95 (1.4) vs. 3.5 (1.5),  $p < 0.01$ ), respectively. No significant differences were found between groups regarding total amount of sedentary time, number of breaks in sedentary time, and maximum length of sedentary bouts. **Discussion** Overall, the findings on activity behavior observed in the present study are similar to those reported previously in a similar population (Evenson et al., 2012). The findings of this study suggest that women in the IA group are at increased risk of developing health problems because of cumulative adverse effects of low levels of PA and prolonged sedentary bouts. These findings underscore the need for interventions aimed at reducing SB and increasing PA among older African-American women. **References** Freedson, P. S., Melanson, E., & Sirard, J. (1998). Calibration of the Computer Science and Applications, Inc. accelerometer. *Med Sci Sports Exerc*, 30(5), 777-781. Evenson, K. R., Buchner, D. M., & Morland, K. B. (2012). Objective measurement of physical activity and sedentary behavior among US adults aged 60 years or older. *Prev Chronic Dis*, 9, E26. DHHS. (2008). 2008 Physical Activity Guidelines for Americans. Retrieved October 2nd, 2008, from <http://www.health.gov/PAGuidelines>.

## EFFECTS OF FOOT PAIN ON DYNAMIC PLANTAR FOOT PRESSURE IN ATHLETES

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*Anadolu University*

**Introduction** The purpose of this study is to investigate the effect of foot pain on plantar peak pressure, maximum force of right and left foot. **Methods** Nine male athletes who have foot pain (FP) (20.50±1.16 year; 1.78±0.06m; 76.64±8.93 kg; 23.85±1.74 kg/m<sup>2</sup>) and 11 athletes (22 ± 3.52 year; 1.78±0.06 m; 75.30±7.74 kg; 23.40±2.41 kg/m<sup>2</sup>) (as the control group) having no history of pain were included in the study. Subjects of FP group were included according to the results of Foot Function Index (FFI) (Budiman-Mak et al. 2013). Dynamic plantar pressure (PP) assessment during walking without shoes was undertaken using the EMED-XL (Novel GmbH, Munich, Germany) PP analysis system sampling at a rate of 100 Hz. The two-step gait initiation protocol with 5 trials was used to obtain foot pressure data. For data analysis the Novel scientific analysis software was used. The following parameters were calculated for the entire foot: Peak pressure (PP in kPa), maximum force (F) contact area (CA in cm<sup>2</sup>), and contact time (CT in ms). The F was normalized with respect to the body weight of each participant. Foot was masked as 'big toe, second toe, toes 3-4-5, MH1: 1st metatarsal head, MH2: 2nd metatarsal head, MH3: 3rd metatarsal head, MH4: 4th metatarsal head, MH5: 5th metatarsal head, middle foot and hind foot'. Before statistical analyses, all of the measures were found to be distributed normally based on the Shapiro-Wilk test. It was examined whether there were any statistically significant differences between the experiment and control group means using independent T test. In the measurements 95% reliability range and  $P < 0.01 - 0.05$  were accepted as significance level. **Discussion** According to descriptive data there is no significant differences of descriptive data between the FP and FFP groups ( $P > 0.05$ ). It was found that there were significant differences between the FP and FFP group in terms of relative F (%BW) in total foot (FP: 95.57±4.84; FFP: 90.37±4.73), big toe (FP: 15.57±3.40; FFP: 9.07±4.30) and second toe (FP: 3.07±1.17; FFP: 1.92±1.10) ( $P < 0.05$ ). In addition to this data absolute F of hind foot (FP:450.94±68.15; FFP: 366.51±109.59), big toe (FP:120.16±33.17; FFP:69.21±36.10) and second toe (FP:23.68±9.22; FFP:14.60±8.73) were found statistically different between FP and FFP groups ( $P < 0.05$ ). Relative PP of big toe (FP: 33.36±7.26; FFP:26.87±7.36) was found statistically different between groups ( $P < 0.05$ ). Contact area (cm<sup>2</sup>) of total foot (FP: 165.22±17.70; FFP:150.53±11.66) and MH1 (FP: 15.37±1.46; FFP:13.53±1.36) was found statistically different between groups ( $P < 0.05$ ). In our findings, increased foot pain would be associated with higher PP, F and CA. Underlying mechanism of these findings may be related with angle deviation of subtalar varus and valgus. **References** Budiman-Mak, E, Conrad, KJ, Mazza, J. and Stuck, RM. (2013). A review of the foot function index and the foot function index. *Journal of Foot and Ankle Research*, 6(5). Contact [lds@anadolu.edu.tr](mailto:lds@anadolu.edu.tr); [deniz\\_yenigelen26@hotmail.com](mailto:deniz_yenigelen26@hotmail.com)



# **FACTORS ASSOCIATED WITH SUCCESSFUL PHYSICAL ACTIVITY INTERVENTION AND ITS EFFICIENCY ON OVERALL PHYSICAL FITNESS IN ADOLESCENTS**

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**Introduction** The purposes of the present study were 1) to investigate potential factors associated with successful physical activity (PA) intervention and 2) to examine the effects of small amounts of additional PA ( $\geq 1,000$  steps per day) on overall physical fitness in adolescents. **Methods** 324 Japanese adolescents (127 boys and 197 girls; age 12-15 years) participated in a 16-week, single-arm intervention study. At baseline, the participants were asked to wear an accelerometer to evaluate their baseline PA levels. Thereafter, all participants were asked to increase their activities above baseline lifestyle levels by  $\geq 1,000$  steps per day for 16 weeks; freely deciding mode, frequency, intensity and content in which the activities occur. During the intervention periods, the participants were asked to record their daily step counts in an activity log. The primary outcome was whether or not the participants achieved the determined goal. The participants who increased their activities by on average  $\geq 1,000$  steps per day during the intervention period were defined as "Achieved group" and "Non-achieved group" for the others. Factors potentially associated with successful PA intervention were measured by using questionnaire. The Secondly outcome was changes in physical fitness of the participants. Japanese standardised fitness test including 8 fitness items was conducted at baseline and after 16 weeks. **Results** Only 33.1% of boys and 24.4% of girls were defined as "Achieved group" in the present study. Higher baseline fitness composite score were positively associated with the successful PA intervention in both boys (odds ratios (ORs) = 1.07,  $p = 0.026$ ) and girls (ORs = 1.05,  $p = 0.037$ ). In addition, confidence in own fitness levels was positively associated with the success in increasing PA for girls ( $5.5 \leq \text{ORs} \leq 11.5$ ,  $p < 0.05$ ). For the effects of additional PA on physical fitness, there was a significant interaction effect (group  $\times$  time) on the fitness composite score in girls ( $F = 9.23$ ,  $p = 0.003$ ), but not in boys ( $F = 0.68$ ,  $p = 0.414$ ). **Discussion** The present study suggested that encouraging adolescents to increase their activities by only providing a pedometer and the active log might be insufficient to increase PA levels for majority adolescents. In addition, this seems particularly true for those who have lower physical fitness and confidence in own fitness levels before an intervention is implemented. However, if the PA intervention is achieved, additional small amounts of PA (i.e.  $\geq 1,000$  steps per day) seem to be effective for improving overall physical fitness, at least in girls.

# Friday, July 8th, 2016

08:00 - 09:30

## Oral presentations

### OP-PM56 Nutrition & Supplementation

#### FIXING THE METABOLIC LEAK IN THE INEFFICIENT MUSCLE CARNOSINE LOADING SCHEME BY ORAL BETA-ALANINE SUPPLEMENTATION

BLANCQUAERT, L.1, BABA, S.P.2, KWIATKOWSKI, S.3, STAUTEMAS, J.1, CHUNG, W.1, BOAKYE, A.A.2, BHATNAGAR, A.2, VEIGA-DA-CUNHA, M.3, DERAIVE, W.1, EVERAERT, I.1

*University Ghent*

1: GHENT University (Ghent, Belgium), 2: University of Louisville (Kentucky, USA), 3: Université Catholique de Louvain (Brussels, Belgium)  
 Introduction Chronic beta-alanine supplementation is becoming increasingly popular to improve high-intensity exercise performance, as it is the rate-limiting precursor of the dipeptide carnosine (beta-alanyl-L-histidine) in muscle (Harris et al., 2006). Yet, only a small fraction (3-6%) of the ingested beta-alanine is used for carnosine synthesis (Stegen et al., 2013). Thus, the aim of this study was to identify the main alternative metabolic route of ingested beta-alanine and to investigate the putative contribution of two beta-alanine transamination enzymes, namely GABA-T and AGXT2, herein. Methods In a first part, mouse and human GABA-T and AGXT2 were cloned and expressed in HEK293T cells and degradation of beta-alanine by recombinant GABA-T and AGXT2 was explored with and without addition of transaminase inhibitors vigabatrin and aminooxyacetate (AOA). The second part consisted of a nutritional intervention study, in which 66 male C57BL/6 mice were supplemented with different dosages of beta-alanine for two weeks and simultaneously received subcutaneous injections with vigabatrin (500mg/kg body weight) or AOA (10mg/kg). Results Recombinant mouse and human GABA-T and AGXT2 were all able to efficiently transaminate beta-alanine. The reaction catalyzed by GABA-T was inhibited by vigabatrin, whereas both GABA-T and AGXT2 activity were inhibited by AOA, a finding which was also confirmed in vivo. Injection of AOA in C57BL/6 mice placed on beta-alanine (0.1% w/v in drinking water) for two weeks lead to a 3-fold increase in circulating beta-alanine levels and to significantly higher levels of carnosine and anserine in skeletal muscle (+128% in soleus, +105% in tibialis anterior, +21% in gastrocnemius) and heart (+541%). In contrast, specific inhibition of GABA-T by vigabatrin did not affect carnosine and anserine levels in either tissue. Discussion Collectively, these data demonstrate that homeostasis of carnosine and anserine in mammalian skeletal muscle and heart is controlled by circulating beta-alanine levels, which are suppressed by hepatic beta-alanine transamination upon oral beta-alanine intake. This transamination pathway likely creates a major metabolic leak in the presently used beta-alanine supplementation protocols. References Harris R, Tallon M, Dunnett M, Boobis L, Coakley J, Kim H, Fallowfield J, Hill C, Sale C, Wise J (2006). Amino Acids, 30(3), 279-289. Stegen S, Blanquaert L, Everaert I, Bex T, Taes Y, Calders P, Achten E, Derave W (2013). Med Sci Sports Exerc, 45, 1478-1485. Contact Laura.blanquaert@ugent.be

#### B-ALANINE SUPPLEMENTATION IMPROVES THE RELAXATION SPEED OF IN-VIVO FRESH AND FATIGUED SKELETAL MUSCLE

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*Nottingham Trent University*

PURPOSE: In fresh muscle, supplementation with the rate-limiting precursor of carnosine, beta-alanine (BA), results in a decline in muscle half-relaxation time (HRT) potentially via alterations to calcium (Ca<sup>2+</sup>) handling. Accumulation of H<sup>+</sup> has been shown to impact Ca<sup>2+</sup> signalling during muscular contraction and carnosine has the potential to serve as a cytoplasmic regulator of Ca<sup>2+</sup> and H<sup>+</sup> coupling, since it competitively binds to both ions. The present study examined the effect of BA supplementation on intrinsic in-vivo knee extensor force production and muscle contractility in both fresh and fatigued human skeletal muscle assessed during voluntary and electrically-evoked (nerve and superficial muscle stimulation) contractions. METHODS: Twenty-three males completed two experimental sessions, pre- and post- 28 days supplementation with 6.4 g.day<sup>-1</sup> of BA (n=12; age, 22 ± 2 years, height, 1.80 ± 0.05 m, body mass, 76.0 ± 7.3 kg, MVIC, 565 ± 86N) or placebo (PLA; n=11; age, 22 ± 1 years, height, 1.83 ± 0.06 m, body mass, 81.4 ± 14.2 kg, MVIC, 600 ± 149N). The Institutional Ethical Review Committee approved the study. Force was recorded during a series of voluntary and electrically evoked knee extensor contractions. RESULTS: BA supplementation had no effects on voluntary or evoked force production, or twitch electromechanical delay and time-to-peak tension. Nonetheless there was a decline in muscle HRT in fresh and fatigued muscle during both resting (3 ± 13%; 19 ± 26%) and potentiated (1 ± 15%; 2 ± 20%) twitch contractions. CONCLUSION: The key findings from the present study are a) no effects of BA supplementation on force production capacity in either fresh or fatigued skeletal muscle, b) the confirmation of our previous findings (Hannah et al. 2015) showing enhanced fresh muscle relaxation speed following 28 days of BA supplementation and c) that the skeletal muscle relaxation speed is also reduced by BA supplementation following muscle fatigue (H<sup>+</sup> accumulation) in the absence of any change to peak force production or contraction time. The mechanism for reduced HRT in fresh and fatigued muscle following BA supplementation is unclear. Due to the importance of muscle relaxation on total energy consumption, especially during short, repeated contractions, BA supplementation may prove to be beneficial. These data are the first to comprehensively examine the effect of BA supplementation on voluntary and electrically evoked contractile properties of in-vivo fatigued human skeletal muscle.

**BETA-ALANINE SUPPLEMENTATION ENHANCES JUDO-RELATED PERFORMANCE IN HIGHLY-TRAINED ATHLETES.**

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**Introduction** In official judo competitions, athletes have to engage in 5-7 matches in the same day (Detanico et al. 2015), during which they perform numerous high-intensity efforts interspersed by short recovery intervals. Thus, glycolytic demand in judo is high and acidosis may limit performance (Artioli et al. 2010). Carnosine is a relevant intracellular acid buffer whose content is increased with beta-alanine supplementation (Harris et al. 2006). Thus, we hypothesized that beta-alanine supplementation could attenuate acidosis and improve judo performance. **Methods** Twenty-three highly-trained judo athletes were randomly assigned to receive either beta-alanine (6.4 g.day<sup>-1</sup>; n=12; age=19 ± 3 y) or placebo (dextrose, 6.4 g.day<sup>-1</sup>; n=11; age=17±2 y). Performance was assessed before (PRE) and after (POST) supplementation through a 5-minute simulated fight (randori) followed by 3 bouts of the Special Judo Fitness Test (SJFT) (Sternkiewicz et al. 2010). Blood samples were collected for blood pH, bicarbonate (HCO<sub>3</sub><sup>-</sup>) and lactate determination. Results Beta-alanine supplementation significantly improved the number of throws per set, as well as the total number of throws (both P < 0.05), whilst placebo did not change these variables (both P > 0.05). Blood pH and HCO<sub>3</sub><sup>-</sup> were significantly reduced after exercise (all P < 0.001), with no between-group differences (all P > 0.05). However, the lactate responses to exercise were higher in the beta-alanine group as compared to placebo (P < 0.05). **Discussion** The likely elevated muscle buffering capacity has probably attenuated muscle acidosis during the judo-specific protocol, thereby allowing for enhanced glycolytic activation and better performance. In conclusion, 4 weeks of beta-alanine supplementation is an effective dietary intervention capable of enhancing judo-related performance in well-trained judo athletes, suggesting that this modality can also benefit from the ergogenic effects of an increased muscle carnosine content. **References** Artioli GG, Iglesias RT, Franchini E, Gualano B, Kashiwagura DB, Solis MY, Benatti FB, Fuchs M, Lancha Junior AH. J Sports Sci 2010; 28(1):21-32 Detanico D, Dal Pupo J, Franchini E, Dos Santos SG. J Strength Cond Res 2015; 29(4):1010-1016. Harris RC, Tallon MJ, Dunnett M, Boobis L, Coakley J, Kim HJ, Fallowfield JL, Hill CA, Sale C, Wise JA. Amino Acids. 2006; 30(3):279-289 Sternkiewicz, S. Antropomotoryka. 1995; 12:29-44. Contact E-mail: carolinekratz@yahoo.com.br

**ACUTE INGESTION OF BETA-HYDROXYBUTYRATE INDUCES NUTRITIONAL KETOSIS AND ALTERS THE METABOLIC RESPONSE TO EXERCISE**

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**Introduction** Ketone bodies, beta-hydroxybutyrate (BHB) and acetoacetate, are fatty acid metabolites produced in the liver as a result of fasting, starvation or a ketogenic diet. Ketone body production is increased during exercise and can be utilized as an alternative to carbohydrate and fat to fuel muscle, but there is a lack of research on the metabolic effects of ingesting BHB prior to exercise. **Methods** Six male trained cyclists (age, 21.3±3.9 y; body mass 72.5±6.1 kg; height 177.5±8.6 cm; VO<sub>2</sub>peak 64.4±4.7 mL/kg/min; Wmax 368±42 W) undertook experimental trials after a 10 h overnight fast comprising of a graded exercise protocol performed on a stationary electronically-braked cycle ergometer (Lode Excalibur Sport, Groningen, Netherlands). The protocol incorporated six stages, with each stage lasting 8 minutes at 30%, 40%, 50%, 60%, 70% and 80% VO<sub>2</sub>peak. Each experimental trial was identical with the exception of the drink consumed, which consisted of either (i) a bolus of plain water (3.8 mL/kg body mass) ingested at 60 minutes and 15 minutes prior to exercise (CON), or (ii) a bolus of BHB salts (0.38 g/kg body mass) in plain water (3.8 mL/kg body mass) ingested at 60 minutes and 15 minutes prior to exercise (KET). Expired air and heart rate were monitored continuously, and blood samples were collected from an antecubital vein at rest and in the last 30 seconds of each stage for measurement of glucose, lactate and BHB (Randox Daytona). Results Ingestion of BHB produced acute nutritional ketosis with plasma BHB concentrations at ~1 mM. This resulted in an increase in RER (0.03 to 0.05; p<0.05) versus water during each stage. Heart rate averaged 6 to 9 bpm higher (p<0.05) with ketone supplementation versus water. No differences in VO<sub>2</sub> (L/min) or gross efficiency were observed at any stage of exercise. Delta efficiency was higher with ketone supplementation at 60% VO<sub>2</sub>peak (CON, 22.1±1.4% vs. KET, 24.6±2.1%; p<0.05). **Discussion** Acute ingestion of BHB salts alters the metabolic response to exercise in trained male cyclists. The increase in RER is indicative of ketone oxidation, suggesting that the muscle is utilising BHB during exercise. Plasma glucose and lactate concentrations remain to be determined before inferences about substrate utilization can be made. Ongoing work is increasing the n-size and will compare differences, if any, for the effects of acute ingestion of BHB salts on male and female cyclists.

**CHANGES IN MUSCLE GLYCOGEN, BODY COMPOSITION, AND ENDURANCE PERFORMANCE DURING 72-HOUR CARBOHYDRATE LOADING WITH EXCESS ENERGY INTAKE**

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**Introduction** Consuming a high-carbohydrate diet for a few days increases muscle glycogen stores (CHO loading). In practical settings, energy intake (EI) during CHO loading tends to exceed the habitual level in order to ingest the requisite carbohydrate amount (10–12 g/kg body mass [BM]/d, Burke et al.). However, few studies have been conducted on the effect of CHO loading with excess EI on body composition and performance. This study aimed to reveal the effects of 72-h CHO loading with excess EI on muscle glycogen concentration, body composition, and endurance performance. **Methods** Eight subjects completed a glycogen-depletion session consisting of endurance and high-intensity intermittent exercise. For 72 h thereafter, the subjects consumed prescribed diets with 12 g/kg BM/d carbohydrate (energy 3686 ± 288 kcal/d, protein 77 ± 7 g/d, fat 33 ± 7 g/d, carbohydrate 770 ± 66 g/d), of which EI is exceeded the habitual diet (2089 ± 258 kcal/d, 73 ± 17 g/d, 65 ± 10 g/d, and 302 ± 51 g/d, respectively). Muscle glycogen concentration was assessed every 24 h after exercise by using <sup>13</sup>C-magnetic resonance spectroscopy. A 3-compartment model of body composition (i.e., fat mass [FM], total body water [TBW], and fat-free dry solid [FFDS]) was assessed at baseline and 72 h after exercise by measuring body density and using the deuterium dilution technique. The endurance performance test requiring the accomplishment of individualized amount of work as fast as possible was completed at baseline and 72 h after exercise. Results Muscle glycogen concentration linearly increased after exercise and reached 2.4- ± 0.8-fold the baseline value at 72 h after exercise (P < 0.001). BM, TBW, and FFDS significantly increased, but FM significantly decreased 72 h after exercise (P < 0.05). Endurance performance significantly improved 72 h after exercise (P < 0.001). **Discussion** CHO loading for 72 h with excess EI increased BM, TBW, and FFDS. These changes were interpreted as increases in muscle glycogen and glycogen-binding water. FM decreased after CHO loading, despite the excess EI. In this study, the amount of carbohydrate intake was largely increased, but the amount of fat intake was reduced by 50% during CHO loading. Because de novo lipogenesis from

carbohydrate is negligible before glycogen stores are saturated, reduction in FM may be induced by reduction in fat intake and glycogen-depletion exercise-related lipolysis. The results of our body composition and performance analyses suggest that CHO loading with excess EI can help improve endurance performance. Reference Burke et al. (2011) J Sports Sci, 29 (S1), S17–S27 Contact kei-suke.shiose@jpnnsport.go.jp

### **NUTRITIVE ADMINISTRATION OF CARBOHYDRATES AND PROTEIN INHIBITS SKELETAL MUSCLE INFLAMMATION AND DAMAGE AFTER ACUTE ENDURANCE EXERCISE**

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Scientific Background: Protein ingestion has been recently described to enhance the effects of carbohydrate drinks on skeletal muscle recovery. The aim of this study was to investigate the beneficial effects of a co-ingestion of carbohydrate and protein by food in amateur sportsmen. Methods: 16 male subjects performed a 10km run at 80% of individual ANS. Immediately after exercise subjects ingest either nothing (control), carbohydrates by eating white bread, or a combination of carbohydrates and protein by eating white bread and a sour milk cheese. Blood samples were taken at different time points. Serum glucose, serum insulin, serum creatine kinase (CK) and the serum levels of IL6, IL 10, MIF and TNF alpha were determined. Results: Blood glucose was increased by endurance exercise. Blood glucose levels decreased rapidly after exercise, here the strongest decrease could be observed in the bread /cheese group. Food uptake results in strong increase of serum insulin not differing between bread and bread/cheese. CK serum levels as a marker for skeletal muscle damage strongly increased 24h after exercise in the control and bread group but not in the bread cheese group. Exercise resulted in an increase of serum IL 6 and MIF which was reduced in the bread/cheese group. Serum IL 10 was increased by bread/cheese ingestion. TNF alpha serum concentration was decreased by exercise. This decrease was antagonized by bread/cheese ingestion. Conclusion: Our data demonstrate that uptake of a combination of protein and carbohydrate by food immediately after endurance exercise effect's physiological responses like blood glucose levels of the individual's and antagonize the induction of serum CK, a marker of skeletal muscle damage. Moreover this nutritive carbohydrate/protein uptake seems to influence the inflammatory response of the skeletal muscle indicated by reduced concentrations of proinflammatory markers and an increase of anti-inflammatory markers.

## **Oral presentations**

### **OP-PM46 Hypoxia**

#### **COMPETING AT ALTITUDE: DOES NATURAL ALTITUDE TRAINING OR SIMULATED LIVE HIGH: TRAIN LOW PROVIDE ATHLETES WITH THE BEST PREPARATION?**

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Introduction Natural altitude training is considered optimal for competition at moderate altitude (2000-3000m) (Mazzeo, 2008), however it remains untested if the same is true at low altitude (600-2000m). Potentially, other altitude training methods such as simulated live high: train low (LHTL) could also facilitate effective acclimation and improved performance at low altitude. This study aimed to compare the effects of natural altitude training and simulated LHTL with a control group, on mean blood lactate concentration (La-), time to exhaustion (TTE) and endurance performance at low natural altitude (~1400m). Methods Twenty-two elite-level, male (n = 15) and female (n = 7) race-walkers completed 14 days of either: low natural altitude (n = 7; living and training at 1380m in Thredbo, Australia); simulated LHTL (n = 7; 14h.d-1 at 3000m simulated altitude); or control (n = 8; living and training at 600m). A 5 x 2km race-walking performance test, and incremental treadmill test incorporating time to exhaustion (TTE) were performed at 1380m altitude Before and After the intervention. A one-way ANOVA was performed to determine differences between groups, with statistical significance set at p < 0.05. Magnitude-based inferences were used to analyse the likelihood of differences between groups exceeding the smallest worthwhile change (SWC) in each variable, which was set at 0.2 of the between-subject standard deviation at baseline. Results There was a significant, post-intervention decrease in [La-] in both the natural altitude (p = 0.048) and simulated LHTL (p = 0.01) groups compared with control. For TTE, there were no significant differences between groups from Before to After, however the improvement in the simulated LHTL group compared with control was likely greater than the SWC. Similarly, race walking performance in the natural altitude group was likely improved from Before to After in comparison to control, a result that approached significance (p = 0.07). Discussion Our findings suggest that either natural altitude training or simulated LHTL can provide both physiological and performance benefits to athletes competing at ~1400m altitude. Whilst natural altitude training at or near the race altitude remains the likely most beneficial option for athletes competing at altitude, simulated LHTL may provide an alternative method to achieve some level of acclimation prior to competition at low altitude. References Mazzeo R. Sports Med. 2008;38(1):1-8.

#### **PREDICTION OF INTERMITTENT CYCLING PERFORMANCE AT ALTITUDE FROM SEA LEVEL CRITICAL POWER**

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Introduction The dose-response effect of altitude has been examined previously for VO2max (Wehrli & Hallen, 2006); but not critical power (CP) and work performed above CP (W'). The aim of this study was to develop an altitude prediction model of CP and W' requiring sea level values only for use in the work-balance intermittent CP model (W'BAL model) at any altitude. Methods Nine trained, male cyclists (mean ± SD; age 34 ± 6 yr, VO2peak 4.57 ± 0.47 L.min<sup>-1</sup>) completed a series of 3 cycling time trials (TT; 12, 7 and 3 min), to determine critical power (CP) and work performed above CP (W') at five simulated altitudes (250, 1250, 2250, 3250 and 4250 m). Least squares regression was used to establish a prediction model of CP and W' for altitudes up to 4250 m. On separate days, an intermittent exercise test incorporating three 'all out' sprints followed by a 3 min TT was performed at 250 m and 2250 m. Predicted and actual CP + W' at



2250 m were used to compute  $W'$  remaining in the intermittent test using both the differential (W'BALdiff) and integral (W'BALint) forms of the W'BAL model. Mixed linear modeling was used to assess the effect of altitude on CP and  $W'$ , and t-tests were used to examine differences between predicted or actual modeled W'BAL, and versus a criterion value of 0 kJ at end test. Results Critical power decreased significantly at all altitudes ( $P < 0.001$ ), which was described by a 3rd order polynomial function ( $R^2 = 0.99$ ). A significant decline in  $W'$  was also found, but only at 3250 m ( $P = 0.03$ ) and 4250 m ( $P = 0.01$ ). A double-linear function characterised the effect of altitude on  $W'$  ( $R^2 = 0.99$ ). Upon completion of the 3 min TT in the intermittent test at 2250 m, W'BALdiff computed from actual ( $-1.29 \pm 3.48$  kJ) was not different to predicted ( $-1.08 \pm 3.27$  kJ;  $P = 0.65$ ). Also, W'BALint was not different between actual modeled ( $-2.83 \pm 2.75$  kJ) and predicted modeled ( $-2.61 \pm 2.56$  kJ;  $P = 0.67$ ). Compared to W'BAL = 0 kJ at end test, no difference was found for W'BALdiff at either 250 m ( $P = 0.33$ ) or 2250 m ( $P = 0.30$ ). However W'BALint was underestimated at 250 m approaching significance ( $P = 0.06$ ), and significantly at 2250 m ( $P = 0.02$ ). Conclusion The altitude prediction model for CP +  $W'$  developed in this study is suitable for use in the W'BAL model under acute hypoxic conditions. The differential W'BAL equation was found to model intermittent cycling performance effectively at both 250 m and 2250 m, however the integral W'BAL model appeared to underestimate actual performance. We recommend use of the differential W'BAL model for tasks involving maximal effort, short duration sprint intervals. References Wehrin & Hallen (2006). Eur J Appl Physiol (2006) 96: 404-412

## CARDIORESPIRATORY RESPONSES DURING NORMOBARIC HYPOXIC EXERCISE: COMPARISON BETWEEN ADULTS AND CHILDREN

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**Introduction** Exposure to altitude and/or normobaric hypoxia reduces aerobic performance in a dose-dependent manner (Wehrin, et al., 2006). Albeit recent investigations (Kriemler, et al., 2016), it currently remains unclear if hypoxia-induced performance reduction is similar in adults and children. The present study aimed to elucidate whether cardio-respiratory responses during submaximal normoxic and hypoxic exercise are comparable between adults and children. **Methods** Twenty-six healthy, low-altitude residents (Adults, N=13, Age=40(4) yrs., Body mass: 73(12) kg; Children, N=13, Age=8(2) yrs., Body mass: 29(7) kg) were tested in normoxia (Nor:  $FiO_2=0.209$ ;  $PiO_2=134(0.4)$  mmHg; 940m) on Day 1 and normobaric hypoxia (Hyp:  $FiO_2=0.162 \pm 0.003$ ;  $PiO_2=105(0.6)$  mmHg; ~3000 m) on Day 2 following an overnight hypoxic acclimation ( $\geq 12$ -hrs). On both days the participants underwent a graded exercise test on a cycle-ergometer (30W:2-min-1) and a simulated skiing protocol on a Pro Ski simulator (3 bouts of 2-min skiing). Minute ventilation (VE), oxygen uptake (VO<sub>2</sub>), capillary-oxygen saturation (SpO<sub>2</sub>) and heart rate (HR) responses were measured continuously during all tests. The graded exercise data were interpolated for two relative workload levels (1 W.kg<sup>-1</sup> & 2 W.kg<sup>-1</sup>). The data from the third exercise bout on the skiing ergometer was used for the analysis. Results Resting SpO<sub>2</sub> was significantly lower in hypoxia (Nor: 97(1)%; Hyp: 91(2)%;  $P < 0.01$ ), with no differences between groups. Higher resting HR in hypoxia, compared to normoxia was only noted in Children (Nor: 78(17); Hyp: 89(17) beats/min;  $P < 0.05$ ). Minute ventilation, O<sub>2</sub> uptake and HR responses were higher during the hypoxic graded test in both groups ( $P < 0.05$ ). Greater change in minute ventilation between normoxic and hypoxic cycling at 2W/kg was observed in Adults as compared to Children ( $P < 0.05$ ). Except for greater HR response during hypoxic vs. normoxic skiing in Children (Nor: 155(19); Hyp: 167(13) beats/min;  $P < 0.05$ ), all other skiing protocol responses were comparable between groups. **Discussion** Our data demonstrate comparable cardiorespiratory responses to submaximal hypoxic exercise in adults and children and corroborate recent findings of Kriemler et al. (2016) obtained during maximal exercise at terrestrial altitude. While the observed greater hypoxia-induced HR response in children was reported previously (Springer, et al., 1991), the underlying mechanisms remain to be elucidated. References Kriemler S, Radtke T, Burgi F, Lambrecht J, Zehnder M, Brunner-La Rocca HP. (2015). Scand J Med Sci Sports, 26, 147-155. Springer C, Barstow TJ, Wasserman K, & Cooper DM. (1991). Med Sci Sports Exerc, 23, 71-79. Wehrin JP, & Hallen J. (2006). Eur J Appl Physiol, 96, 404-412. Contact tadej.debevec@ijs.si

## POSITIVE EXPIRATORY PRESSURE IMPROVES ARTERIAL AND CEREBRAL OXYGENATION IN SUBJECTS EXPOSED TO HYPOBARIC AND NORMOBARIC HYPOXIA

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**Introduction** Positive expiratory pressure (PEP) is commonly used in critical care medicine to improve gas exchange and has been shown to limit hypoxia-induced reduction in arterial oxygen saturation (Nespoulet et al., 2013). However, no analyses have been conducted so far to compare PEP efficiency depending on the type (normobaric vs. hypobaric; NH vs. HH) and the duration of the hypoxic exposure. The aim of this study was to assess arterial and tissue oxygenation while using a PEP device after prolonged exposure to simulated (NH) vs. real (HH) altitude. **Methods** Fifteen healthy volunteers completed three randomized sessions consisted in 24 h of exposure to either normobaric normoxia (NN, inspired O<sub>2</sub> fraction:  $FiO_2=20.9\%$ ), NH (hypoxic room 3450 m,  $FiO_2=13.6\%$ , barometric pressure:  $PB=716$  mmHg, inspired O<sub>2</sub> pressure:  $PiO_2=91$  mmHg) or HH (Jungfraujoch 3450 m,  $FiO_2=20.9\%$ ,  $PB=481$  mmHg,  $PiO_2=91$  mmHg). After the 6th (+6h) and the 22nd (+22h) hours of exposure, subjects wore a face-mask allowing 2 x 5 min of quiet PEP (10 cmH<sub>2</sub>O) breathing interspaced with 5 min of free breathing. Arterial (SpO<sub>2</sub>, pulse oximetry), quadriceps (Mox) and cerebral (Cox) oxygenation (near-infrared spectroscopy), mean cerebral artery blood velocity (MCAv, transcranial Doppler), ventilation and cardiac function, were recorded continuously. Responses to PEP were average over the two 5-min periods for each time point. Results SpO<sub>2</sub> before PEP was significantly lower in HH (87% on average for both time points) compared to NH (91%) and NN (97%), and SpO<sub>2</sub> was higher at +22h compared to +6h. PEEP did not affect SpO<sub>2</sub> in NN but increased SpO<sub>2</sub> similarly in NH and HH ( $+4.3 \pm 2.5$  and  $+4.7 \pm 4.1\%$ , respectively at +6h and  $+3.5 \pm 2.2$  and  $+4.1 \pm 2.9\%$ , respectively at +22h), the SpO<sub>2</sub> increase being significantly higher at +6h compared to +22h. When pooling all conditions, an inverse correlation was shown between SpO<sub>2</sub> value before PEP and the amplitude of PEP-induced increase in SpO<sub>2</sub> ( $R = -0.7$ ). Cox was significantly improved with PEP in both NH and HH ( $P < 0.05$ ) with no difference between sessions. Mox was not affected by PEP. MCAv was reduced by PEP, whatever the session or the time point considered ( $-6.0 \pm 4.2$  cm/s on average). **Discussion** Data indicate that PEP could be an attractive non-pharmacological tool to improve arterial and cerebral oxygenation under both normobaric and hypobaric mild hypoxic conditions in healthy subjects. Future research should explore the relationship between such optimisation of arterial and tissue oxygenation despite a potentially threatened brain perfusion, and the development of acute mountain illnesses during higher and/or longer (chronic) altitude sojourns. References Nespoulet H. et al. (2013). Plos One, 23;8(12) e85219.

**INFLUENCE OF HYPERTHERMIA AND HYPOXIA ON PERFORMANCE AND PACING DURING A CYCLING TIME TRIAL**

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**Introduction** The regulation of prolonged self-paced exercise has received considerable interest over the last decade with various models of regulation having been proposed to modulate performance (Abbiss & Laursen, 2008; Edwards & Polman, 2013; Roelands et al., 2013). The aim of this study was to examine the influence of alterations in maximal oxygen uptake ( $\dot{V}O_{2\max}$ ) in mediating performance and pacing during prolonged time trial exercise in cool, hot and hypoxic conditions. **Methods** Twelve well-trained cyclists completed a 750 kJ time trial in temperate (COOL, 18°C), hot (HOT, 35°C) and hypoxic (HYP, 18°C,  $FI_{O_2}$ : 0.145) conditions, creating models with a stable, progressively decreasing, and acutely decreased  $\dot{V}O_{2\max}$ , respectively. Power output, cardiorespiratory, temperature and perceptual measurements were taken throughout the time trials. **Results** Trial completion was faster in COOL ( $48.2 \pm 5.7$  min) compared with HOT ( $55.4 \pm 5.0$  min) and HYP ( $60.1 \pm 6.5$  min) ( $P < 0.001$ ), with HOT being faster than HYP ( $P = 0.028$ ). Core temperature reached  $39.0 \pm 0.6^\circ\text{C}$  (COOL),  $39.8 \pm 0.5^\circ\text{C}$  (HOT) and  $38.5 \pm 0.4^\circ\text{C}$  (HYP;  $P < 0.01$ ). Power output during COOL was higher than HOT from 40% of work completed onward ( $P < 0.05$ ) and for the entirety of HYP ( $P < 0.001$ ), in which it was lower than HOT at 20–30% ( $P < 0.05$ ). Normalized power output during COOL and HYP varied by ~13% and ~16% respectively, whereas a ~27% variation occurred in HOT.  $\dot{V}O_2$  in COOL was higher than HOT from 70% onward ( $P < 0.01$ ) and higher than HYP throughout exercise ( $P < 0.001$ ). Relative to baseline  $\dot{V}O_{2\max}$  (% $\dot{V}O_{2\max}$ ) in normoxia (COOL and HOT) and hypoxia (HYP), % $\dot{V}O_{2\max}$  during HOT ( $78 \pm 8\%$ ) was lower than COOL ( $84 \pm 7\%$ ;  $P = 0.005$ ) and HYP ( $87 \pm 5\%$ ;  $P = 0.003$ ). The rating of perceived exertion increased in all condition ( $P < 0.001$ ) with the rise in HOT being greater than HYP ( $P = 0.029$ ). Thermal discomfort increased in all conditions ( $P < 0.001$ ) and significantly more so in HOT ( $P < 0.001$ ). **Conclusions** Despite an acutely reduced  $\dot{V}O_{2\max}$  and power output in HYP, pacing and % $\dot{V}O_{2\max}$  were similar to COOL. In contrast, the progressive decrease in  $\dot{V}O_{2\max}$  and power output in HOT resulted in a more variable pacing pattern with % $\dot{V}O_{2\max}$  decreasing throughout exercise. However, These data support the premise that pacing is associated with maintaining an optimal performance intensity (Périard & Racinais, 2015), in conjunction with acute and progressive alterations in  $\dot{V}O_{2\max}$ . **References** Abbiss CR & Laursen PB. (2008). *Sports Med*, 38, 239–252. Edwards AM & Polman RC. (2013). *Sports Med*, 43, 1057–1064. Périard JD & Racinais S. (2015). *J Appl Physiol*, 118, 1258N1265. Roelands B, de Koning J, Foster C, Hettinga F & Meeusen R. (2013). *Sports Med*, 43, 301–311.

**Oral presentations****OP-BN16 Muscle & Tendon Architecture****INSUFFICIENT ACCURACY OF THE ULTRASOUND-BASED DETERMINATION OF THE ACHILLES TENDON CROSS-SECTIONAL AREA**

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**Introduction** The accurate assessment of the Achilles tendon cross-sectional area (CSA) is a crucial prerequisite to investigate morphological tendon plasticity and to calculate the tendon Young's modulus (i.e. material properties) (Arampatzis et al., 2007). Besides the established magnetic resonance imaging (MRI), ultrasonography emerged as an alternative imaging technique for the measurement of the tendon CSA. The purpose of the present study was to assess the objectivity and reliability of the ultrasound-based methodology and its validity with respect to an MRI-based assessment. **Methods** The Achilles tendon CSA of 17 healthy male participants ( $27.8 \pm 3.9$  yrs.,  $180.3 \pm 6.7$  cm,  $76.3 \pm 8.5$  kg) was assessed by means of ultrasonography at the proximal, medial and distal position of the free tendon five times each on two separate days and three independent observers segmented the CSAs. For the validation, MRI-based CSA measurements were provided accordingly. **Results** The objectivity and reliability analysis of the ultrasound-based method revealed significant observer and measurement day effects ( $p < 0.05$ ), despite high intra-class correlation coefficients for the three observers ( $> 0.93$ ) and for both days ( $> 0.89$ ), respectively. The typical percentage error between both days was in average 7.1%. Comparing both methods, ultrasonography underestimated (19% in average) the CSA values obtained by MRI ( $p < 0.05$ ). Although the correlation coefficients of both methods were high in all three positions ( $> 0.88$ ), the respective range of the limits of agreement (Bland and Altman, 1986) of up to  $+28 \text{ mm}^2$  and  $-2 \text{ mm}^2$  evidence considerable inconsistency. **Discussion** The results of the present study provide evidence of strong limitations of the ultrasound-based Achilles tendon CSA determination methodology regarding the three mayor test quality criteria. Besides the dependency of the CSA determination from the observer, the ultrasound method is not sensitive enough to detect physiological changes in Achilles tendon morphology, as reported for longitudinal intervention studies (Arampatzis et al., 2007; Bohm et al., 2014). Furthermore, the validity analysis revealed a lack of agreement between both methods, since the ultrasound technique provided CSA values from 36% below to 3% above (i.e. relative limits of agreement) those determined by MRI as the accepted gold standard. Therefore, the ultrasound-based methodology cannot be recommended for the accurate Achilles tendon CSA determination in vivo. **References** 1. Arampatzis et al. (2007). *J Exp Biol*, 210: 2743–2753. 2. Bland and Altman (1986). *The Lancet*, 327: 307–310. 3. Bohm et al. (2014). *J Exp Biol*, 217: 4010–4017. Contact sebastian.bohm@hu-berlin.de

**EFFECTS OF KNEE COOLING ON IN VIVO PATELLAR TENDON MECHANICAL PROPERTIES**

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**INTRODUCTION** Controversy exists regarding the temperature dependency of tendon mechanical properties (Kubo et al., 2005; Muraoka et al., 2008). Specifically, no studies have investigated the effects of knee cooling on the in vivo human patellar tendon. Therefore, the aim of this study was to assess the material properties of the patellar tendon before and after local ice application. **METHODS** Twenty young, healthy women volunteered for the study. B-mode ultrasonography was used to record patellar tendon elongation during isometric ramp contraction of the knee extensors (5–7 s,  $90^\circ$  knee angle), and calculate tendon stiffness, Young's modulus as well as maximum strain and stress. Skin temperature was measured by infrared thermometry. Data were acquired before and after 30 min of local icing of the knee joint and compared by paired samples t-tests. **RESULTS** After cold exposure, skin temperature at the patellar tendon dropped from  $26.1 \pm 1.7$  to  $9.3 \pm 2.1^\circ\text{C}$ . Tendon stiffness and Young's modulus increased from  $2189 \pm 551$  to  $2705 \pm 902 \text{ N}\cdot\text{mm}^{-1}$  ( $+24\%$ ,  $p = 0.007$ ) and

1.32±3.4 to 1.60±4.9 GPa (+21%,  $p=0.010$ ), respectively. Tendon strain decreased from 8.6±1.6% to 7.8±1.4% (-10%,  $p=0.004$ ). A small, albeit significant reduction in maximum tendon force was observed (from 5148±1176 N to 4957±1048 N, -3.7%,  $p=0.03$ ). **DISCUSSION** Our data show a significant impact of local cold exposure on in vivo patellar tendon mechanical properties, especially on tendon stiffness and Young's modulus. The observed tendon stiffening may influence the operating range of sarcomeres, limiting the force generation capacity of knee extensor muscles acting on the descending limb of the length-tension curve. On the other hand, the increased stiffness might benefit rate of force development, thus countering the consequences of reduced enzymatic activity described for muscles under cold exposure (Drinkwater & Behm, 2007). Even more, a stiffer tendon would facilitate more accurate joint control (Rack & Ross, 1984). In conclusion, we found a significant impact of local cold exposure on in vivo patellar tendon mechanical properties, which is assumed to influence quadriceps muscle function, especially in explosive contractions. **REFERENCES** Drinkwater EJ & Behm DG. *Appl Physiol Nutr Metab*. 2007; 32: 1043-1051. Kubo K et al. *Clin Biomech (Bristol, Avon)*. 2005; 20: 291-300. Muraoka T et al. *Cells Tissues Organs*. 2008; 187: 152-160. Rack PM & Ross HF. *J Physiol*. 1984; 351: 99-110. **CONTACT** Dr. Robert Csapo: robert.csapo@uibk.ac.at **FUNDING** L. M. Alegre is recipient of a "Salvador de Madariaga" grant from the Spanish Ministry of Education, Culture and Sport.

## CONTRIBUTION OF BICEPS BRACHII TENDON MECHANICS TO FORCE STEADINESS IN YOUNG AND OLD ADULTS

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**Introduction:** Age-related decline in force steadiness (FS) is attributed to differences in absolute strength (1) as well as neural mechanisms associated with motor unit discharge rate variability, and inter-muscular coherence (2). However, muscle force is transmitted through the tendon and the age-related differences in tendon properties (3) have not been previously considered in upper-limb force control. Thus, the purpose of this study was to determine the contribution of the biceps brachii (BB) tendon to age-related decline in low levels of force steadiness in young and old adult men. It was hypothesized that a more compliant tendon in the old men would reduce force control during low-force matching tasks. **Methods:** Seven young (23±4yrs) and five old (81±3yrs) men participated in the present study. Isometric elbow flexion maximal voluntary contractions (MVC) were performed as well as submaximal targets at 2.5, 5, 10, 20, 40 and 60% MVC in a neutral position. Submaximal target forces were held for 5 seconds to assess force steadiness using the coefficient of variation (CV) in force around the target level. Tendon elongation and cross-sectional area were recorded for submaximal contractions with ultrasound to obtain tendon mechanical properties at 2.5% MVC. Surface electromyography (sEMG) of the BB short and long head, and lateral triceps were recorded. **Results:** Young men (254.8±52.3N) were stronger than old men (206.8±30.3N) ( $p=0.056$ ). Young had lower CV (1.1±1.6%) of force compared with old (2.1±1.0%) for all submaximal contractions ( $p<0.001$ ). Surface EMG was similar between young and old. Tendon elongation was greater in old (2.7±1.7mm) compared to young (1.2±0.6mm) ( $p=0.06$ ) at 2.5% MVC. Young (35.7±20.5N/mm) had greater tendon stiffness than old (9.8±5.6N/mm) at 2.5% MVC ( $p=0.04$ ), and stiffness was moderately correlated with force steadiness ( $r=0.51$ ). Young's modulus was higher in young (1583.7±921.1GPa) compared with old (617.9±547.4GPa) ( $p=0.06$ ). **Discussion:** These results indicate that young men are steadier than old men, and this difference might be due to a stiffer tendon improving force transmission from muscle to bone. Thus, changes in tendon mechanics with aging play a key role in older adults' ability to perform precise motor tasks of the elbow flexors. 1. Brown RE et al. (2010). *Eur J Appl Physiol*, 110(6):1251-1257. 2. Enoka RM et al. (2003). *J Electromyogr Kinesiol*, 13(1):1-12. 3. Narici MV et al. (2008). *Disabil Rehabil*, 30(20-22):1548-1554. rowan\_smart@hotmail.com

## DIFFERENTIAL STRAIN OF THE GASTROCNEMIUS TENDON DURING ISOMETRIC PLANTARFLEXION IN DIFFERENT FRONTAL PLANE FOOT POSITIONS

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**Introduction** The Achilles tendon (AT) is one of the most commonly injured sites in the human body. Tissue degeneration has been identified as the main cause (Kannus & Jozsa 1991), which may be influenced by shear forces and non-uniform strain distribution in the tendon. Non-uniform strain may be the result of rearfoot posture as the triceps surae is not only a plantarflexor, but also exerts inversion/eversion moments at the calcaneus (Arndt et al. 1999). The purpose of this study was to investigate possible strain differences in the gastrocnemius tendon by quantifying the displacement of the muscle-tendon junction (MTJ) of the lateral (GL) and medial (GM) heads of gastrocnemius. **Methods** 16 participants (9 male, 7 female, 26.3 ± 4.71 years) performed ramped isometric plantarflexions to 80%MVC with their left foot while the foot was in 10° eversion, 0° neutral and 10° inversion. Ultrasound imaging was used to determine MTJ displacement of GL and GM. Resting length of the GL and GM tendon was measured with a tape measure after marking the GL and GM MTJ and AT insertion on the calcaneus on the skin under ultrasound guidance. Strain was calculated from displacement and resting length. A One-Way ANOVA was used to test for statistical differences between the three foot positions. Differences between GL and GM were tested with a paired-samples t-test (both  $\alpha=0.05$ ). **Results** GL tendon strain at 80%MVC was 6.5±2% in eversion, 6.4±2% in neutral and 6.3±2% in inversion. Strain of the GM tendon was 8.2±2% in eversion, 8.4±2% in neutral and 8.1±2% in inversion at 80%MVC. There was no significant difference in strain for GL or GM between the three foot positions. Strain did not differ between GM and GL at lower contraction levels, but a significantly higher strain was found for GM tendon than GL tendon at 70%MVC ( $p=0.38$ ) and 80%MVC ( $p=0.01$ ). **Discussion** A difference in gastrocnemius tendon strain was not found in different frontal plane foot positions. However, GM tendon strain significantly exceeded that of the GL tendon at higher activation levels. This suggests that GM was more activated than GL contributing more to the overall ankle torque. This may be the result of the higher physiological cross-sectional area of GM (Albracht et al. 2008). Further investigation into the effect of frontal plane foot posture and GL and GM function on AT strain distribution is necessary to better understand the aetiology of injury and to improve lower leg muscle models. **References** Kannus, P., Jozsa L. (1991). *J Bone Joint Surg Am*, 73, 1507-1525. Arndt, A., Brüggemann, G.-P., Koebke, J., Segesser, B. (1999). *Foot Ankle Int*, 20, 450-455. Albracht, A., Arampatzis, A., Baltzopoulos, V. (2008). *J Biomech*, 41, 2211-2218.

## ACUTE EFFECTS OF LAB- AND FIELD-BASED CONTRACT-RELAX AND MODIFIED CR STRETCHING ON KNEE FLEXOR MUSCLE-TENDON MECHANICS

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**Introduction** Similar mechanical and neurological changes have recently been reported at the ankle following traditional contract-relax (CR) stretching and a modified contract-relax (MCR) technique where the contraction phase was performed 'off stretch' (Kay et al., 2016).

However, as these techniques were performed in a dynamometer, the efficacy of the modified technique in an athletic environment remains unknown. Therefore, the acute effects of both techniques were examined in lab- and field-based environments. Methods Using a randomised, cross-over design, 17 recreationally active subjects performed the CRlab, CRfield, MCRlab and MCRfield hamstring stretches (4 x 10-s stretches + 5-s contractions) on separate days. Before and after the stretches, maximal isometric and passive knee flexor moment and knee extension range of motion (ROM) were recorded on an isokinetic dynamometer. Semitendinosus electromyographic (EMG) activity was recorded simultaneously, whilst ultrasound imaging was used to record biceps femoris tendon elongation. Results Significant increases in knee extension ROM (4.6-5.2°;  $P < 0.01$ ) and elastic energy potential (12.0-23.6%;  $P < 0.05$ ), and decreases in the slope of the passive moment curve (8.9-12.2%;  $P < 0.05$ ) and tendon stiffness (10.8-15.1%;  $P < 0.05$ ) were observed in all conditions. A significant increase in peak passive moment (i.e. stretch tolerance) was observed after field-based stretches only (14.3-14.8%;  $P < 0.01$ ). No significant change ( $P > 0.05$ ) in maximal isometric strength, or volitional or reflexive EMG was observed in any condition. A significantly greater increase in elastic energy potential was observed following field- than lab-based stretches ( $P < 0.05$ ), however no difference in between-condition changes was found in any other measure ( $P > 0.05$ ). Conclusion The similar mechanical changes observed after CR and MCR stretching in lab- and field-based environments are indicative of common underlying mechanisms explaining the analogous ROM improvements. These data confirm both the efficacy of the MCR stretch technique to enhance knee flexor ROM and the ecological validity of performing this technique in an athletic environment. The implications for current practice are substantial as subjects completed the MCR technique without partner assistance, yet achieved similar acute increases in ROM as traditional CR stretching (i.e. the most effective stretching mode). Thus, the MCR stretching technique represents an equally effective yet more practical stretching paradigm. References Kay AD, Dods S, Blazevich AJ. (2016). Acute effects of contract-relax (CR) stretch versus a modified CR technique. *Eur J Appl Physiol*. doi: 10.1007/s00421-015-3320-8 Contact: tony.kay@northampton.ac.uk

## ACHILLES TENDON ADAPTATION TO NEUROMUSCULAR ELECTRICAL STIMULATION

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Achilles tendon adaptation to neuromuscular electrical stimulation Running head: NMES and tendon adaptations Abstract Purpose: Neuromuscular electrical stimulation (NMES), used as strength training mode, is known to improve neuromuscular function in healthy individuals with an increase in maximal voluntary contraction (MVC) as the main result. However, it remains unknown if NMES can induce tendon stress enough to lead to changes in tendon architecture or mechanical properties. Thus, the present study aimed to investigate the effect a long term NMES training program of the triceps surae (TS) muscle on architectural and mechanical properties of the Achilles tendon (AT) changes. Methods: Eight young male subjects ( $27 \pm 3.5$  yr) performed a 12 weeks high frequency NMES training program of TS muscle under isometric condition. Achilles tendon architecture was assessed using ultrasonography at rest to investigate changes following NMES training in free AT length, total AT length between musculotendinous junction (MTJ) between medial gastrocnemius and Achilles tendon insertion to calcaneus, and cross sectional area (CSA) at 25%, 50% and 75% of the free AT length. Mechanical properties of the musculotendinous junction between medial gastrocnemius and Achilles tendon were investigated from force and ultrasonographic measurements during maximal isometric ramp contractions. Results: NMES training did not lead to significant changes in the maximum elongation capability, free and total AT length, and AT CSA. Significant increase has been evidenced following a 12-weeks NMES training period in AT force (+25.2%), and stiffness (+5.2%) ( $P < 0.05$ ). After normalization with regard to Achilles tendon dimensions and moment arm, Young's modulus and maximal stress show significantly increase after NMES intervention (+12.4 and 23.4% respectively) ( $P < 0.05$ ). Conclusions: The present results highlight that a high frequency NMES training of the triceps surae muscle over 12 weeks induce a repeated stress sufficient enough to lead to impaired mechanical properties of the Achilles tendon. Thus, high frequency NMES could be an adjunct method for tendinopathy rehabilitation. Moreover, these results suggest that NMES may also be used to induce muscle and tendon stress enough to lead to adaptations during an imposed hypo-activity forbidding external work and then at least attenuate atrophy phenomenon. Correspondence Adrien Létocart, CNRS UMR 7338, Biomécanique et Bioingénierie, Université de Technologie de Compiègne, 60205 Compiègne cedex, France Tel +33 (0) 3 44 23 48 44; Email: adrien.letocart@utc.fr

## Oral presentations

### OP-BN10 Muscle Function

#### INTER-MUSCLE DIFFERENCES IN HAMSTRINGS STRAIN DURING A STRAIGHT LEG RAISE TEST: AN ELASTOGRAPHY STUDY

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Introduction Muscle's shear modulus (SeM) measured with ultrasound elastography method, changes as a function of joint angle [1] due to strain increase within a passively stretched muscle. Inter-muscle differences in SeM were also reported for the same joint angle: the medial gastrocnemius showing the highest stiffness [1] has a shorter muscle belly length [2] compared to the soleus showing the lowest stiffness. Thus, presumably relatively larger length change of a shorter muscle causes the higher differences in SeM. This may apply to the hamstrings having different muscle belly lengths: semimembranosus (SM) = semitendinosus (ST) < biceps femoris (BF). The aim of this study was to test the hypothesis that SeM is in reverse order with the lengths of hamstring muscles. Methods Ten healthy males ( $22 \pm 1$  yr) participated. In a supine position, the pelvis of a participant was secured to the bed and the fully extended knee joint was fixed to a lever arm of an isokinetic dynamometer. SeM from SM, ST, and BF (long) and hip joint torque were measured during a Straight-Leg-Raise test: The hip joint was changed from 40° (0=full extension) to 70° (ascending) with 10° increments, then from 70° to 40° (descending). Based on Hawkins and Hull [3], muscle-tendon unit lengths were estimated and relative changes in length (dL) were calculated to determine the dL-SeM relationship. The change of the area under the dL-SeM curves in the ascending and the descending phases was used as an index of hysteresis. One-way analysis of variance and multiple comparisons with Bonferroni correction were performed with a significance level of  $p < 0.05$ . Results and Discussion The passive hip extension torque and SeM of all muscles increased during hip flexion and decreased during hip extension with a significant amount of hysteresis. SM exhibited significantly higher SeM than other muscles at all angles studied as well as the ascending/descending slopes of dL-SeM curves. Our results showing inter-muscle strain



differences of hamstrings with SM being the most affected suggest that SM is responsible for the limitations of the hip joint range of motion. This notion is consistent with the larger hysteresis of SM SeM (31%) compared to ST (17%) and BF (14%) which might be the sign of prominent stretching effect on SM. Presently shown differences between SM and ST does not support the initial hypothesis and suggests factors on SeM other than dL, such as fascicle length differences between hamstring muscles (SM < BF < ST) [4]. References 1) Hirata, K. et al. (2015) J Biomech, 48: 1210-1213. 2) Ward, S.R. et al. (2009) Clin Orthop Relat Res, 467: 1074-1082. 3) Hawkins, D., Hull M.L. (1990) J Biomech, 23: 487-494. 4) Yamaguchi, G.T. et al. (1990) In: Multiple Muscle Systems. Springer, 717-774. Contact ykawa@waseda.jp

## THE INFLUENCE OF SODIUM BICARBONATE ON MAXIMAL FORCE AND RATES OF FORCE DEVELOPMENT IN THE CALF AND TRICEP DURING FATIGUING EXERCISE IN HUMANS

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**Introduction** The effect of sodium bicarbonate (NaHCO<sub>3</sub>) on fibre-specific maximal force production and rates of force development has been previously investigated in animal models (Broch-Lips et al., 2007; Higgins et al., 2013), with evidence suggesting an improved capacity to rapidly develop force (RFD) in fast- compared to slow-twitch muscle (Higgins et al., 2013). To date, these findings have not been replicated in the exercising human. In the present study, we have attempted to model in vivo the fatigue profile of maximal force and RFD in the calf (C) and triceps surae (TRI) after NaHCO<sub>3</sub> ingestion. **Methods** In a double-blind, 3-way repeated measures design participants (n=8) ingested either 0.3 g·kg<sup>-1</sup> NaHCO<sub>3</sub> (ALK) or equivalent calcium carbonate (PLA) prior to either 2-min of continuous (1Hz) supramaximal stimulation (300ms at 40Hz) of the C or TRI. Maximal voluntary efforts coupled with direct muscle stimulation of C or TRI were measured at baseline, 1-min and 2-min. **Results** Maximal voluntary force declined similarly over the 2-min in both muscles (-50.1±5.1N; p<0.001) irrespective of ALK or PLA (p=0.28). Voluntary (v)RFDmax (normalised to maximal force) was higher in TRI compared to C throughout the trial (TRI: 10.0±0.3; C: 4.9±0.4; p<0.001), but displayed a similar decline (-2.0±0.4; p<0.05). vRFDmax was higher in ALK than PLA (ALK: 7.8±0.2; PLA: 7.2±0.4; p<0.05). Maximal twitch amplitudes declined as a function of time for both C and TRI (-33.5±4.2N; p<0.001), but were not different between ALK or PLA (p=0.68). Twitch (t)RFDmax (normalised to maximal twitch) was higher in TRI compared to C (TRI: 9.1±0.5; C: 5.3±0.3; p<0.001), and did not decline during the 2-min. **Discussion** Although vRFDmax was better maintained during the 2-min in the ALK condition, no differences were observed between the calf and triceps surae for electrically stimulated fatigue. These findings contrast with recent findings in murine models (Higgins et al., 2013), however may also be representative of the difficulty of measuring the effect of pH on different muscle groups in vivo. Although the muscle groups selected have been shown to be predominantly fast- (~70% in TRI (Johnson et al., 1973)) and slow-twitch (~ 80% in C (Gollnick et al., 1974)), we cannot discount other processes intimately involved in attenuating fatigue (e.g. Hennemen's size principle) in the exercising human. **References** Broch-Lips M, Overgaard K, Praetorius H, Nielsen O. (2007) J Appl Physiol, 103, 494-503. Gollnick P, Sjodin B, Karlsson J, Jansson E, Saltin B. (1974) Pflugers Arch, 348, 247-255. Higgins M, Tallis J, Price M, James R. (2013) Eur J Appl Physiol, 113, 1331-1341. Johnson M, Polgar J, Weightman D, Appleton D. (1973) J Neurol Sci, 18, 111-129.

## THE INFLUENCE OF TRUNK ORIENTATION ON LOWER LIMB KINEMATICS AND LEG FUNCTION

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**Introduction** Being almost half of the total body mass, the trunk and its alignment can have an important impact on human motion (De Leva, 1996). Walking with maintaining bent postures may interfere with the pendulum mechanism. The stance dynamics of walking could be approximated by a bipedal spring-mass model. Compliant leg behavior provides explanation for basic dynamics of walking and running (Geyer, 2006). By modelling compliant leg behavior along the leg axis as a parallel spring-damper system, we aim to investigate the contribution of a spring-damper system to the leg behavior as a function of trunk orientation. **Methods** Kinematic data (Qualisys, 240Hz) and kinetic data (Kistler, 1000 Hz) of 12 able-bodied adults (6 m, 6 f) were recorded while walking at self-selected normal speed with regular erect trunk alignment (RE) and fully flexed trunk (FT). Axial leg function was modelled as parallel spring and damper elements:  $F_a = k(l_0 - l) - c\dot{l}$  ( $F_a$ , axial leg force;  $l_0$ , spring rest length;  $l$ , instantaneous effective leg length;  $\dot{l}$ , rate of change in the effective leg length).  $k$  and  $c$  are the effective leg stiffness and leg damping, respectively, obtained with a nonlinear fit by minimizing for each trial the sum of squared distances between measured forces and the forces calculated with equation (Andrada et al., 2014). **Results** Compared with RE gait, FT walking demonstrated significantly increased hip, knee and ankle flexion angles at TD and TO as well as greater pick hip and knee flexion angles along with greater ankle dorsiflexion and plantarflexion angles during the gait cycle. On contrary, hip, knee and ankle ranges of motion decreased. The angle of attack at TD and TO significantly decreased for FT (62; 112) compared to RE (66.1; 116), respectively. Effective leg length at TD remained almost unaffected ( $P=0.514$ ), whereas effective leg length at TO significantly decreased by 5.7%. Compared to RE walking, dimensionless effective leg stiffness significantly decreased almost 2 times and damper increased 3.4 times during FT gait. **Discussion** Walking with fully flexed trunk was associated with drastic kinematic adaptations in lower limb joints necessary for maintaining dynamic balance (Saha et al., 2008). Effective damping property of the leg, induced by bent posture, was responsible for compensatory kinematic adjustments during FT gait. Gait with bent posture is hypothesized to influence leg function such as leg length, leg stiffness and leg damping; thus, our findings would shade further light on the interaction between trunk orientation and leg operation. **References** Andrada E, Rode C, Sutedja Y, Nyakatura J, Blickhan R. (2014). Proc Biol Sci, 281, 20141405. De Leva P. (1996). J Biom, 29, 1223-1230. Geyer H, Seyfarth A, Blickhan R. (2006). Proc Biol Sci, 273, 2861-2867. Saha D, Gard S, Fatone S. (2008). Gait Posture, 27(4), 653-660. Contact soran.aminiaghdam@uni-jena.de

## REGIONAL ACTIVITY OF THE BICEPS FEMORIS AND SEMITENDINOSUS MUSCLES IN NORDIC HAMSTRING EXERCISE AND STIFF-LEG DEADLIFT

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**Introduction** Sprinting-type hamstring strain injuries mainly occur in the biceps femoris (Malliaropoulos et al., 2010), with the highest incidence in the proximal region (Silder et al., 2008). It has been shown previously that during the hip-dominant stiff-leg deadlift exercise, biceps femoris is preferentially activated compared to other hamstring muscles (Ono et al., 2011), while in the knee-dominant Nordic hamstring exercise, the semitendinosus is primarily involved (Bourne et al., 2015), implying task-specific relative involvement of hamstring muscles. In this study, we examined whether proximal, middle and distal regions of the biceps femoris and semitendinosus are activated

heterogeneously during these exercises. **Methods** To date, 10 male subjects without previous hamstring injury have participated in this study, which is ongoing. 16-channel array electrodes were attached over the biceps femoris and semitendinosus muscles to record electromyographic activity from different muscle regions during the Nordic hamstring and stiff-leg deadlift exercises. Root-mean-square activities for the distal, middle and proximal regions of the muscles were calculated in the lengthening phase of the tasks and normalized to the activity in maximal voluntary isometric contraction. Regional differences were analyzed using one-way repeated-measures ANOVA. Significance level was set at  $P < 0.05$ . **Results** During Nordic hamstring exercise, biceps femoris muscle activity was 22% lower in the proximal region compared to the distal region on average ( $p < 0.001$ ), while semitendinosus muscle did not show regional differences in muscle activity. However, in stiff-leg deadlift, no differences were observed between regions in either of the muscles. **Discussion** Our results imply that recruitment of biceps femoris muscle regions is heterogeneous and task-specific. Lower activity in the proximal region may be a contributing factor to region-specific muscle strain injuries. Future studies should determine whether these findings can be replicated in real-life movements associated with hamstring strains; and how lower contribution of the proximal region can be modified by training. **References** Bourne et al. (2015) *Scand J Med Sci Sports*, doi: 10.1111/sms.12494. Malliaropoulos et al. (2010) *Am J Sports Med* 38: 1813-1819. Ono et al. (2011) *Res Sports Med* 19(1):42-52. Silder et al. (2008) *Skelet Radiol* 37(12): 1101-1109. Contact andras.a.hegyi@jyu.fi

## EXPLOSIVE TORQUE CAPACITY AND FASCICLE BEHAVIOUR DURING ACCELERATED CONCENTRIC CONTRACTIONS

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**Introduction** Rate of torque development (RTD) is considered to be a functionally more relevant neuromuscular measure than maximal voluntary torque. However, despite the fact that many movements are characterized by acceleration, RTD usually is still evaluated during maximal voluntary isometric contractions (MVC) and it has never been obtained for accelerated instead of isovelocity concentric contractions. Therefore, this study investigated explosive torque capacity and fascicle behaviour during isometric and fast concentric contractions of quadriceps femoris. **Methods** Ten participants performed an isometric contraction (ISO), an isovelocity and additional concentric knee extensions (CON) at given angular accelerations ranging from 700 to 4000°·s<sup>-2</sup> on a isokinetic dynamometer (IsoMed2000, D&R Ferstl, GmbH, Hemau, GER, 1 kHz) that all resulted in an angular velocity of 300°·s<sup>-1</sup> at 40° knee flexion. Participants performed three MVC at the ISO and all CON conditions, which resulted in a total of 30 MVCs. Ultrasound (LogicScan 128 CEXT-1Z Kit, Telemed, Vilnius, Lithuania, 103-124 Hz) of vastus lateralis was measured to determine muscle fascicle length, pennation angle and fascicle velocity (FV) under each contraction conditions. Muscle torque and ultrasound data from CON were always obtained at the target angle of 40°. Additionally torque at 40° knee flexion was corrected for inertia and the corresponding isometric torque was obtained at the specific time from contraction onset to the time when the target knee angle of 40° was reached during CON. **Results** While isometric explosive torque capacity decreased from 189.7±39.7 Nm (ISO700) to 139.0±46.1 Nm (ISO4000) because of reduced available contraction time and increasing FV, the corresponding time matched explosive torque capacity (ETC) during concentric contractions increased with acceleration from 100.2±28.4 Nm (CON0) to 134.5±31.6 Nm (CON4000) and equaled isometric torque capacity during accelerations  $\geq 3000^\circ\text{s}^{-2}$ . This was accompanied by a reduction in FV from 43.2±25.0 mm·s<sup>-1</sup> (CON0) to 24.1±15.1 mm·s<sup>-1</sup> (CON4000). Time matched fascicle length and pennation angle showed no significant differences between ISO and CON. **Discussion** Our results provide novel evidence that acceleration influences the explosive torque capacity during concentric contractions. Enhanced force production with increasing acceleration can be explained by decreasing FV and reduced force depression. Based on model calculations from exemplar data it further was shown that MTU velocity differed from horizontal FV in terms of reduced FV so that tendon shortening likely contributed to overall MTU shortening velocity. These findings demonstrate that there is a crucial influence contraction history and series elasticity on ETC during accelerated concentric contractions. Patrick.Bakenecker@rub.de

## MOTOR ADAPTATIONS TO UNILATERAL QUADRICEPS FATIGUE DURING A BILATERAL PEDALING TASK

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**Purpose:** We aimed to investigate how motor coordination adapts to unilateral fatigue of the quadriceps muscle during a constant-load bilateral pedaling task. We first hypothesized that this local fatigue would induce a decrease in the knee joint power. Then, we aimed to determine whether this decrease would be compensated by i) between-joints compensations within the ipsilateral leg, ii) an increased contribution of the contralateral leg or iii) both. **Methods:** Fifteen healthy volunteers were tested during 1-min pedaling tasks at 350 W (90 rpm) before and after a fatigue protocol consisting of 15-min of electromyostimulation on the quadriceps muscle. Motor coordination was assessed from myoelectrical activity (22 muscles), pedal forces and joint powers calculated through inverse dynamics. **Results:** Maximal knee extension force decreased by 28.3±6.8% ( $P < 0.0005$ ) immediately after electromyostimulation. A decrease in knee joint extension power produced by the ipsilateral leg during pedaling was observed (-22.8±12.3 W;  $P < 0.0005$ ). To maintain the task goal, participants primarily increased the power produced by the contralateral leg during the flexion phase. This was achieved by an increase in hip flexion power (+14.9±8.6 W,  $P < 0.0005$ ) confirmed by an increased activation of the tensor fascia latae muscle ( $P = 0.003$ ). Within-leg compensations in antiphase (i.e. flexion) were also observed in some, but not all, participants. **Conclusion:** These results provide evidence that the nervous system readily adapts to unilateral fatigue by preferentially compensating with the contralateral leg during the flexion phase, i.e., synchronously with the decreased knee extension power. This might be explained by both a strong neural coupling between legs and mechanical constraints.

## Oral presentations

### OP-BN02 Neuromuscular

#### ACUTE WHOLE BODY VIBRATION IS ASSOCIATED WITH SPINAL AND SUPRASPINAL ADAPTATIONS

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**Introduction** Whole body vibration (WBV) has been demonstrated to improve functional movement control (Rittweger, 2010), but the knowledge about the underlying neurophysiological mechanisms remains fragmentary: Investigations have shown an inhibition of spinal excitability shortly after WBV while corticospinal modulation has been reported to be facilitated – but during WBV, only. Especially evidence regarding the maintenance of adaptations following vibration has not been clarified, yet. Therefore, this study aimed to investigate the acute adaptations of corticospinal and spinal excitability to WBV in one study. **Methods** In 44 healthy subjects corticospinal (A) and spinal adaptations (B) were tested before (t1), immediately (t2), 2 (t3), 4 (t4) and 10min (t5) after a 1-min-bout of WBV (30Hz, 3mm). (A) Transcranial magnetic and (B) Peripheral nerve stimulation were applied respectively, with the changes in motor evoked potentials (MEP) and H-reflexes being assessed in the m. soleus (SOL) and the m. gastrocnemius medialis (GM) by an rmANOVA. Body position was controlled with background electromyography (EMG) of SOL, GM as well as m. tibialis anterior (TA) and goniometric recordings of ankle and knee joint excursions with equivalence statistics. **Results** After vibration, (A) MEPs were significantly elevated in SOL compared to baseline values (t2 +15%, t3 +22%, t4 +15%, t5 +20%;  $P<0.05$ ), but did not change significantly in GM (t2 +32%, t3 +9%, t4 +8%, t5 +22%;  $P=0.07$ ). In contrast, (B) H-reflexes were diminished for SOL (t2 -19%, t3 -21%, t4 -20%, t5 -14%;  $P<0.05$ ) as well as GM (t2 -14%, t3 -16%, t4 -18%, t5 -16%;  $P<0.05$ ). Statistical equivalence was observed for SOL background EMG, ankle and knee joint deflections for (A) as well as SOL and GM background EMG and ankle joint deflections for (B). **Discussion** After an acute bout of WBV, results revealed (A) a sustaining facilitation of corticospinal pathways concomitant with (B) a suppression in spinal circuits. Those effects persisted for a minimum of 10 minutes and might illustrate increased corticospinal excitability while spinal excitability is inhibited. Functionally, those adaptations may point towards increased voluntary motor control (Chen and Zhou, 2011; Nielsen and Petersen, 1995): Facilitation comprising the origin of supraspinal structures might be associated with greater central movement control. Especially for populations with neurological motor diseases affecting the locomotor system this finding might be beneficial regarding motor learning and voluntary movement execution. **References** Chen Y-S, Zhou S. (2011). Gait Posture, 33(2), 169-178. Nielsen J, Petersen N. (1995). J Physiol. 484 (Pt 3), 777-789. Rittweger J. (2010). Eur J Appl Physiol, 108(5), 877-904. Contact anne.krause@sport.uni-freiburg.de

#### THE WILLINGNESS TO TOLERATE HIGHER LEVELS OF PERIPHERAL FATIGUE MIGHT EXPLAIN THE IMPROVED PERFORMANCE DURING HEAD-TO-HEAD CYCLING COMPETITIONS.

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1: University of Essex, School of Biological Sciences, Centre for Sports and Exercise Science (Colchester, UK) 2: University of Groningen, UMCG, Center for Human Movement Sciences (Groningen, The Netherlands) **Introduction** Perceptual affordances provided by the environment could influence the maximal effort an athlete is willing to exert, and alter pacing behavior and performance (Smits et al. 2014). In this perspective, the presence of an opponent has been shown to improve cycling performance as result of a faster initial pace (Corbett et al. 2012). The present study aimed to explore the potential differences in the origin of fatigue that could explain the performance improvement when racing against opponents. **Methods** Twelve moderately trained participants completed a maximal incremental test and three 4-km time trials (TT) on a VeloTron cycle ergometer. After a familiarization TT (TTfam), participants performed in random order a TT with no opponent (TTno) or a virtual opponent (TToppo). Repeated-measures ANOVAs ( $p<0.05$ ) were used to examine differences in pacing and performance related to power output, velocity, and finishing times. Measures of neuromuscular function for the assessment of central and peripheral fatigue were evaluated before and after the trial by delivering twin electrical stimuli (200- $\mu$ s duration; 10ms interval) to the right femoral nerve during MVC and at rest. In total three variables were obtained to quantify muscle performance; the maximal voluntary contraction (MVC), the voluntary activation (VA) and the potentiated twitch (PT). **Results** TToppo was completed faster compared to TTno (382.2 $\pm$ 31.9s vs. 393.6 $\pm$ 21.9s,  $P=0.022$ ), mainly due to a faster initial pace during TToppo. The reduction in MVC was higher in TToppo compared to TTno (MVCpre-vs-post: -17.5 $\pm$ 12.4% vs. -11.4 $\pm$ 10.9%,  $P=0.032$ ). This difference can be assigned to the higher levels of peripheral fatigue found after TToppo compared to TTno (PTpre-vs-post: -23.1 $\pm$ 14.0% vs. -16.2 $\pm$ 11.4%,  $P=0.041$ ), while no differences were found for central fatigue (VApre-vs-post: -4.9 $\pm$ 6.7% vs. -3.4 $\pm$ 5.0%,  $P=0.274$ ). **Discussion** The presence of a competitive opponent seems to enable the participants to use a greater degree of their physiologic capacity that is not fully accessed when competing alone. The present study has shown that the improved performance during head-to-head competitions compared to individual cycling time-trials could be assigned to the willingness to tolerate higher levels of peripheral fatigue. **References** Smits BLM, Pepping G-J, Hettinga FJ (2014) Sports Med, 44(6): 763-775 Corbett J, Barwood MU, Ouzounoglou A, Thelwell R, Dicks M (2012) Med Sci Sports Exerc, 44(3): 509-515 Contact fjhett@essex.ac.uk

#### INFLUENCE OF ACHILLES TENDON STIFFNESS ON TORQUE STEADINESS IN YOUNG AND OLD ADULTS

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**Introduction** When an individual produces a constant torque during an isometric voluntary contraction, torque fluctuates around the target level (2). Those fluctuations decrease non-linearly with the increase in contraction intensity (6), and are greater in old than young adults (3) at low torque levels (<15%1). Even though the extent of torque steadiness has been associated with neural mechanisms (2), mechanical properties of the tendon could also influence the finite control of torque output (4), especially in old adults who experience an age-related decrease in tendon stiffness (5). As no study has investigated the influence of tendon stiffness on torque steadiness, the aim of this project was to investigate the influence of Achilles tendon stiffness on torque steadiness during submaximal isometric contractions in young and old adults. **Methods** 14 young (23.6 $\pm$ 3.0yrs) and 14 old (71.3 $\pm$ 5.1yrs) adults participated in the study. Torque steadiness was assessed as the coefficient of variation (CV) for torque during voluntary isometric contractions performed with the plantar flexor muscles

at 5, 10, 15, 20 and 30% of maximal torque. Achilles tendon cross-sectional area and stiffness, estimated from the force-elongation relation obtained from the displacement of the muscle-tendon junction of the gastrocnemius lateralis during isometric contractions, were assessed by ultrasonography. Results The CV for torque was greater in old than young adults for the 5% torque ( $p=0.032$ ). Tendon stiffness was greater in young ( $171.6 \pm 56.1$  N/mm) than old adults ( $92.1 \pm 35.5$  N/mm,  $p<0.001$ ). Stepwise, multiple-regression analysis indicated that maximal torque and age predicted tendon stiffness (adjusted  $R^2=0.50$ ,  $p<0.001$ ). Moreover, tendon stiffness was associated with CV for torque during contractions performed at 5 ( $r^2=0.42$ ), 10 ( $r^2=0.18$ ) and 15% ( $r^2=0.10$ ) of maximal torque. Discussion These results indicate that Achilles tendon stiffness may contribute to plantar flexion torque steadiness, such that a reduction in tendon stiffness promotes greater variability in submaximal force output. This study further suggests that mechanical properties of the muscle-tendon unit should be considered when investigating performances in fine motor tasks and their alteration with ageing. References 1. Baudry et al. *J Neurophysiol.* 103:623-31;2010 2. Enoka et al. *J Electromyogr Kinesiol.* 13:1-12;2003 3. Galganski et al. *J Neurophysiol.* 69:2108-15;1993 4. Rack and Ross. *J Physiol.* 351:99-110;1984 5. Stenroth et al. *J Appl Physiol.* 13:1537-44;2012 6. Tracy and Enoka. *J Appl Physiol.* 92:1004-12;2002 j.johanns@ulb.ac.be Ms Johanna Johansson is supported by a grant of the National Research Fund of Luxembourg

## **INFLUENCE OF ACETAMINOPHEN INGESTION ON PERFORMANCE DURING INTERMITTENT MAXIMAL VOLUNTARY ISOMETRIC CONTRACTIONS**

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**Introduction** Acetaminophen (ACT) is the most commonly used medicine for general pain relief with emerging evidence suggesting that ACT can improve endurance exercise performance (e.g., Mauger et al., 2010). The ergogenic effect of ACT ingestion has been attributed to a lower pain and effort sensation permitting a higher power output during exercise. However, the physiological mechanisms that underlie the potential ergogenic effects of ACT ingestion are unclear. The purpose of this study was to explore the potential mechanistic bases for improved fatigue resistance following acute ACT consumption. **Methods** Following ethical approval and initial familiarisation, and in a randomised, double-blinded, cross-over experimental design, 13 active males completed 60 isometric maximum voluntary contractions (MVCs) of the knee extensor muscles after ingestion of 1g of maltodextrin (placebo) and 1g of ACT. Each MVC was 3-s in duration and interspersed by a 2-s passive recovery, with the critical torque (CT) taken as the mean torque over that last 12 MVCs and  $W'$  taken as the total amount of work completed above CT. Electromyography (EMG) was measured continuously during the 60 MVC protocol with peripheral nerve stimulation (PNS) administered every 6th contraction through the protocol for assessment of neuromuscular fatigue development. The compound action-potential (M-wave characteristics) in response to PNS was measured to assess changes in excitability, contractility and voluntary drive. **Results** The average torque (expressed as a % of the pre-exercise MVC) achieved across the 60 MVCs was greater with ACT ( $61 \pm 11\%$ ) compared to PL ( $58 \pm 14\%$ ;  $P<0.05$ ). Likewise, CT was increased with ACT ( $44 \pm 13\%$ ) compared to PL ( $40 \pm 15\%$ ;  $P<0.05$ ), but  $W'$  was not different between ACT and PL ( $P>0.05$ ). Neuromuscular function was not different between the interventions during or following the 60 MVC protocol ( $P>0.05$ ). **Discussion** Acute ingestion of ACT increased mean MVC torque over the 60 MVC protocol, consistent with findings of improved fatigue resistance during whole body locomotor exercise. The greater exercise capacity afforded by acute ACT ingestion was accompanied by similar end points in voluntary activation and m-wave amplitude, suggestive of a slower rate of neuromuscular fatigue development, and an increased CT. The increase in CT and attenuated decline in neuromuscular function during intense exercise provide novel insights into the mechanisms that underlie improved endurance exercise performance after acute ACT ingestion. **References** Mauger, A.R., Jones, A.M., & Williams, C.A. (2010). Influence of acetaminophen on performance during time trial cycling. *J. Appl. Physiol.* 108, 98–104. Contact pm273@exeter.ac.uk

## **TIMING OF MUSCLE ACTIVATION IS ALTERED DURING SINGLE-LEG LANDING TASKS FOLLOWING ACL RECONSTRUCTION AT THE TIME OF RETURN TO SPORT.**

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**INTRODUCTION** Several studies showed how the lower limb landing pattern is altered months and years following anterior cruciate ligament reconstruction (ACL). Existing literature is controversial in reporting successful or unsuccessful recovery of the motor control of landings after surgery (Bryant et al., 2009; Gokeler et al., 2010). The aim of this study was to compare the timing of activation of knee extensor and flexor muscles between anterior cruciate ligament reconstructed (ACL-R) and healthy subjects performing single-leg landing tasks at the time of return to sport. **METHODS** Fifteen male and 8 female patients at an average of 6 months following ACL reconstruction using either patellar tendon or semitendinosus and gracilis autograft were recruited. Fifteen male and 11 female served as the control group. Participants performed a Stop Landing (SL) in which they were asked to land holding a bent knee position of  $30^\circ$  and a Smooth Landing (SML) in which they were asked to land smoothly absorbing the impact. In both tasks they landed on a force plate from a 20 cm height platform. Normalized vertical ground reaction force (vGRF/BW), knee angular displacement and muscle activation of Vastus Lateralis (VL), Vastus Medialis (VM), Rectus Femoris (RF), Biceps Femoris (BF) muscles in the examined limb were recorded during the whole landing phase. One-way ANOVA was used to analyze the differences between the two groups ( $p<0.05$ ). **RESULTS** ACL-R patients showed longer pre-impact EMG duration of quadriceps and hamstrings muscles in the SL task (VM:  $137 \pm 49$  vs  $92 \pm 26$  ms, RF:  $131 \pm 51$  vs  $88 \pm 37$  ms, VL:  $142 \pm 56$  vs  $90 \pm 42$  ms, BF:  $190 \pm 42$  vs  $160 \pm 37$  ms, ST:  $188 \pm 45$  vs  $148 \pm 43$  ms) and in the SML task (VM:  $137 \pm 50$  vs  $81 \pm 24$  ms, RF:  $113 \pm 50$  vs  $85 \pm 23$  ms, VL:  $138 \pm 48$  vs  $75 \pm 21$  ms, ST:  $173 \pm 48$  vs  $143 \pm 36$  ms) as well as a wider Initial Contact (IC) knee angle (SL:  $9 \pm 5$  vs  $16 \pm 9^\circ$ ; SML:  $9 \pm 5$  vs  $17 \pm 10^\circ$ ) compared with healthy participants. No differences were found for vGRF/BW. **DISCUSSION** At the time of return to sport ACL-R group underlined longer quadriceps and hamstrings pre-impact EMG duration and a wider IC knee angle showing an altered neuromuscular control of single-leg landing tasks when compared to healthy subjects, thus increasing the risk of re-injury. **REFERENCES** Bryant AL, Newton RU, Steele J (2009) *J Electromyogr Kinesiol* 19:988–997 Gokeler A, Hof AL, Arnold MP, Dijkstra PU, Postema K, Otten E (2010) *Scand J Med Sci Sports* 20:e12–e19 CONTACT j.rocchi@uniroma4.it



## BIOMECHANICAL CHARACTERISTICS OF VERTICAL DROP JUMP TEST AND THE RISK OF ACL INJURY IN YOUNG FEMALE BASKETBALL AND FLOORBALL PLAYERS

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**Introduction** Young female athletes participating in sports involving running, pivoting, jumping and landing are at increased risk of sustaining anterior cruciate ligament (ACL) injury. Knee valgus loading plays a critical role in the mechanism of ACL injury. So far, however, few prospective studies have investigated biomechanical risk factors of ACL injury, and only one study has found an association between knee valgus loading and future ACL injury. Thus, the purpose of the study was to investigate the biomechanical risk factors of ACL injuries in young female athletes from basketball and floorball. **Methods** A total of 171 female basketball and floorball players (aged 12–21) participated in a vertical drop jump (VDJ) test using 3D motion analysis. The following biomechanical variables were analyzed in six separate Cox regression models: 1) knee valgus angle at initial contact (IC), 2) peak knee abduction moment, 3) knee flexion angle at IC, 4) peak knee flexion angle, 5) peak vertical ground reaction force (GRF), and 6) medial knee displacement (MKD). We registered new ACL injuries and players' match and training exposure until April 2014 (range, 1–3 years). Cox regression models were used to calculate hazard ratios (HRs) and 95 % confidence intervals (CIs). **Results** Fifteen new ACL injuries occurred during the study period (0.2 injuries / 1 000 player hours). Peak knee flexion angle (HR for 10 unit change 0.47; 95 % CI 0.27 – 0.81) and peak vertical GRF (HR for 100 unit change 1.31; 95 % CI 1.12 – 1.54) were associated with increased risk for ACL injury. Knee valgus angle at IC (HR for 10 unit change 1.89; 95 % CI 0.69 – 5.00), knee flexion angle at IC (HR for 10 unit change 1.31; 95 % CI 0.69 – 2.48), peak knee abduction moment (HR for 10 unit change 1.12; 95 % CI 0.89 to 1.43), and medial knee displacement (HR for 10 unit change 1.95; 95 % CI 0.72 – 1.24) were not significantly associated with ACL injuries. Of the adjustment factors, players' lower height (HR 0.85; 95 % CI 0.74 to 0.98), and playing at adult league level (HR 4.85; 95 % CI 1.14 to 20.62) were risk factors of ACL injury. Age, weight, sport and previous ACL injury were not significantly associated with ACL injuries. **Discussion** This prospective study showed that landing with decreased knee flexion and high vertical ground reaction force were associated with increased risk of ACL injury in young female basketball and floorball players. Our study did not find any significant associations between frontal plane biomechanics and future ACL injury. Based on these findings, preventive training should include neuromuscular training not only to avoid valgus movement but also to avoid stiff landings. **References** Hewett TE, Myer GD, Ford KR, et al. *Am J Sports Med.* 2005;33(4):492-501. Krosshaug T, Steffen K, Kristianslund E, et al. *Am J Sports Med.* 2016 (online first). Contact [maria.leppanen@jyu.fi](mailto:maria.leppanen@jyu.fi)

## Oral presentations

### OP-PM77 Overuse & Injuries - Treatment Modalities

## THE EFFECT OF DIFFERENT COLD WATER IMMERSION PROTOCOLS ON RECOVERY FROM EXERCISE-INDUCED MUSCLE DAMAGE

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Cryotherapy is widely accepted as recovery strategy to accelerate muscle recovery from strenuous exercise. Cold water immersion (CWI) is one of the most popular cold modality. It has been suggested that the therapeutic effect of CWI begins with water at 15 °C, but it is also assumed that lower temperatures may provide better outcomes (Merrick et al. 2003; Wilcock et al. 2006). However, the optimal temperature of CWI on the time course of muscle damage recovery are still controversial. Therefore, the aim of this study was to compare the effects of CWI at 15°C and CWI at 5°C on recovery from exercise-induced muscle damage. Forty-five college students performed a damaging exercise (5x20 drop jumps) and they were randomly allocated into one of three groups: 1) CWI at 5°C (G5, n=14), 2) CWI at 15°C (G15, n=14) or 3) control (CG, n=14). Individuals from CWI groups had their lower limbs immersed in water for 20 min, whereas those from control group remained seated for the same period. Isometric strength, countermovement jump (CMJ) performance, delayed-onset muscle soreness (DOMS), and serum creatine kinase (CK) activity were measured before, immediately after, 24, 48, 72, 96 and 168 h post-exercise. There was no difference between groups for isometric strength recovery (p=0.73). However, both G5 and G15 groups had a quicker recovery in CMJ performance than control group (p<0.05). Furthermore, G15 recovered CMJ performance 72 h, whereas G5 recovered only 96 h after EIMD. The control group did not recover CMJ at any time point investigated. G15 also demonstrated no significant difference on CK activity from baseline after 72 and 168 h post-exercise, whereas the CK from both G5 and GC remained higher than baseline throughout study's period. There was a trend toward lower DOMS (p=0.06) in G15 when compared to the GC 24 h post-exercise. CWI hastened CMJ performance recovery, but not the isometric strength recovery. This discrepancy suggest that CWI might enhance aspects of stretch-shortening cycle, such as: utilizing elastic energy of structures of the musculature, activating proprioceptive reflexes, increasing the time to produce force and/or by potentiating sarcomere length (Byrne et al. 2004; White et al. 2014). Furthermore, the groups demonstrated different time course recovery on CMJ. G15 recovered linearly, whereas both G5 and GC demonstrated a further decline in performance. This second drop in performance might be associated with a secondary damage as consequence of excessive inflammatory response (Byrne et al. 2004). In summary, the results of the present study suggest that independent of the temperature CWI may enhance muscle damage recovery. Also, it appears that 15 °C may improve recovery from strenuous exercise when compared to lower temperatures. **References** Merrick MA, Jutte LS, Smith ME. (2003). *J Athl Train*,38(1),28–33. Wilcock IM, Cronin JB, Hing WA. (2006). *Sports Med*,36(9),747-765. White GE, Rhind SG, Wells GD. (2014). *Eur J Appl Physiol*,114,2353–2367. Byrne C, Twist C, Eston R. (2004). *Sports Med*,34(1),49-69.

## DIFFERENCES IN PLANTAR PRESSURE DISTRIBUTION IN ELITE CYCLISTS WITH OVERUSE INJURIES

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**Introduction** To date, the relationship of the plantar pressures in cyclists and the occurrence of injuries is not well-defined (Carpes et al., 2010). The purpose of this study was to determine the differences between the plantar pressure pattern of cyclists with patellofemoral

syndrome (PS), iliotibial band syndrome (ITBS) and those with non-overload lower limbs injury (NI). Material and methods: In a sample of 50 professional cyclists, the plantar pressures were recorded while pedalling using the Biofoot / IBV® system. For pressure analysis, the foot was divided into 9 zones: 3 zones for fingers (F1, F2, F3), 3 zones for the metatarsals (C1, C2, C3), 2 zones for the midfoot (M1, M2) and the hindfoot area (H). Setting cadence at 100 rpm, two powers (100 and 200 Wats.) were used. The order of the test conditions was counterbalanced among all participants. Repeated measures ANOVA was performed with 4 intra-subject factors: Group (NI vs. PS or ITBS), power (100 vs. 200 Wats.) x Foot (Left vs. right) x Zones (F, C, MT, or M, L). Results: A significant interaction Group x Zone x Foot was found:  $F(1,50,46.66) = 6.07$ ,  $p = .009$ ,  $\eta^2 = .16$ , when cyclists with PS and NI were compared. The post hoc analyses indicated that differences occurred between both, right and left feet in cyclist with PS in areas F and C (forefoot). An interaction Group x Zone was also found:  $F(1,25) = 3.15$ ,  $p = .088$ ,  $\eta^2 = .11$ , comparing ITBS with NI cyclists. Further analysis showed that cyclists with ITBS applied more pressure in the L zone (lateral). Conclusions: As compared to NI cyclists, those with PS show a different plantar pressure pattern with higher pressures in the forefoot areas, in particular on the medial zones as described by other authors (van Zyl et al., 2001; Wanich et al., 2007). Moreover, cyclists with ITBS showed a distinct plantar pressure pattern compared with NI group. It was identified by greater pressure on the lateral foot area. Carpes, F. P., Mota, C. B., & Faria, I. E. (2010). On the bilateral asymmetry during running and cycling – A review considering leg preference. *Physical Therapy in Sport*, 11(4), 136-142. van Zyl, E., Schwellnus, M. P., & Noakes, T. D. (2001). A Review of the Etiology, Biomechanics, Diagnosis, and Management of Patellofemoral Pain in Cyclists. *International SportMed Journal*, 2(1), 1-34. Wanich, T., Hodgkins, C., Columbiere, J.-A., Muraski, E., & Kennedy, J. G. (2007). Cycling injuries of the lower extremity. *The Journal of the American Academy of Orthopaedic Surgeons*, 15(12), 748-756

## FISH OIL COUPLING WITH THERAPEUTIC ULTRASOUND FACILITATES HEALING OF RUPTURED ACHILLES TENDON

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Introduction Achilles tendon rupture is common in athletes but there is no consensus on the optimal treatment. Fish oil is rich in omega-3 fatty acids (n-3) and has been shown to suppress inflammation (Calder, 2013), promote collagen synthesis (Hankenson et al., 2000) and hence enhance connective tissue healing. Therapeutic ultrasound has long been reported to be effective for treating soft tissue injuries. The aims of the present study were to investigate the effect of topical fish oil coupled with ultrasound on healing of partial Achilles tendon rupture in a rat model. Methods Eighty five Sprague-Dawley rats with surgically hemi-transected right Achilles tendons were randomly assigned into four groups ie. topical placebo ointment as control (CON), topical fish oil (FO), ultrasound (US) and combination of ultrasound and fish oil (FU). Half of the animals were treated for 2 weeks while the rest were treated for 4 weeks. The right Achilles tendons were harvested after the treatment period for biomechanical assessments including structural stiffness and ultimate tensile strength (UTS). The values after normalization with the intact Achilles tendon were then compared between groups and treatment duration using two-way analysis of variance (ANOVA). Results The FU group demonstrated significant improvement in structural stiffness and UTS than CON at 4 weeks ( $p < 0.05$ ). Significantly higher UTS was observed in US than CON for both treatment periods ( $p < 0.05$ ). The FO group had increased structural stiffness at 4 weeks ( $p < 0.05$ ) than CON. Discussion Our findings revealed that fish oil either applied alone or incorporated with ultrasound improved biomechanical properties of injured tendon for longer treatment period. Although the actual mechanism behind is not certain, it is possible that the role of n-3 as a cyclooxygenase (COX) inhibitor may contribute to the positive findings as agreed with Virchenko et al. (2004). COX is an enzyme signaling pain and inflammation and hence n-3 suppress inflammation (Calder, 2013). In addition, our findings revealed that therapeutic ultrasound is effective in promoting tendon healing, which is consistent with the previous studies (Ng et al., 2003; Yeung et al., 2006). References Calder, P. C. (2013). *Br J Clin Pharmacol*, 75(3), 645-662. Hankenson, K. D., Watkins, B. A., Schoenlein, I. A., Allen, K. G. D., & Turek, J. J. (2000). *Proc Soc Exp Biol Med*, 223(1), 88-95. Ng, C. O. Y., Ng, G. Y. F., See, E. K. N., & Leung, M. C. P. (2003). *Ultrasound Med Biol*, 29(10), 1501-1506. Virchenko, O., Skoglund, B., & Aspenberg, P. (2004). *Am J Sports Med*, 32(7), 1743-1747. Yeung, C. K., Guo, X., & Ng, Y. F. (2006). *J Orthop Res*, 24(2), 193-201.

## MOVEMENT DYSFUNCTIONS IN LUMBAR AND HIP AREA RELATED TO OVERUSE INJURES IN HANDBALL MALE PLAYERS OF THE FIRST NATIONAL LEAGUE.

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Introduction In Handball many players train and play with pain during the season. Sometimes overuse injuries are overlooked, and evidence shows that altered movement patterns have a direct influence in this type of lesion. We try to show the direct relationship between movement failures in a specific direction and overuse injuries in first national league handball players. Methods A sample of 22 handball male players (mean age: 25.8 years) was included in the study. The mean period performing as elite athletes was 7.7 years. During two seasons, overuse injuries were recorded. Movement test for lumbar spine and hip control were performed (Comerford et al. 2012). The test were recorded and assessed during its performance and after reviewed by two physical therapists. Every video was assessed with the Kinovea® software to record angles and timing. Injuries over 2.5 on VAS and failure in the tests were compared. Results There 10 cases (45.4%) reporting left knee pain, 4 (18.2%) right knee pain, and 6 (27.3%) referred low back pain. Hip flexion during forward bending showed a mean range of  $86.4 \pm 12.6$  degrees, over the benchmark. Prone knee flexion was  $109.5 \pm 6.3$  on average, failing in 21 cases (95.5%) the benchmark range. During execution of prone knee flexion, the stabilizer disclosed a mean value  $73.2 \pm 8.9$  mmHg of values, being above the benchmark range in 5 cases (22.7%) and below in one case (4.5%). Failure in double knee flexion in prone position was related to the experience of pain in the jumping knee ( $p < 0.05$ ). Monopodal squat failure in the jumping knee was related with the experience of low back pain ( $p < 0.05$ ). All cases with low back pain displayed failure during Crook lift test. Discussion Failure in crook lift test and prone knee flexion were related to extension and rotation lumbar spine syndromes. Likewise hip position and its range of motion can be linked to low back pain (Van Dillen et al. 2000), as well as with knee pain (Levinger et al. 2007). Overuse pain recorded in lumbar and knee and failed tests on low back spine and hip seem to lead to an extension rotation dysfunction pattern in lumbar spine and lack of rotation control on the hip, especially in the jumping leg. Further studies with an extensive sampling should be performed to understand the role of motion dysfunction on the development of overuse injuries. References Comerford M, Mottram S. (2012) Kinetic control: the management of uncontrolled movement. Elsevier Australia. Van Dillen LR, McDonnell MK, Fleming DA, Sahrman SA. (2000). *JOSPT*, 30(6), 307-316. Levinger P, Gilleard W, Coleman C. (2007). *Phys Ther Sport*, 8(4), 163-168

## PREDICTING TOMMY JOHN SURGERY IN MAJOR LEAGUE BASEBALL: A MACHINE LEARNING APPROACH

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**Introduction** In the current decade, the number of ulnar collateral ligament reconstruction surgeries (also known as Tommy John surgery—TJS) in Major League Baseball (MLB) has increased 44% compared with the preceding decade, and 305% since the 1990s. With this surgery imposing an average 21 months away from MLB competition (Erickson et al., 2014) and potentially leading to declines in performance (Keller et al., 2014), there is an obvious need to curtail the epidemic. The aim of this study was to develop a machine learning model that could form part of the injury screening process in MLB. Methods 75 MLB relief pitchers who underwent TJS between 2010 and 2015 were identified and an age-matched control group of MLB relief pitchers created. Data relating to demographics, playing activity and 148,301 pitch trajectories were harvested from MLB databases. Two machine learning classifiers—naïve Bayes (NB) and linear support vector machine (SVM)—were constructed and optimized using a brute force approach (i.e., parsing every possible combination of predictor features). The predictive accuracy of each model (i.e., how accurately it predicted whether a pitcher would undergo TJS) was then assessed using six-fold cross-validation. To provide more explicit practical insight into the risk factors for TJS, a logistic regression was performed and odds ratios computed on significant ( $P < .05$ ) features. Results The SVM predicted TJS with an accuracy of 79% and NB with 80%. Optimization procedures revealed pitch speed, spin rate and average days between games to be the most valuable predictors of TJS. According to the odds ratios: (1) each 1 m/s increase in mean pitch speed increased a pitcher's odds of undergoing TJS by 48%; (2) each additional day a pitcher was afforded between consecutive games reduced his odds of TJS by 29%. Discussion Based on their predictive accuracy, the machine learning classifiers developed in this study could be deployed as part of an injury screening program to identify MLB relief pitchers who are at risk of catastrophic UCL injury. While MLB pitchers who throw with greater speed are reportedly more effective (Whiteside et al., 2015) the current data suggest that these pitchers are also more susceptible to TJS—an instructive finding for practitioners. Moreover, these data revealed that pitchers who were afforded more time between consecutive games had significantly lower odds of undergoing TJS—a finding with obvious implications for franchise-level roster management and league-wide policies in MLB. References Erickson B, Gupta A, Harris J, Bush-Joseph C, Bach B, Abrams G, San Juan A, Cole B & Romeo A. (2014). *Am J Sports Med*, 42(3), 536–543. Keller R, Steffes M, Zhuo D, Bey M, & Moutzouras V. (2014). *J Shoulder Elbow Surg*, 23(11), 1591–1598. Whiteside D, Martini D, Zernicke R, & Goulet, G. (2015). *J Strength Cond Res*. In press. Contact DWhiteside@tennis.com.au

## MOTOR ABILITIES OF PEOPLE WITH MEDIAN FOREARM NERVE INJURIES

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**INTRODUCTION** Forearm nerve injuries, although rare, can cause significant disability in functional abilities of injured hand. In majority of cases they are caused by cuts made by sharp objects, injuries caused by chainsaw or grinder, falls, gunshot injuries or traffic accidents (Rasulic et al., 2015). They can be associated with other injuries, such as soft tissue lacerations, bone fractures and vascular traumas (Puzovic et al., 2015). Although treatment of peripheral nerve injuries (PNI) significantly advanced during last 60 years, functional outcome still may be unsatisfactory. The aim of this study was to examine hand motor abilities of people surgically treated after median forearm nerve injury. **METHODS** Study included 30 subjects surgically treated because of traumatic median forearm nerve injury. Subjects with peripheral nerve tumors or different entrapment syndromes were excluded from the study, as well as the subjects with associated ulnar and/or radial nerve injury. After signing written information consent subjects performed motor ability testing of the injured and healthy hand. Testing was performed at least 3 years after the surgery. Test battery included: Purdue pegboard testing (PPT), Minnesota rate of manipulation testing (MRMT), hand grip (HGS) and pinch grip strength testing (PGS). Statistical procedures were done using the PASW 18 statistical package. The study was approved by the relevant Ethics Committee and it was part of a doctoral thesis project. **RESULTS** Results show that subjects with median forearm nerve injuries have weaker motor abilities of the injured hand in comparing to the non injured one. Motor abilities of the injured hand are highly influenced by the location of forearm injury, proximal vs distal and severity of the injury. In all the subjects, HGS was significantly lower in injured hand in comparing to non-injured one ( $p=0.05$ ), while with PGS it wasn't the case. PPT also showed significantly lower results of injured hand ( $p=0.05$ ), MRMT showed significant differences in subjects with proximal forearm nerve injuries ( $p=0.05$ ), while in subjects with distal forearm nerve injuries there wasn't significant differences. **DISCUSSION** Muscle denervation as a consequence of PNI causing lower muscle strength tested by hand grip dynamometer and fine hand and fingers coordination tested by PPT. Location of injury is influencing the functional outcome, since in proximal PNI during recovery axon has to bridge longer distance from the site of injury to the end motor organ. **REFERENCES** Rasulic L, Puzovic V, Rotim K, Jovanovic M, Samardzic M, Zivkovic B, Savic A. (2015). *Acta Clin Croat*, 54, 19–24. Puzovic V, Samardzic M, Jovanovic M, Zivkovic B, Savic A, Rasulic L. (2015). *Vojnosanit Pregl*, 72, 961–967. Corresponding author: Puzovic Vladimir puzovic.vladimir@gmail.com

## Oral presentations

### OP-PM27 Team Sports Performance

## PHYSIOLOGICAL PATTERNS OF ADAPTATIVE REACTIONS DETERMINE SUCCESS OR FAILURE IN CANADIAN NAT'L BASKETBALL: A 2014-2015 STUDY

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**Introduction:** The purpose: identify adaptational patterns in the cardiac system related to success or failure in Olympic level basketball players. **Methods:** The study involved 8 athletes of the Canadian Nat'l Men's Basketball Team. Data were obtained from 2 competitive periods: unsuccessful - 2014 (3 weeks) and successful - 2015 (8 weeks), where the Team was a finalist of the Pan-American games. The physiological parameters of the Central Nervous System (CNS), Autonomic Nervous System (ANS) and Cardiac System (CS) were frequently collected and assessed by Omegawave Team technology (Finland) using ECG and Direct Current Potential (DC) methods. Electrical cardiac activity was recorded using a portable, wireless, single-channel amplifier, located in a special chest belt. Two electrodes were placed

inside the belt in the medium axillary line on the right and left sides at a position close to lead V6 (Wilson). Recording time was 4 minutes and took place before training or competition (5:00 am to 12:00 pm). ECG amplitude analysis and Heart Rate Variability (HRV) methods were utilized. Data were analyzed using SPSS 23 (USA). Descriptive characteristics are presented as mean and standard deviation (SD). Data were checked for normality. Comparisons between two groups were made using Two-Independent-Samples Mann-Whitney U-test. Results: The following changes in data were observed in 2015 (compared to the 2014 period): HRV Parameters reflecting the activity of the parasympathetic division the ANS and autonomic contour of regulation were significantly lower. Vagal activity index (dX) was significantly decreased ( $P<0.05$ ) by 0.024 sec (5.3%), falling to  $0.427\pm0.15$  sec. RMSSD was significantly decreased ( $P<0.05$ ) by 36.5 ms (25%), falling to  $111\pm49$  ms. High Frequency power significantly decreased ( $P<0.05$ ) by 12 n.u. (21%), falling to  $46\pm20$  n.u. Conversely, parameters characterizing the activity of the sympathetic branch of the ANS and central contour regulation increased. Tension Index significantly increased ( $P<0.05$ ) by 13.5 r.u. (72%), rising to  $32\pm41$  r.u. Low Frequency/High Frequency Ratio significantly increased ( $P<0.05$ ) by 0.93 r.u. (102.9%) and reached  $1.83\pm1.74$  r.u. ECG parameters showed a significant increase (19.3%) in the amplitude of Q, R and S waves. The level of CNS activation also significantly increased. DC potential significantly increased by 5.29 mV (38.6%), rising to  $19\pm9.4$  mV. Discussion: Changes in HRV parameters, the increase in DC potential and the increase in the amplitudes of Q, R and S waves seem to have contributed to better results in the 2015 season. Contact: roman.fomin@omegawave.com

## EFFECT OF FATIGUE ON JUMP SHOT ACCURACY IN EXPERT AND JUNIOR BASKETBALL PLAYERS

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Introduction Fatigue is a multifactorial mechanism that involves the central nervous system, the peripheral nervous system and the muscular system. Moreover fatigue can also involve physiological factors. Fatigue is part of basketball and can influence the overall level of performance [1, 2]. The aim of the present study was to investigate the effect of fatigue on jump shot accuracy in expert and junior basketball players. Methods 11 elite (age  $26\pm6$  yrs) and 10 junior (age  $18\pm1$  yrs) basketball players were enrolled in the study. After a standardized warm up they were asked to perform 3 series of 20 consecutive jump shots following a low, medium and high fatigue protocol respectively. Rest among the three series of shots was set in 4 minutes. Heart rate was measured continuously and the Borg rating of Perceived Exertion (RPE) Scale was administered at the end of each series of shots. Fatigue protocol consisted on a combination of walking, running and sprinting with side-cutting manoeuvres. All jump shots were performed in correspondence of the free throw line. Results Elite players showed a better shot accuracy with respect to junior players for low (83% vs 64%), medium (75% vs 57%) and high (76% vs 60%) level of fatigue. Statistical analysis showed no effect of fatigue for both elite and junior players considering the whole series of 20 shots. However elite players increased significantly their shot accuracy comparing the first 10 shots and the last 10 shots during the high fatigue protocol. Discussion Elite players showed a better shot accuracy with respect to the junior players at each level of fatigue. However for both groups fatigue didn't influenced the shot accuracy itself. Interestingly, only in the high fatigue condition, the accuracy of elite players referred to the last 10 shots was better than the accuracy referred to the first 10 shots. These findings underlined the importance of proposing levels of intensity as close as possible to those experienced in real matches also in shooting workouts. References 1. Lyons M., Al-Nakeeb Y. and Nevill A. "The Impact of Moderate and High Intensity Total Body Fatigue on Passing Accuracy in Expert and Novice Basketball Players". J Sports Sci Med. 2006 Jun 1;5(2):215-27. 2. Taghreed A., "The Effect of Upper Extremity Fatigue on Grip Strength and Passing Accuracy in Junior Basketball Players". J Hum Kinet. 2013 Jul 5;37:71-9. Contact Giuseppe.marcolin@unipd.it

## JUMP PERFORMANCE AND FORCE-VELOCITY PROFILING IN HIGH-LEVEL VOLLEYBALL PLAYERS: A PILOT STUDY.

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Introduction Jump performance is the most important physical determinant of volleyball (VB) performance, at all levels of play (Ziv and Lidor, 2010). Research and practice have long sought to improve players jump height through specific strength training (Newton et al., 2006). Recently, the concept of optimal force-velocity (FV) profile has been related to jump performance: in addition to maximal lower limbs power (Pmax), a well-balanced FV profile is a key factor (Samozino et al., 2014). We investigated jump performance, Pmax and FV imbalance in pre-professional and professional VB players. Methods Using a simple method based on five loaded squat jumps, we determined Pmax and the FV imbalance (FVimb), i.e. the % difference between a player's actual and optimal FV profiles (Samozino et al., 2014) in the following groups: young elite (32 females, 22 males), professional (6 females, 8 males), professional in beach-VB (5 males). Results In both female and male players, jump height increased with the level of play (from 26.6 cm in young females to 37.8 cm in pro beach-VB males), as did Pmax (from 23.2 to 31.0 W/kg). All the groups tested showed on average a FVimb towards a deficit in maximal force capability. This FVimb was very similar between groups: -37 and -34% for female young and professional players, and -34 and -33% for male young and professional players, respectively. Interestingly, these FVimb were very variable within groups (coefficients of variation of 37 to 150%). Additional computations showed that on average, 10.4 % better jump heights (range: 0-38%) could be expected in these players should FVimb be reduced, all other things (e.g. Pmax) being equal. Discussion This pilot study provides a descriptive reference for young and professional high-level VB players, and paves the way for more individualized training programs. Indeed, we observed that the majority of players had a force deficit (negative FVimb), which means that, ceteris paribus, a force-oriented training program would result in improved jump performance in most players. However, the interest of this approach is that some players had an optimal FV profile and even a velocity deficit (high within-group variability), which means they would benefit from a different strength training than the majority of their teammates. This study supports the interest of an individualized FV profiling and strength work to improve jump height in VB players. References Newton RU, Rogers RA, Volek JS, Hakkinen K, Kraemer WJ. (2006). J Strength Cond Res, 20, 955-961. Samozino P, Edouard P, Sangnier S, Brughelli M, Gimenez P, Morin JB. (2014). Int J Sports Med, 35, 505-510. Ziv G and Lidor R. (2010). Scand J Med Sci Sports, 20, 556-567. Contact aurelien.broussal@gmail.com



## THE ACUTE EFFECTS OF VARYING WHOLE BODY VIBRATION EXPOSURE ON THE JUMP HEIGHT OF CLUB VOLLEYBALL PLAYERS

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**Introduction** Whole body vibration (WBV) has demonstrated rapid improvement to muscle strength or power when being vibrated on a platform. However, WBV studies have utilised sedentary individuals as participants and limited on athletes whom strength and power are their primary development in sport. There is an opportunity for South African athletes to improve their power output during game time using whole body vibration or as warm up protocol before games. The objective of this study was to measure the acute effects of varying high and low frequencies [0, 30, 35, 40, and 50 Hz] set at high and low displacements of WBV for 30 seconds on the countermovement jump performance in club volleyball players. **Methods** A single-blinded repeated-measures crossover study design was conducted. Club volleyball players ( $n=30$ ), 27 males (age,  $25.33 \pm 5.86$  years; height,  $1.83 \pm 0.73$  m; weight,  $84.06 \pm 13.23$  kg) completed countermovement jumps (CMJs) of maximal volition to assess peak power pre and post (immediately) randomised WBV stimuli set at varying frequency (0, 30, 35, 40, and 50 Hz), displacement (2-4 vs. 4-6 mm), and duration (30 seconds) combinations. Results Significant main effects were found for power (pre-to-post WBV,  $p < 0.048$ ), with repeated measures analysis of variance (paired sample test) emphasising that there was significant mean improvement of 9.4% in CMJ as a result of WBV at 35Hz but no significant change at other frequencies. Therefore, this study demonstrates that for athletic trained men, an acute 30-second bout of vertical WBV at 35Hz and 4-6mm peak-to-peak displacement significantly improves explosive jumping performance in comparison to other frequencies. **Conclusion** Acute vertical WBV for 30 seconds at 35Hz may be utilised as part of the warm up session to enhance explosive power in volleyball players; however, the acute mechanisms for improvements still need further well controlled investigations on chronic WBV training utilising strength/ power trained athletes.

## MATURATION AND ANTHROPOMETRIC CORRELATES OF AEROBIC CAPACITY IN TOP ELITE YOUNG FEMALE VOLLEYBALL PLAYERS: PWC170 VS. STEP TEST

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**Introduction** From a physiological point of view, performance in volleyball relies mostly on anaerobic power and anthropometry (1-6). Nonetheless a minimum of aerobic capacity is necessary for volleyball players to cope with the demands of training and certain game situations (e.g. long-lasting rallies). Whether two inexpensive tests of aerobic capacity, the physical working capacity at heart rate 170 bpm (PWC170) and YMCA step test, can be used interchangeably has not been examined yet. The aim of the present study was to examine the relationship between the YMCA step test and PWC170 in top elite young female volleyball players. **Methods** Forty-three selected female volleyball players (age 13.0 (0.6) yrs, height 171 (6) cm, weight 61.6 (6.6) kg) performed a series of anthropometric and aerobic capacity tests (PWC170 and YMCA step test). Results HR in the end of YMCA test correlated with PWC170 indices (0.780.087). **Conclusions** PWC170 and YMCA test showed very large correlations and their use in young volleyball players is further recommended. The lack of relationship of aerobic capacity with anthropometric and age parameters should be considered in training planning by coaches and fitness trainers. **References** 1. Nikolaidis, P.T., Afonso, J., Knechtle, B., Clemente-Suarez, V.J., Torres-Luque, G. Cuadernos de Psicología del Deporte (indexed in ISI, Scopus), 2016 epub. 2. Nikolaidis, P.T., Afonso, J., Clemente-Suarez, V., Padilla, J., Driss, T., Knechtle, B., Torres-Luque, G. Sports 2016; 4(1):9. 3. Laporta, L., Nikolaidis, P.T., Luke, T., Afonso, J. Journal of Human Kinetics 2015; 47(1):249-257. 4. Nikolaidis, P.T., Busko, K., Afonso, J., Chtourou, H., Padulo, J., Goudas, K., Heller, J. Human Physiology, 2015;41(6):636-643. 5. Nikolaidis, P.T., Afonso, J., Busko, K., Ingebrigtsen, J., Chtourou, H., Martin, J.J. Kinesiology 2015;47(1):75-81. 6. Nikolaidis, P.T., Afonso, J., Busko, K. Sport Sciences for Health 2015;11(1):29-35. Contact pademil@hotmail.com

## Oral presentations

### OP-PM28 Swimming

#### PERFORMANCE MODELLING IN SWIMMING

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**Introduction** Modelling the individual load-performance relationship to deduce information about convenient application of load and recovery phases to achieve optimal adaptation processes and estimate fitness and fatigue levels is essential for training theory. The existing linear and non-linear systems models abstract real-world settings and underlying physiology and need to be compared regarding their predictive accuracy, ability to copy adaptations and included variables (Taha & Thomas, 2003). **Methods** Training load and performance of five elite swimmers (17-27y, 1f/4m) was assessed for 25 weeks by recording swimming kilometers (volume) weighted by different stress levels (intensity) and performing Semi-Tethered-Tests (3x20m freestyle, increasing resistance) twice a week. Data was analyzed and modelled using the Fitness-Fatigue-Model (FF-Model), the Performance-Potential-Model (PerPot) and the Performance-Potential-Double-Model (PerPot DoMo) (Perl & Pfeiffer, 2011). Mean absolute percentage error (MAPE) and intraclass correlation coefficient (ICC) were computed to estimate the goodness of fit (model-fit) i.e. compare empirical and simulated performance. Results Resulting MAPEs  $\pm$ SD and mean ICCs were  $3.07 \pm 1.81\%$  and .65 for the FF-Model,  $2.94 \pm 1.23\%$  and .72 for PerPot and  $2.58 \pm 1.16\%$  and .81 for PerPot DoMo. **Discussion** The results indicate a slightly better goodness of fit for the PerPot DoMo in comparison to the FF-Model and PerPot, but no significance because of the high variance and small sample size. Two separate inputs (volume/intensity) enable PerPot DoMo to model performance more precisely than with one input (FF-Model, PerPot), though the model fit of all three models is appropriate regarding the performance's dynamics and variations. **References** Perl, J & Pfeiffer, M (2011). Int J Comp Sci Sport 10 (2), 85-92. Taha, T & Thomas, SG (2003). Sports Medicine, 33(14), 1061-1073. Contact chrasche@uni-mainz.de

## OXYGEN UPTAKE RESPONSE AT SUPRAMAXIMAL SWIMMING INTENSITIES – STUDY OF 50, 100 AND 200 METERS TIME TRIALS

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**Introduction:** Oxygen uptake kinetics (VO<sub>2</sub>K) is an important method for sports performance analysis, as faster kinetics seem to delay fatigue and improve performance. In swimming, VO<sub>2</sub>K studies focus mainly on submaximal transitions, however 95% of swimming events are performed at maximal or supramaximal intensities. This study aimed to describe the VO<sub>2</sub>K response at 50, 100 and 200 meters front crawl performance. **Methods:** Fourteen well trained male swimmers (age  $16.57 \pm 1.8$  yr.; mass  $70.5 \pm 9.95$  kg; height  $1.78 \pm 0.08$  m) completed a discontinuous incremental test designed with 6x250m plus 1x200m steps for maximal oxygen uptake (VO<sub>2</sub>peak) assessment, as well as the maximal aerobic swimming velocity (MAV). In complementary days and in randomized order swimmers maximal performance at 50, 100 and 200 meters were evaluated for VO<sub>2</sub>peak (VO<sub>2</sub>peak50, VO<sub>2</sub>peak100, VO<sub>2</sub>peak200, respectively), oxygen deficit determination and VO<sub>2</sub>K analysis. VO<sub>2</sub>K parameters (time delay, time constant and amplitude) were determined using a monoexponential modelling. All tests were conducted using a breath-by-breath apparatus (K4b2, Cosmed, Italy) connected to a swimming snorkel (AquaTrainer, Cosmed, Italy) for pulmonary gas sampling. **Results:** VO<sub>2</sub>peak ( $58.1 \pm 6.3$  ml/kg/min) was significantly different from VO<sub>2</sub>peak50 and VO<sub>2</sub>peak100 ( $49.5 \pm 4.9$  and  $55.6 \pm 6.1$  ml/kg/min, respectively), but not from VO<sub>2</sub>peak200 ( $57.7 \pm 6.8$  ml/kg/min). MAV ( $1.31 \pm 0.07$  m/s) was significantly different from the 50 and 100 m velocity ( $1.66 \pm 0.11$  and  $1.49 \pm 0.08$  m/s, respectively), but didn't show significant differences with the 200 m velocity ( $1.32 \pm 0.07$  m/s). Time delay and amplitude didn't present any significant differences between distances, but the time constant (τ) does, reducing as the exercise became shorter and more intense ( $8.1 \pm 2.2$  s vs  $11.2 \pm 2.3$  s vs  $16.3 \pm 6.9$  s for the 50, 100 and 200 m, respectively). Oxygen deficit didn't show any significant differences. **Discussion:** The VO<sub>2</sub>peak obtained in the incremental test was only reached in the 200m time trial, however we could say that near maximal values of VO<sub>2</sub> (approximately 96%) can be reached within 1 min of strenuous exercise, as seen in the 100m trial. This results are in line with Carter et al (2006) and Hettinga et al (2008) that observe similar results performed in running and cycling, respectively. Despite the VO<sub>2</sub> response was faster as the swimming trials became shorter, the differences on oxygen deficit at the onset of each trial was not observed. **References:** Carter, H., Pringle, J.S., Barstow, T.J., Doust, J.H. (2006). Oxygen uptake kinetics during supra VO<sub>2</sub>max treadmill running in humans. *Int J Sports Med*, 27(2),149-57. Hettinga, F.J., De Koning J.J., Foster C. (2009). VO<sub>2</sub> response in supramaximal cycling time trial exercise of 750 to 4000m. *Med Sci Sports Exerc* 41(1):230-6

## EFFECTS OF CIRCADIAN RHYTHMS ON NIGHT-TIME SWIMMING DURING THE OLYMPICS: WILL PERFORMANCE BE AFFECTED? – A PILOT STUDY FOR RIO 2016

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**Introduction** The impact of Circadian rhythms (CRs), among other factors, on sporting performance is already known (Cappert T, 1999). Unlike the usual timings for international events, the swimming competitions in the 2016 Olympics will be held between 22.00 and 00.30. Therefore, the aim of this study was to analyse sleep quality (SQ), heart rate variability (HRV), heart rate recovery (HRR) and the total mood disturbance (TMD) index during a week of night-time training and the influence they have on the state of overreaching. **Methods** Three male swimmers, qualified to the 2016 Olympics in Rio, were monitored during a week of night-time training sessions to correspond with the timings of Rio's semi-finals and finals. Assessments of SQ was calculated using actigraphy (Sensewear, Bodymedia USA), HRR, HRV (Minicardio, Hosand – Italy) and TMD were conducted five times during the whole simulation exercise with intervals of two days and once on the habituation day. All athletes answered a "morningness/eveningness" questionnaire in relation to the chronotype profile. The CRs were made to shift by five hours, such that the athletes woke up at 11.00 and retired for the day at 02.00, while their nutritional intake was integrated with Tryptophan in order to improve SQ. **Results** The Univariate ANOVA showed that, for HRV, which was classified in terms of Very Low Frequency (VLF), Low Frequency (LF) or High Frequency (HF), SQ showed significant effects between each time period (T0-T1-T2-T3-T4):  $F=9.481$  and  $p=0.002$ ,  $F=6.603$  and  $p=0.007$ ,  $F=9.209$  and  $p=0.002$ ,  $F=19.189$  and  $p<0.0001$ , respectively. Conversely, the Univariate ANOVA showed no significant effect on HRR, ( $F=0.817$  and  $p=0.542$ ). Finally, TMD was very low at the start ( $5.50 \pm 3.51$ ) respect  $81.00 \pm 18.90$  during the last session ( $p=0.031$ ). **Discussion** The main findings indicated that there are effects on HRV, SQ and TMD. The data suggest that training late at night increased sleep disturbance, fatigue and changes in autonomic functioning hinted at the onset of an overreached state. More than two days under "late night" conditions can inhibit the performance of athletes, with a major impact on their "morningness" profile. In order to reduce such an impact, greater emphasis must be placed on identifying the nutritional and sleep needs of elite swimmers, in order to put together adequate recovery strategies that will help them train effectively to maximize performance outcomes. **References** Sleep in Elite Athletes and Nutritional Interventions to Enhance Sleep – Halson S. – *Sports Med*. 2014 Review: Time of Day Effect on Athletic Performance: An Update – Cappaert T. – J. Strength. Cond. Res. 1999 Circadian Rhythms in Sports Performance: An Update – Drust B. et al. – *Chronobiol. Int*. 2005 Sleep, Circadian Rhythms, and Athletic Performance – Thun E. et al. – *Sleep Med. Rev*. 2015 Contact Gian Mario Migliaccio (info@sportsciencelab.uk)

## OXYGEN UPTAKE AND BLOOD LACTATE IN FULL AND FRACTIONATED SYNCHRONIZED SWIMMING DUET ROUTINES IN ELITE SWIMMERS

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**Introduction** Synchronized swimming (SS) combines intense muscular exercise with body position changes and prolonged apnoeic periods that impose additional physiological demands (Rodríguez-Zamora et al. 2012). Oxygen uptake (VO<sub>2</sub>) and blood lactate (Lab) have traditionally been used as key indicators to assess the internal load in sports. No studies have examined VO<sub>2</sub> in SS. We aimed to describe the time course of VO<sub>2</sub> and Lab across fractionated competitive routines in elite swimmers. **Methods** 16 elite junior and senior swimmers (age  $16.5 \pm 2.5$  years, height  $165 \pm 7$  cm, body mass  $53 \pm 8$  kg) completed eight full duet routines fractionated into two periods in coincidence with prolonged apnoeic periods. Measurements were taken before exercise (PRE) and before and after the full routine (FULL), and before and after the first and second prolonged apnoeic phases (Pre/PostAP1, Pre/PostAP2). Capillary blood samples were obtained from the earlobe at rest and at min 3, 5, (7) after each subroutine. VO<sub>2</sub> was estimated from 30-s backward extrapolation of breath-by-

breath postexercise measurements (K4 b2 Cosmed, Italy). RPE was measured with the Borg CR-10 scale. RM-ANOVA and post-hoc Bonferroni tests compared values obtained before and after the five subroutines ( $P < 0.05$  for significance). Results Exercise duration (s), peak Lab (mmol·l<sup>-1</sup>), and peak VO<sub>2</sub> (ml·kg<sup>-1</sup>·min<sup>-1</sup>) was, respectively: PRE: 0, 1.0±0.5, 10.4±3.4; PreAP1: 67±21, 3.7±1.6, 54.7±6.5; PostAP1: 81±22, 3.8±2.2, 55.5±9.6; PreAP2: 171±25, 4.9±1.9, 60.2±11.1; PostAP2: 183±23, 5.7±2.0, 60.7±10.8; and FULL: 197±10, 5.9±1.4, 61.8±15.1. All postexercise VO<sub>2</sub> and Lab values were different from PRE, but VO<sub>2</sub> was similar among subroutines and compared with FULL ( $P > 0.38$ ). Peak Lab was higher after FULL than after PreAP1 and PostAP1 ( $P = 0.04$  and  $0.005$ ). Discussion Continuous measurement of VO<sub>2</sub> and Lab during SS routines is not possible due to the frequent immersion phases. The fractionation strategy used here allowed us to build up a picture of the time course of these parameters across competitive duet routines in elite swimmers. VO<sub>2</sub> showed a fast rate of increase during exercise (e.g., ~90%VO<sub>2</sub>peak was attained after ~67 s). Since no differences were noted between in any of these parameters before and after prolonged apnoeic phases, we propose that the fast rate of increase of VO<sub>2</sub> and Lab accumulation are essentially caused by the high energy demands of exercise and not by the prolonged hypoxic bouts, despite the dramatic effect on heart rate. References Rodriguez-Zamora L, Iglesias X, Barrero A, Chaverri D, Erola P, Rodriguez FA (2012). PLoS One. 7: e49098. Contact farodri-guez@gencat.cat

## SLEEP CHARACTERISTICS IN YOUNG FEMALE SYNCHRONIZED SWIMMERS

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Introduction Sleep is considered to be one of the most important recovery techniques for elite athletes in both training and competition periods(1). Because little is known about the sleep pattern in athlete populations, the aim of this study was to identify sleep patterns in Belgian elite synchronized swimmers (SS). Methods 15 Belgian elite SS (14.5±1.4 years old; 7.4±0.9h of training per week), wherefrom 10 entered a competition, were included in this study. Daily sleep registration was made using a sleep diary, during a 12 week specific training and competition period. Total sleep time (TST) and sleep efficiency (SE = TST/time in bed) were calculated. Week and weekend sleep parameters were compared for all subjects during the entire period using a Paired Samples T-Test. The same statistical analysis was used for comparison between a training and competition period in all competitive athletes. Repeated Measures ANOVA was used to detect both differences in sleep parameters between a training period and the night before a competition and to identify day-to-day variability. Level of significance was set at  $p < 0.05$ . Results SS went to sleep and got up earlier during week versus weekend nights (22:02±0:29 vs. 22:49±0:41,  $p < 0.001$ ; 7:25±0:14 vs. 8:50±0:26,  $p < 0.001$ ), which led to a shorter TST, but not SE (539±38min vs. 580±46min,  $p < 0.001$ ). In competition periods, SS went to sleep earlier than during training periods, both in week (21:45±0:33 vs. 22:00±0:25,  $p = 0.024$ ) and weekend nights (21:53±0:38 vs. 22:44±0:39,  $p = 0.004$ ). Furthermore, in competition weekends, SS got up earlier than during training weekends (7:35±0:51 vs. 8:51±0:28). No significant differences in TST and SE were observed. The night before the competition, SS went to bed and got up earlier than during a normal weekend night (21:41±0:41 vs. 22:44±0:39). TST was diminished the night before the competition compared to a normal weekend night (509±70min vs. 580±50 min), however, without differences in SE. After a late training session, TST, but not SE, was shorter than during normal week nights (527±39min vs. 543±39min,  $p = 0.001$ ). Discussion SS tend to compensate sleep debts from the previous week during weekends which is not beneficial for recovery, due to a disruption of the sleep/wake cycle(2). Although SS adapt their sleep/wake rhythm before a competition, no equal TST is obtained compared to a normal night's sleep. Also, an impaired TST was observed in SS the night after a late night training session due to the late bedtime hour. Coach's awareness of the influence of training and competition scheduling on their athlete's sleep seems very important. References 1. Halson SL: Sleep in elite athletes and nutritional interventions to enhance sleep. Sports Med 2014, 44 Suppl 1: S13-S23. 2. Morin C, Espie C. Insomnia: a clinical guide to assessment and treatment. New York: Kluwer Academic Plenum Publisher; 2003.

## EVALUATION OF COACH-ASSISTED TRAINING VERSUS SELF-TRAINING IN AMATEUR SWIMMERS

PINNA, V.1, GIORDO, M.P.2,3, TOCCO, F.1, MULLIRI, G.1, GHIANI, G.1, CRISAFULLI, A.1, MAMELI, O.2, CARIA, M.A.2

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Introduction There is plenty of study on the quantification of physical performance in competitive athletes. This information is also extended to population over 40 yrs old (Baker and Tang, 2010). However investigations dealing with the effect of self-training procedures in amateurs athletes is not abundant. Aim of the present study was to compare the cardio-metabolic effects of two different training plans: a coach-assisted program followed by master swimmers (MS), and a self-administered program carried out by leisure swimmers (LS). Methods 18 healthy and active males were divided in 2 groups regularly practicing swimming 3 times a week in the last 3 years: MS (age: 48.4±7.4) usually taking part in competitions, and LS (age: 50.3±6.8) with the only aim to keep a good level of physical fitness. MS adhered to a specific training protocol administered by a Certified Coach of Italian Swimming Federation, while LS followed a self-administered workout. The total training distance covered by both groups was equal. Cardiovascular and metabolic parameters at the beginning of the study (T0) and after six months (T6) were assessed by means of a portable metabolic system during an incremental treadmill test, until exhaustion (Pinna et al. 2013). Results The two groups showed a significant increase in total time (TT) performance without any treatment effect (TT; MS=+11.9±13.4% vs. LS=+8.3±15.5%;  $p > 0.05$ ). Likewise, maximum speed reached (Msp) increased without any difference between groups (MS=+6.5±9.3% vs. LS=+2.1±10.6%;  $p > 0.05$ ). Of note, the MS group increased their maximal aerobic capacity with respect to the LS group (VO<sub>2</sub>max=+12.6±14% and +2.5±5.4% respectively;  $p < 0.05$ ). A similar phenomenon was observed for VO<sub>2</sub> at anaerobic threshold (VO<sub>2</sub>AT; MS=+16.8±16.8% vs. LS=+2.5±5.4%;  $p < 0.05$ ). Chronotropic response and index of the anaerobic capacity (CO<sub>2</sub> excess) were unmodified in both groups. Conclusions Our results show that only the coach-assisted training was able to evoke significant physiological adjustments in parameters related to aerobic capacity such as VO<sub>2</sub>max increase and VO<sub>2</sub>AT. Considering the equivalent amount of work in terms of total distance covered in MS and LS, this different outcome may be due to the training periodization followed by MS. Of note, these improvements can be detected by a specific cardiopulmonary treadmill tests. References Baker AB, Tang YQ. (2010). Exp Aging Res, 36, 453-477. Pinna M, Milia R, Roberto S, Marongiu E, Olla S, Loi A, Ortu M, Migliaccio GM, Tocco F, Concu A, Crisafulli A. (2013). J Physiol Sci, 63,7-16. Contact [virginia.pinna@gmail.com]

## Oral presentations

### OP-PM58 Gene Networks in Response to Exercise

#### CHANGES IN ISOMETRIC KNEE FLEXION TORQUE AND HAMSTRINGS EMGS UNDER THE DIFFERENT OF MUSCLE-TENDON LENGTH CONDITIONS

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**Introduction** Hamstrings muscle group is composed of the biceps femoris long head (BF), semimembranosus (SM), and semitendinosus (ST). The muscle-tendon length (ML) of each muscle is affected by hip and knee angle positions. Previous research reported that the amount of length change was different in each muscle. Kumazaki et al. (2012) reported that hamstrings generated maximal knee flexion torque where the knee joint was almost fully extended position, but EMG activities during the isometric contraction of hamstrings were maintained a similar level. It's still unclear how the different ML by changing hip and knee angles affects exerting force. The purpose of this study was to compare joint torque and EMG activities of the BF, SM, and ST under different ML conditions. **Methods** Thirteen healthy young subjects (age:  $21.1 \pm 1.0$  yrs, BH:  $173.1 \pm 4.4$  cm, BW:  $71.1 \pm 8.7$  kg) performed maximal isometric knee flexion by using the dynamometer (CON-TREX). Knee flexion torque data were collected from 10 combinations of hip and knee positions; knee flexion angle (Kangle) at 05, 30, 60, 90, 105 degree for both sitting (S) or prone (P). Surface EMG were recorded from 3 places on same muscle which were at the mid-point, proximal, and distal of the muscle belly in BF, ST and SM. Estimated ML was calculated using the equation from Hawkins and Hull (1990). **Results & Discussion** In hamstrings, the shortest ML were observed at P-Kangle105 and the longest ML were at S-Kangle05. Relative ranges of changes in ML as compared by thigh length were 0.35, 0.36 and 0.40 for BF, ST and SM, respectively. Higher knee flexion torque were observed at relatively longer ML conditions. Although total EMG activity was almost constant along every ML conditions. EMGs in both BF and SM decreased at both P-Kangle60, S-Kangle60, whereas, EMG in ST maintained steady regardless of changing ML. **Conclusion** Maximum knee flexion torque was observed under longer ML conditions such as S-Kangle05 posture. On the other hand, EMGs of hamstrings showed almost constant regardless of ML changes. **References** Kumazaki, T., Ehara, Y. and Sakai, T. (2012). *Int J Sports Med*, 33, 950-954. Hawkins, D. and Hull, M.L. (1990). *J Biomech*, 23, 487-494. Contact Email address [yukinayama@gmail.com]

#### CHANGES OF SKELETAL MUSCLE TRANSCRIPTOME IN ENDURANCE-TRAINED MEN AFTER ACUTE EXERCISE

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Changes in the human skeletal muscle transcriptome during early (1-4 h) and late (24-96 h) recovery periods after acute endurance exercise were investigated by DNA microarray in several studies. The goal of our work is to investigate changes of skeletal muscle transcriptome in endurance-trained men 4 h and 8 h after acute exercise using high-throughput RNA sequencing. Ten amateur endurance-trained athletes carried out bout of cycling (65 min, 70%  $\dot{V}O_{2max}$ ). Biopsies from the m. vastus lateralis were taken prior to exercise, and at 4 h and 8 h after. Total RNA was taken from samples of two subjects for RNA sequencing by Illumina HiSeq 2000 instrument prior to exercise, and at 4 and 8 h after (six samples in total). The differential expression of individual genes was confirmed by quantitative PCR using samples from all subjects ( $n=10$ ). 199 and 177 genes changed expression level ( $P_{adj} < 0.05$ ) at the 4 and 8 h after exercise accordingly; and only 68 genes displayed overlap. The expression of genes encoding transcription factors (TFs) increased for 12 genes and decreased for 13 genes after 4 h of recovery. Noteworthy, after 8 h recovery number of genes with decreased expression rose to 22. Well-characterized genes involved in regulation of OXPHOS and metabolic processes were among genes, which demonstrated increased expression, whereas many transcriptional repressors involved in clock and metabolic regulation were among genes, which decreased expression. Using Gene Ontology Enrichment Analysis with Reduce and Visualize Gene Ontology tool we revealed main groups of genes related to "regulation of cellular metabolism" and "response to organic substance" (at 4 h) and to "regulation of transcription" and "response to endogenous stimulus" (at 8 h). Surprisingly, we did not find main groups related to regulation of lipid or carbohydrate metabolism or mitochondrial biogenesis. Moreover, only 12 and 14 genes out of 1100 genes, which encode mitochondrial proteins, increased expression 4 h and 8 h after exercise, accordingly. We speculate that low number of changes in expression of genes, related to regulation of mitochondrial biogenesis, lipid and carbohydrate metabolism, is explained by fitness level of our subjects. Finally, to retrieve TFs that potentially might regulate genes after exercise TRANScripTION FACtor database was used. The largest number of TFs was associated with up-regulated genes at 4 h of recovery. Considerable part of these TFs consisted of basic-leucine zipper family TFs, namely members of AP-1 and ATF/CREB subfamilies. In conclusion, in endurance trained skeletal muscle acute exercise induced increased expression of genes encoding TFs, which regulate OXPHOS and metabolic processes, and decreased expression of genes, which encode transcription repressors. During early recovery period AP-1 and ATF/CREB related TFs may play an important role in regulation of exercise-induced genes expression. The work was supported by RSF grant № 14-15-00768.

#### GENE NETWORKS IN HUMAN SKELETAL MUSCLE FOLLOWING ENDURANCE EXERCISE ARE PRESERVED IN BLOOD NEUTROPHILS

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**Introduction** It remains incompletely understood whether there is an association between exercise-induced transcriptional patterns of skeletal muscle and blood leukocytes (Fehrenbach, 2007). This lack of knowledge is mainly due to the difficulties in comparing gene expression in the muscle and leukocytes between studies, as the studies involved different subjects, exercise protocols and sampling time-points. Using our original data on the changes in muscle and blood neutrophil transcriptomes in the same eight trained men before and 3, 48 and 96 h after 2 h cycling and running (Neubauer et al., 2013, 2014) enabled us to overcome these limitations and to directly compare the muscle and neutrophil transcriptomes. **Methods** Weighted gene co-expression network analysis (WGCNA), an advanced bioinformatic, network-driven method (Langfelder and Horvath, 2008), was applied for a systematic comparison. WGCNA was used to



verify whether clusters of inter-connected and interacting genes are preserved among skeletal muscle and neutrophils, and to assess correlations of muscle gene networks with blood inflammation and muscle damage markers. Results Three clusters of inter-connected genes were evident in muscle tissue and blood neutrophils, preserved across all time-points before and after exercise and functionally related to mitochondria and cell-physiological processes, including acetylation. Muscle gene sub-networks related to immune responses and acetylation correlated strongly with plasma creatine kinase activity, total leukocyte and neutrophil counts, C-reactive protein and interleukin-6 plasma concentrations. Discussion This is the first study that has identified gene networks that exist in both skeletal muscle and a blood leukocyte subset after acute exercise. These findings are a key step forward towards the potential use of particularly blood neutrophil gene profiling to assess muscle health and disease. Furthermore, the identified links between muscle gene networks and blood variables provide important information for developing blood biomarker panels to track changes in the muscle following exercise or other physiological stresses. Collectively, these findings highlight the value of WGCNA in sport science and physiology to analyze large, high-dimensional datasets. References Fehrenbach E. (2007). *J Appl Physiol.*, 102, 7-8. Langfelder P. and Horvath S. (2008). *BMC Bioinformatics*, 9, 559. Neubauer O. et al. (2013). *J Appl Physiol.*, 114, 1677-1688. Neubauer O. et al. (2014). *J Appl Physiol.*, 116, 274-287.

### THE EFFECTS OF ENDURANCE EXERCISE TRAINING ON THE EXPRESSION OF AMPK CATALYTIC A SUBUNIT AND MTOR SIGNALING PATHWAY IN PLANTARIS MUSCLE OF MIDDLE-AGED RATS

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**Introduction** The human muscle mass is reduced from 0.5 to 1% per year after 30 years old and this reduction significantly increased after 65 years old which eventually could cause sarcopenia (Nair, 2005). It is well known that the high level of inflammatory cytokines such as (including TNF- $\alpha$ , IL-6) appearing in the middle-aged people is highly relevant to the muscle mass loss of the muscle mass and decreased muscle strength (Visser et al., 2002). It has been reported that pro-inflammatory cytokines have an ability to can increase the protein degradations in skeletal muscle both in vitro and in rodent models (Haddad et al., 2005). We investigated the effects of endurance exercise training on the expression of AMPK catalytic  $\alpha$  subunit and mTOR signaling pathway in plantaris muscle of middle-aged rats. **Methods** Twenty of each age group: 50-week-old male Wistar rats and 8-week-old rats were randomly assigned into two groups: sedentary or exercise group. The exercise groups underwent a motor drive treadmill exercise (22 m/min, 30 min/day, 5 days/week) for 4 weeks. The expression level of AMPK, p-AMPK, AMPK $\alpha$ 1, AMPK $\alpha$ 2, mTOR, p70S6Kinase, 4E-BP1 in plantaris muscle were analyzed by western blotting. **Results** The AMPK, phospho-AMPK, mTOR, p70S6K protein contents in plantaris muscle were significantly decreased and AMPK $\alpha$ 1, 4E-BP1 protein contents were increased as aging. But AMPK $\alpha$ 2 protein contents were not changed. However after 4 weeks of endurance exercise training, AMPK, AMPK $\alpha$ 2 protein contents were significantly increased and 4E-BP1 level was decreased. The AMPK $\alpha$ 1 protein contents were tend to decreased, but it was not significantly different after exercise training. The p70S6K protein contents also show same level after exercise training. **Discussion** We thought that a high level of inflammatory cytokine and a lower level of anti-inflammatory cytokine cause the muscle mass loss and declined reaction to exercise training as the aging, which is considered to be influenced by reduced AMPK activity and PGC-1 $\alpha$  expression (Jung et al., 2015). We concluded endurance exercise training increase AMPK protein contents, especially it come from the increase of AMPK $\alpha$ 2 protein. These molecular changes were stimulated mTOR signaling pathway, but it did not show differences in the age. **References** Haddad F, Zaldivar F, Cooper DM, Adams GR. (2005). *J Appl Physiol*, 98, 911-917. Jung SR, Ahn NY, Kim SH, Byun JY, Joo YS, Kim SW, Jung YH, Park SL, Hwang IS, Kim KJ. (2015). *J Physiol Sci*, 65, 515-521 Nair KS. (2005). *Am J Clin Nutr*, 81, 953-963. Visser M, Pluijm SM, Stel VS, Bosscher RJ, Deeg DJ. (2002). *J Am Geriatr Soc*, 50, 1774-1781. Contact to e-mail : kjk744@kmu.ac.kr

### THE RNA EXPRESSION OF IGF1 ISOFORMS AND MYOMIR FAMILY MEMBERS IN A HYPERTROPHIC MUSCLE RAT MODEL

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**Introduction** Different insulin-like growth factor-1 (IGF-1) splice variants (IGF1, IGF-1Ea, and IGF-1Ec (MGF)) is suggested to have different functions in muscle hypertrophy. Besides these growth factors microRNAs as fundamental post-transcriptional regulators also regulate hypertrophy. The myomiR family, miRNAs specifically expressed in muscle tissues, include the miR-1, miR-133, miR-206, which are arranged into homologous genes clusters: the miR-1-2/miR-133a-1, the miR-1-1/miR-133a-2 and the miR-206/miR-133b (1). These genes clusters have been shown to be regulated by IGF1 proteins (2). To gain insight into the mechanism of muscle hypertrophy we investigate their expressions at RNA levels in our muscle overload animal model. **Methods** Compensatory overload of plantaris was accomplished by the bilateral removal of its synergists. The dorsal muscles of both legs were exposed, and the major portion of the gastrocnemius was excised after a blunt dissection, while the soleus muscle was entirely excised. Total RNA from plantaris skeletal muscle samples (~30 mg) was extracted with NucleoSpin RNA kit. RNA concentration, purity and integrity (RIN) was determined with an Agilent 2100 Bioanalyzer (RINs ranged from 7.1 to 8.9). One microgram of total RNA was used to synthesize cDNA using Tetro cDNA Synthesis Kit. The real-time quantitative PCR analyses were performed on a Rotor-Gene 6000 thermal cycler instrument. Reported values were normalized to the average values of the internal standards (housekeeping gene/miR). Statistical significance was assessed by ANOVA. The significance level was set at  $p = 0.05$  (Statistica ver. 12.). **Results** The mRNA level of all three IGF1 splicing variants was markedly upregulated in hypertrophic muscle: IGF1 3.5-fold, IGF1-Ea 2.7-fold, IGF1-Ec 3.2-fold ( $p < 0.01$ ). In contrast to, the RNA levels of myomiR members were downregulated: miR-1 and miR-133a 2-fold ( $p < 0.02$ ), or unchanged miR-206. The RNA level of both miR-1 miR-133a correlated negatively with that of IGF1-Ea and Ec splice variants ( $R = -0.84$ ,  $-0.88$  and  $R = -0.79$ ,  $-0.89$  respectively,  $p = 0.02$ ). However the RNA level of miR-206 shows no correlation with any of IGF1 splice variants. **Discussion** In our overload hypertrophic rat model the well-known muscle growth factor IGF1's all splice variants are similarly upregulated. However not every myomiR members show similar expression pattern. The correlation analysis shows a strong relation among IGF1 variants and two member of myomiR gene cluster: miR-1,-133a RNAs expression pattern. However the third member of these gene clusters miR-206 shows no correlation. These expression profiles may reveal the fine regulation of myomiR gene cluster's promoter activity by IGF1 variants in this model. **References** 1 Anderson C, Catoe H, Werner R (2006) *Nucleic Acids Res.* 34(20):5863-71. 2 Ma G, Wang Y, Li Y, et al. (2015) *Int J Biol Sci.* 11(3):345-352. Contact Zoltán Bori, Research Institute of Sport Sciences, University of Physical Education, bori@tf.hu

## ERYTHROPOIETIN DOES NOT PROMOTE HUMAN SKELETAL MUSCLE PROTEIN SYNTHESIS

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**Introduction:** Erythropoietin (EPO) is a glycoprotein hormone produced in response to tissue hypoxia; a process that results in a larger number of circulating erythrocytes and a better oxygenation of the active tissues. We previously showed that the EPO-receptor (EPO-R) is expressed in human skeletal muscle tissue (1). In cell lines expressing high levels of EPO-R, EPO treatment activates the phosphatidylinositol 3-kinase (PI3)/Akt (Akt) pathway and the Ras/mitogen-activated kinase (MAPK) signalling pathways, the 2 major pathways involved in the regulation of protein synthesis in human muscle. We hypothesized that EPO triggers protein synthesis in human skeletal muscle via the activation of Akt and MAPK signalling. **Methods:** Healthy young (n=10, 18-30 y) and older (n=10, 60-75 y) males received a bolus intravenous injection of 10'000 IU EPO (Recormon®) or placebo while subjected to a primed (0.34 mg/kg) constant infusion (0.0085 mg/kg/min) of L- [ring-13C6] phenylalanine. Venous blood samples were collected every 30 min and vastus lateralis muscle biopsy samples were obtained at rest (2h post-EPO) and 2 h following an acute bout of resistance exercise (3 sets of 14 repetitions of isotonic knee extension exercise at 60% 1RM) (4 h post-EPO). Mixed skeletal muscle fractional synthesis rate and phosphorylation levels of the members of the Akt and MAPK pathways were measured in muscle tissue. Muscle intracellular and bound protein [ring-13C6]-L-phenylalanine enrichments were determined by gas chromatography-mass spectrometry (GC-MS) using their tert-butyl dimethylsilyl derivative. **Results:** Exercise activated Akt but not MAPK signalling in young subjects only. EPO had no effect on fractional synthesis rate (protein synthesis) or on the activation of Akt or MAPK signalling following exercise. **Conclusion:** An acute EPO injection had no effect on skeletal muscle protein synthesis or markers of anabolic signalling in human skeletal muscle. These results suggest that the reported effects of EPO on human skeletal muscle are likely not due to the direct activation of the EPO-R, but rather a consequence of the well established enhanced oxygen carrying-capacity of the blood. **References** 1. Lamon S, Zacharewicz E, Stephens AN, Russell AP. EPO-receptor is present in mouse C2C12 and human primary skeletal muscle cells but EPO does not influence myogenesis. *Physiological reports*. 2014;2(3):e00256.

## Oral presentations

### OP-BN18 Sport Technology: Equipment 1

#### EFFECT OF SLOPE ON DISTANCE TO ZERO SKID AND COEFFICIENT OF FRICTION OF A PUTTED GOLF BALL

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**Introduction** A recent study (Griffiths et al. 2016) determined a method of finding the coefficient of kinetic friction for a number of different surfaces with use of a numerical simulation, however this method was only applicable to completely level surfaces. Therefore the aim of this study was to determine the effect that a sloped surface has on a putt golf ball, before finding the mean coefficient of kinetic friction of each variable, using a numerical simulation. **Methods** Twenty valid putts were tracked for the first 40cm of their travel across three different surfaces namely; rubber, a putt mat and MFC, on five different slopes; 0°, 1.2°, -1.2°, 2.2° and -2.2°, using a high speed video camera (360 frames per second). In order for a putt to be selected for analysis it had to fall within the following criteria; Initial ball speed - 3.4mph ± 0.25, Cut/hook spin - <20rpm and Initial launch angle - 0.75°-2.5°. A numerical simulation was created using the work of Penner, 2002 and Hierrezuelo & Carnero, 1995 to determine the coefficient of kinetic friction of each individual putt. **Results** The distance to zero skid was smallest for the 2.2° slope on the rubber, putt mat and MFC surfaces yielding mean values of 2.71", 8.24" and 12.5" respectively, whilst the -2.2° slope yielded the largest mean values of 3.08", 9.14" and 18.34" respectively. Results suggest that the greater the slope, the smaller the distance it takes for a golf ball to achieve pure rolling motion (i.e. negative relationship). The mean coefficient of kinetic friction for the rubber, putt mat and MFC surfaces ranged from  $\mu_k=0.74-0.75$ ,  $\mu_k=0.25-0.26$  and  $\mu_k=0.15-0.16$  respectively. **Discussion** The simulation was found to be accurate to 0.01μ in predicting the coefficient of kinetic friction of the three surfaces at different gradients of slope. It would be of interest for future research to investigate the relationship artificial surfaces have with grass (outdoor golf greens). If found to be similar it may be applicable to replicate putting green characteristics away from the golf course, for players to familiarise themselves with the conditions in order to prepare themselves for competition play. **References** Griffiths I, McKenzie R, Stredwick H, & Hurron P. (2016). In *Proceedings of the 10th International Symposium on Computer Science in Sports (ISCSS)* (pp. 129-138). Springer International Publishing. Hierrezuelo J, & Carnero C. (1995). *Physics Education*, 30(3), 177. Penner AR. (2002). *Canadian Journal of Physics*, 80(2), 83-96.

#### EFFECTS OF DIMPLE ON A SOCCER BALL FLIGHT

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**Introduction** It has been reported that the aerodynamic force applied to the ball changes in accordance with the number of panels and their orientation, consequently changing the flight trajectory (Goff et al., 2014; Hong & Asai, 2014; Hong et al., 2015). However, as the shapes on the surface of a soccer ball are a combination of various forms of panels and complicated seams, the influence that these shapes have on the aerodynamic force acting on the soccer ball is mostly unclear. Hence, in this study we aerodynamically studied the shape of the panels and the surface design (presence or absence of dimples). **Methods** In this study, we introduced dimples on the surface of a soccer ball and examined their effect on the aerodynamic forces acting on the ball using a wind tunnel. We targeted three types of soccer balls in this study, namely, a soccer balls constructed from 32 panels, 12 panels and 6 panels, all of which are made out of the same material (leather). In addition, for each type of soccer ball, we constructed a type with dimples (dimple width of 3 mm and depth of 1 mm) and a type without dimples, making a total of six types of soccer balls. We then studied and measured the effect of the number of panels and the presence or absence of dimples on these six types of soccer balls using a wind tunnel experiment and revealed the aerodynamic characteristics. **Results** The drag coefficient of soccer balls with dimples in the supercritical region, the soccer ball with 32 panels had the smallest drag value of approximately 0.10 ( $Re = 2.3 \times 10^5$ ) whereas the soccer ball with 12 and 6 panels had a

value of approximately 0.15 ( $Re = 2.1 \times 10^5$ ) and 0.17 ( $Re = 2.1 \times 10^5$ ). However, for the case of soccer balls without dimples, the soccer ball with 32 panels had a drag coefficient value of approximately 0.13 ( $Re = 3.5 \times 10^5$ ) and the soccer ball with 2 and 6 panels had a value of approximately 0.12 ( $Re = 3.5 \times 10^5$ ) and 0.12 ( $Re = 3.4 \times 10^5$ ). Furthermore, in a wind speed of 30 m/s, the variations in the lift and side force in the case of a soccer ball with 32 panels without dimples were 2.5 N and 2.6 N, respectively. Likewise, the dimple soccer balls with 32 panels were 1.3 N and 1.7 N, respectively. Conclusion The presence or absence of dimples on the surface of a soccer ball greatly varied the drag working on the ball. From this, it is plausible that, in the speed range used during a pass and a long kick, soccer balls with dimples have the possibility of flying faster, whereas, in the speed range used during powerful shots, soccer balls without dimples have the possibility of flying faster. In addition, during the flight of a soccer ball, horizontal motion is believed to be more stable for soccer balls with dimples than for soccer balls without dimples. References Goff E, Asai T, Hong S. (2014) J Sports Eng and Tech, 228, 188-194 Hong S, Asai T. (2014) Sci. Rep. 4, 5068 Hong S, Asai T, Seo K. (2015) Sci. Rep. 5, 15108

## SPIN BOWLING PERFORMANCE PARAMETERS AND ANALYSIS WITH A SMART CRICKET BALL

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Introduction Cricket is the 2nd-most popular sport in the world. In spin bowling, the ball is delivered at a slower speed than fast bowling, with putting a high spin rate on the ball, such that it bounces at an angle to the flight path. The aim of this research is to define and evaluate parameters for performance analysis with a smart cricket ball. Methods The smart cricket ball (Doljin and Fuss, 2015) used in this study is Mark 2 of the first prototype (Fuss et al., 2012). Mark 2 of the smart cricket ball is wireless (data transfer and inductive charging), and contains high-speed gyros, a circular PCB and a battery. The software of the ball calculates a range of performance parameters before release of the ball, among which are: spin rate, angular acceleration, precession speed, and normalised precession, torques and power about the centre of the ball, efficiency, pitch of the spin axis at release, and location and path of the centre of pressure between ball and hand. The data were collected during off- and leg-spin deliveries of 15 bowlers at different performance levels. The data were analysed statistically with regression analyses. Results and Discussion While the pitch of the spin axis at release, which should be 90 deg, i.e. perpendicular to the plane of the seam, indicates the amount of seam wobble, the most important performance parameter is the spin rate – the faster, the better. Yet, the spin rate alone is only an effect and does not explain its cause. The causes identified in this research are the torque imparted on the ball through the centre of pressure, the resulting acceleration and power, as well as precession and efficiency. E.g., two different bowlers produce the same spin rate, however one bowler requires less torque, acceleration and power than the other. The precession rate (speed of the moving spin axis) is caused by a torque that could have been used for improving the spin rate (and the kinetic energy at release) if the precession was avoided. The peak precession rate, the peak normalised precession (angle between spin axis and torque vector at the beginning of imparting spin on the ball; Fuss et al., 2015), and the efficiency (actual angular kinetic energy over ideal one if the precession was avoided) do not correlate well as they are taken at different times) and as they also depend on the spin delivery (wrist-spin and top-spin deliveries are more efficient than finger-spin and back-spin). However, the ratio of maximal acceleration to maximal spin rate correlates well with the peak precession ( $r = 0.89$ ). The greater this ratio is, the more slender is the acceleration spike (shorter time period), and it seems that the precession shortens this time period. References Fuss FK, Smith RM, Subic A. (2012). Proc Eng, 34, 128-133. Doljin B, Fuss FK. (2015). Proc Tech, 20, 133-137. Fuss FK, Doljin B, Ferdinands RED, Beach A. (2015). Proc Eng, 112, 196-201. Contact franz.fuss@rmit.edu.au

## INTERFACE PRESSURE GENERATED BY SPORTS GLOVES TO THE HAND OF THE WEARER AND ITS IMPACT ON SPORTS GLOVES ENGINEERING.

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Functional sporting gloves are commonly used and are often required in a number of sports such as hockey, baseball, lacrosse, cricket, golf and cycling. The main role of sports gloves is functional: protection from impact and abrasion or greater grip or dexterity of the wearer. It is also highly desirable that the sport gloves do not restrict the wearer's grip and dexterity. Glove design should enable dynamic freedom of movement while allowing avoidance of excessive pressure that could impede the grip strength; range of motion; performance of task; and physiological comfort of users [1]. Previous researchers have mainly focused on hand anthropometry data for development of a glove sizing system and on its pattern [2]. An earlier study [3] focused on the skin relaxed-strain ratio at the dorsal side of the hand to determine the skin deformation behaviour during various sports activities and demonstrated that the metacarpal regions had significantly higher skin relaxed-strain ratio than the phalangeal and metacarpal-carpal regions in both dynamic postures. These findings provide valuable information to be incorporated into sports and functional glove pattern design for improving the fit, comfort, performance and functionality of a sport glove. However, further studies are needed to quantify the interface pressure generated by sport gloves to the hand of the wearer in different hand postures and at different hand regions. The current study explores the interface pressure at the dorsal hand side during different dynamic postures which are typical for various sport activities. Fifteen female participants between the ages of 25-35 years with hand size medium (M) wore sports gloves and performed a relaxed hand posture and two dynamic postures. There were significant differences in the interface pressure between the experimental postures, especially in phalangeal and metacarpal regions. It was determined that sports gloves generate significantly larger interface pressure in the metacarpal region than in the phalangeal region and metacarpal-carpal region. This study has further contributed to enhancing the knowledge of the glove's behaviour during various sports activities and the interface pressure generated by them which are important for the engineering of sports and functional gloves with improved fit, comfort, and functionality. [1] E. Sparks, "Design Issues in Military Footwear and Handwear," in *Advances in Military Textiles and Personal Equipment*, ed: Woodhead Publishing, 2012, pp. 139-164. [2] K. M. Robinette and J. F. Annis, "A nine-size system for chemical defense gloves," *Armstrong Aerospace Medical Research Laboratory, Wright-Patterson Air Force Base, OH1986*. [3] Nasir, S.H., Troynikov, O. and Watson, C., 2015. Skin deformation behaviour during hand movements and their impact on functional sports glove design. *Procedia Engineering*, 112, pp.92-97.

## Oral presentations

### OP-PM21 Soccer Assessments

#### TIME-MOTION ANALYSIS IN ELITE SOCCER PLAYERS: SMALL-SIDED GAMES VS. MATCH PERFORMANCE

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**Introduction:** Video-analysis and global positioning system (GPS) are used to determine players' loads and drills during soccer activities. Small-sided games (SSGs) are generally utilized as skill-based conditioning drills, the workload intensity of which is a crucial feature. The aim of the study was to compare the equivalent distance (ED, i.e., the distance that a given player would have run, given the actually measured overall energy expenditure, had he been running at constant speed throughout the whole match) (di Prampero et al., 2015) determined during SSG in different pitch dimension with average ED during official matches (EDmatch). For this approach, the interchangeability of video analysis and GPS during SSGs is a crucial issue and was also assessed (Buchheit et al., 2014). **Methods:** Twenty-five elite soccer players (Italian Serie A) performed a total of 1033 and 1532 observations for collective possession plays (SSG-P) and SSGs with goalkeeper (SSG-G), respectively. SSGs were evaluated by GPS (10 Hz; accelerometer: 100 Hz, 16G Tri-Axis). For each player, a median of  $39 \pm 14$  SSG-P (mean  $\pm$  SD) and  $57 \pm 17$  SSG-G were examined on different pitch dimensions. Each drill was normalized per meter covered in one minute (m-min<sup>-1</sup>) and area per player (m<sup>2</sup>-player). In addition, thirty-nine official matches ( $18 \pm 9$  observations per player) were monitored by semi-automatic multiple cameras. Lastly, a typical training session with SSGs was monitored with both GPS and video-analysis to assess the interchangeability of the two methodologies. **Results:** A small typical error of the estimate (TEE: 0.07, 95% confidence intervals: 0.04/0.13) and a higher correlation ( $r^2=0.99$ ,  $P<0.001$ ) were found between ED calculated from GPS and video-analysis. A correlation ( $r^2=0.788$ ,  $P<0.001$ ) between ED and area per player was found only for SSG-P. The regression line in SSG-P crossed EDmatch at an average area of  $95 \pm 8$  m<sup>2</sup>-player with a smaller dimension ( $36 \pm 1$  m<sup>2</sup>-player) for central defenders (CD) than other roles ( $P<0.05$ ). **Discussion:** A small TEE and a higher correlation permitted a comparison between GPS and video-analysis with these technologies. Due to a lower tactical and higher physical involvement than in SSG-G, ED increased with area per player and induced average EDmatch only during SSG-P, with a less area per player in CD. These findings may contribute to better assess workloads using SSG-P with respect to match intensity for each role. **References:** di Prampero PE, Botter A, Osgnach C (2015). Eur J Appl Physiol, 115(3):451-69 Buchheit M, Allen A, Poon TK, Modonutti M, Gregson W, Di Salvo W (2014). J Sports Sci, 32(20):1844-57 Contact: andrea.riboli@unimi.it

#### CRITERION VALIDITY OF THE LOUGHBOROUGH SOCCER PASSING TEST IN ELITE YOUTH SOCCER

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**INTRODUCTION** Successful passing is a key component of skilled performance in football, particularly for elite youth players. Owing to the difficulty of assessing passing performance in a controlled environment in games, field tests have been developed to isolate the measurement of this skill. The Loughborough Soccer Passing Test (LSPT) is commonly used to assess passing performance under time pressure. The test is reliable and displays discriminant validity in youth soccer. Here we report its criterion validity with such athletes. **METHODS** Twenty-five players from the U18 state representative team (age  $15.1 \pm 0.6$ ) performed the LSPT. The first eight games of the season were then recorded and coded for passing ability using a custom-made coding window from commercially-available software (Sports-Code, Hudl). Data were coded according to two scenarios. The first reflected overall success rate for all passes within a game. The second scenario represented a high-quality passing situation and passes were included only when they met all the following criteria: the player had performed  $\leq 3$  touches before the pass, the pass led to a scoring opportunity or forward movement of a team-mate, the pass occurred across halves or in the opponent's half, and pass direction was forward or sideways. Inter-rater agreement was assessed for overall passing success rate using Cohen's kappa. Criterion validity of the LSPT scores was assessed as the correlation between the players' mean passing score and their LSPT score. The validity correlation coefficient was then adjusted to take into account the error of the criterion using the intraclass correlation coefficient (ICC) for the mean passing score in 8 games. **RESULTS** Inter-rater agreement kappa was 1.00. The ICC for 8-game reliability was 0.67 for overall passing success and 0.75 for the high-quality situation. Overall validity of the LSPT compared to the criterion was very poor for both time-only LSPT (corrected  $r=0.59$ ) and LSPT total time (corrected  $r=0.58$ ). Validity of the LSPT compared to the criterion in the high-quality passing scenario was impractical for both time-only LSPT (corrected  $r=0.32$ ) and LSPT total time (corrected  $r=0.18$ ). **DISCUSSION** This study demonstrated for the first time that the LSPT does not have criterion validity in Australian elite youth football. Despite the strong reliability and discriminant validity, attention must be paid to the interpretation of the test result, as it does not accurately represent in-game passing performance. **CONTACT** Dr Fabio R. Serpiello, fabio.serpiello@vu.edu.au

#### HIGH INTENSITY EVENTS AND POST-MATCH FATIGUE IN FOOTBALL

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**Introduction** Football matches produce post-match fatigue and time until full recovery may take several days (Nedelec et al., 2012). The slow recovery, probably related to muscle damage, has been associated to the high intensity activities during the match (e.g. Russel et al., 2016). However, the role of accelerations and decelerations in this relationship is not well understood. Therefore, the aim of this study was to investigate high intensity events (HIE) in football matches using Inertial Measurements Units (IMU) and its interaction on post-match fatigue and indicators of muscle damage. **Methods** Six Norwegian 2. division teams ( $n=81$ ) were recruited to play three matches. IMUs (Catapult Optimeye S5, Australia) with 100Hz accelerometer, magnetometer, and gyroscope were worn in a vest placed on the upper back. HIE, the sum of accelerations, decelerations, change of directions efforts and jumps ( $>2.5$  m-s<sup>-1</sup>), were quantified and expressed as counts per minute. Players were divided into keepers (KE; $n=6$ ), central defenders (CD; $n=13$ ), full backs (FB; $n=13$ ), central midfielders (CM; $n=23$ ), wide midfielders (WM; $n=16$ ) and attackers (AT; $n=10$ ). Countermovement jumps (CMJ; $n=56$ ) and Creatine Kinase (CK; $n=35$ ) were measured 1 hour pre and 1, 24, 48 and 72 hours' post-match (KE excluded). Differences were deemed likely (L), very likely (VL) and most likely (ML) when there was a likelihood of  $> 75\%$ ,  $95\%$  and  $99\%$  of the difference exceeding an effect size of 0.2 respectively. The interaction of HIE on fatigue was investigated using mixed model analysis (fixed effects: time-HIE and random effects: subjects +



teams). Results On average, HIE occurred  $2.1 \pm 0.7$  times per minute (mean  $\pm$  SD) including  $0.3 \pm 0.1$  accelerations,  $0.5 \pm 0.2$  decelerations,  $1.3 \pm 0.5$  changes of direction and  $0.05 \pm 0.03$  jumps and were position depended: WM ( $2.5 \pm 0.5$ ), CM ( $2.4 \pm 0.5$ ), AT ( $2.2 \pm 0.5$ ), FB ( $2.0 \pm 0.6$ ), CD ( $1.8 \pm 0.5$ ) and KE ( $0.8 \pm 0.2$ ). Differences ranged from L to VL. The percent changes from pre to +1h, +24h, +48, and +72h were -6.6 (VL), -6.2 (VL), -6.6 (VL) and -4.7 (L) for CMJ height and 69 (ML), 112 (ML), 42 (L), 4.1 (unclear) for CK respectively. Lastly, our model showed no interaction of HIE on neither CMJ nor CK for any of the time points. Discussion HIE were found to be position depended and thus, players from different positions are loaded differently in matches. The match load produced neuromuscular fatigue lasting for 72 hours. However, a direct interaction of total HIE on fatigue or muscle damage was missing, suggesting that the match load and fatigue relationship is more complex. Player fitness, pre-match fatigue, and match effort could possibly interact in this relationship. References Nedelec, M et al. (2012). Sports Medicine, 42, 997-1015 Russel, M et al. (2016). Human Movement Science, 45, 96-101

## RELATIVE ACCELERATION AS A NEW INDICATOR OF GAME INTENSITY IN SOCCER

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**Introduction** Intensity in team sports has been commonly measured on the basis of distances covered in different speed zones. It was recently noted that the problem with this approach is that short acceleration does not contribute to game intensity because the required speed is not achieved. Relative acceleration accounts for these short-term actions and may be therefore a more valid indicator of game intensity. **Methods** During 14 official games, 90 positional datasets were collected from 69 elite junior players (mean age,  $17.0 \pm 0.6$  y) of the highest and 91 datasets from 69 sub-elite junior players (mean age,  $17.9 \pm 0.9$  y) of the second highest national U18 championship levels, using the Local Position Measurement System. Based on the raw acceleration and speed data, each acceleration peak was identified as a single action. For each action, the relative acceleration was calculated as a ratio between the acceleration of the action and the maximum possible acceleration, dependent of the initial running speed, which was determined in a sprint test conducted prior to the games. All actions were classified into four intensities based on the relative acceleration and the initial running speed. The number of high-, moderate-, low-, and very low-intensity actions were then compared with commonly used speed zones (high-speed running [HSR]  $> 19.8$  km·h<sup>-1</sup> and sprinting [S]  $> 25$  km·h<sup>-1</sup>). Differences between the two performance levels were determined by calculating the effect sizes (ES). Results Elite junior players had more of high- (84 vs 66), moderate- (90 vs 82), and low- (183 vs 176) intensity actions. The difference is larger in high- (ES, 0.91) than in moderate- (0.48) and low- (0.28) intensity actions. The number of high-intensity actions yields a larger ES than the commonly used indicators of game intensity such as distances covered in high-speed zones (HSR: 522 vs 431 m; ES, 0.50; S: 111 vs 76 m; ES, 0.51). Comparison between the elite and sub-elite players for specific positions yielded a larger ES when number of high-intensity actions rather than common speed zones were used, except for fullbacks (central midfield: ES of 1.38 vs 0.52 [HSR]/0.09 [S]; centre back: ES of 0.68 vs 0.48/0.31; forward: ES of 1.47 vs 0.52/-0.03; wide midfield: 0.64 vs -0.89/0.28; fullbacks: ES of 0.87 vs 1.22/1.88). **Discussion and Conclusion** The differences in game intensity between elite and sub-elite junior soccer players is larger when expressed by number of high-intensity actions calculated with relative acceleration than by commonly used speed zones. The difference can be explained by the fact that using relative acceleration to determine intensity results in taking high accelerations from low initial running speeds as well as lower accelerations from high initial speeds into account. Therefore, the new indicator proposed here removes the bias introduced by the commonly used speed zones. Contact karin.sonderegger@baspo.admin.ch

## COGNIFOOT - ASSESSING THE COGNITIVE-MOTOR PERFORMANCE OF SOCCER PLAYERS: OBJECTIVE MEASUREMENTS VS COACHES' EVALUATION

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The cognitive-motor performance, defined here as the capacity to rapidly use sensory information and transfer it into efficient motor output, represents a major contributor to performance in almost all sports, involving soccer. The difficulty is to assess this complex cognitive-motor performance in a standardized and quantitative manner while preserving the ecological validity of the tested tasks. For this purpose, we used a high-technology system (COGNIFOOT, patent pending) which combines a visual environment simulator fully synchronized with a motion capture system. With this device, objective real-time measurements of several parameters such as response time and kicking accuracy were done in a large (10 x 8 meters – length x width) turf-artificial grass playground on which players could execute real soccer skills. Forty-six (46) young elite soccer players aged between 11 and 16 years who all belonged to the U12-U13-U14-U15-U16 categories of the same youth soccer academy were tested. Each player had to shoot the ball as fast and as accurately as possible towards a 0.2 meters-diameter visual target projected onto a large screen (4 x 3 meters – width x height) located 5 meters in front of him/her (a short pass situation). The response times were computed as the delay between the appearance of the visual stimulus and the initial movement of the ball, thus, including a motor preparation phase. The response times were found to decrease with increasing age of the players (on average from 1100 ms to 1020 ms for the U12 and U15-U16 categories, respectively) while the kicking accuracy increased linearly with age indicated by smaller spatial errors (from 45 to 29 cm for the U12 and U15-U16 categories). These data were converted into 5 point-scales in order to compare them with the judgement of the coaches, who also used a 5 point-scale to evaluate the reactivity and the kicking accuracy of their players, respectively. The global cognitive-motor performance indices computed from these two types of evaluations were highly correlated when considering every single age category. However, coaches' more subjective evaluations across age groups were not consistent and failed to detect the age effect measured via the COGNIFOOT system. The functional implications of these findings for talents identification will be discussed together with the potential interest of this new type of sport technology for testing/training the cognitive-motor performance.

## Oral presentations

### OP-SH08 Psychology: Burnout & Stress

#### PERCEIVED COACH AUTONOMY SUPPORT AND ATHLETE BURNOUT: THE MODERATING ROLE OF EXPERIENTIAL AVOIDANCE

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**Introduction** Researchers have investigated that perceived coach autonomy support could prevent athlete burnout (Quested & Duda, 2011). However, few studies have investigated the when and whether or not perceived coach autonomy support can alleviate athlete burnout empirically. Therefore, authors draw on an interactionism perspective to suggest low experiential avoidance individuals benefit most from perceived coach autonomy support. Experiential avoidance is a generalized unwillingness to remain in contact with private experiences leading to actions inconsistent with one's values and goals (Hayes, Wilson, Gifford, Follette, & Strosahl, 1996, p. 1153). Therefore, the present study examined the relationship between perceived coach autonomy support and athlete burnout is moderated by experiential avoidance. **Methods** To allay common-method bias concern, we used a time-lagged design to collect data during two periods. Athletes completed experiential avoidance and athlete burnout instruments at time 1. After 3 months, perceived coach autonomy support and athlete burnout were assessed. To examine our hypothesis, the completed variables collected from 141 athletes with a mean age of 21.14 years. The athletes were recruited from department of athletic performance and physical education. All participants read and signed the informed consent form indicating their ethical rights. **Results** The results indicated that perceived coach autonomy support was negatively related to athlete burnout. Furthermore, experiential avoidance weakened the relationship between perceived coach autonomy support and athlete burnout. **Discussion** Our study helps explain that athletes low in experiential avoidance benefit more from perceived coach autonomy support than those high in experiential avoidance. We contribute to the literature by identifying new boundary conditions. Furthermore, the present study contributes to athlete burnout research by adopting an interactionist perspective to understand how perceived coach autonomy support and experiential avoidance jointly shape athlete burnout. **References** Hayes, S. C., Wilson, K. G., Gifford, E. V., Follette, V. M., & Strosahl, K. (1996). Experimental avoidance and behavioral disorders: A functional dimensional approach to diagnosis and treatment. *Journal of Consulting and Clinical Psychology*, 64(6), 1152. Quested, E., & Duda, J. L. (2011). Antecedents of burnout among elite dancers: A longitudinal test of basic needs theory. *Psychology of Sport and Exercise*, 12, 159-167. Contacts: r72226@gmail.com

#### THE PREDICTION OF DISEMPOWERING MOTIVATIONAL CLIMATE ON BURNOUT AMONG YOUTH BADMINTON PLAYERS: THE MEDIATING EFFECTS OF BASIC PSYCHOLOGICAL NEEDS.

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**Introduction** Athletes' burnout has been an important issue which results in dropout the sport. The present study aimed to examine whether the impact of coach's disempowering motivational climate on burnout is mediated by basic psychological needs among youth badminton players. **Methods** One hundred and fifty-two high school badminton players (males=85, females=67, Mage=16.55) were recruited to this study. Participants were asked to complete questionnaires which include Disempowering Motivational Climate Questionnaire (Appleton, Ntoumanis, Quested, Viladrich, Duda, 2015), Basic Need Satisfaction Scale (Deci, Ryan, Gagné & Kornazheva, 2001), and Athlete Burnout Questionnaire (Raedeke, & Smith, 2001). **Results** Results showed that disempowering motivation climate positively predicted exercise burnout ( $R^2=21\%$ ). Disempowering motivational climate negatively predicted relatedness, competence, and autonomy. The explained variances were 18%, 6.1% and 3.5% respectively. In addition, in terms of the mediating effect of basic psychological needs, the prediction of disempowering motivational climate on burnout was only mediated by competence but not relatedness and autonomy. **Discussion** In accord to the previous studies regarding the relationships between motivational climates and burnout (Kang, 2004; Wang, 2008), disempowering motivational climate negatively predicted burnout. Moreover, one of the basic needs – competence played as a mediator. In other words, disempowering motivational climate negatively influence youth badminton players' competence and then negatively predicted their burnout. According to these results, coaches should avoid creating disempowering motivational climate to protect athletes' competence and then reduce the tendency of the burnout. **References** Deci, E.L., Ryan, R. M., Gagné, M., Leone, D. R., Usunov, J., & Kornazheva, B.P. (2001). Need satisfaction, motivation, and Well-Being in the work organizations of a former eastern bloc country: A Cross-Cultural Study of Self-determination. *Personality and Social Psychology Bulletin*, 27, 930-942 Kang, L. C. (2004). The relationships or goal orientation, perceived motivational climate, coping strategies, perceived effectiveness of coping, and burnout among baseball players. (Unpublished doctoral dissertation). Raedeke, T. D. (1997). Is athlete burnout more than just stress? A sport commitment perspective. *Journal of Sport and Exercise Psychology*, 19, 396-417. Raedeke, T. D. & Smith, A. L. (2001). Development and preliminary validation of an athlete burnout measure. *Journal of Sport and Exercise Psychology*, 23, 281-306. Wang, C. L. (2008). Perceived motivation climate and burnout on basketball players, *Sports Coaching Science*, 12, 1-12. Contact wendy601412@gmail.com

#### REGULARLY EXERCISING STUDENTS REPORT LESSER EXHAUSTION AND PERCEIVED STRESS, BUT THE WEEKLY VOLUME OF EXERCISE APPEARS TO BE UNIMPORTANT

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**Introduction** Several reports in the scholastic literature suggest that regular physical exercise buffers psychosocial stress. There is also a tendency to prescribe a minimal volume of exercise in detecting measurable effects. However, this presumption was challenged a while ago (Szabo, 2003). In the current study, we tested the perceived stress and burnout in exercising and non-exercising university students to establish whether the claims in the literature materialize in the real life situation. **Methods** A volunteer sample ( $n=372$ ) of Norwegian and Hungarian undergraduate and postgraduate university students completed both the 'Maslach Burnout Inventory Student Scale' (MBISS; Schaufeli et al., 2002) and the 'Perceived Stress Scale' (PSS; Cohen et al., 1983). Exercising students also reported the frequency and the best estimated duration of their weekly exercise. Data were analysed with a multivariate analysis of variance. **Results** While there

was no statistically significant difference in the perceived (reported) burnout and stress between undergraduates and postgraduates, exercisers reported less exhaustion ( $13.44 \pm 5.05$  vs.  $14.84 \pm 5.67$ ,  $p=.034$ ,  $d=.26$ ) on the MBISS and lower perceived stress ( $40.39 \pm 8.47$  vs.  $44.05 \pm 9.92$ ,  $p=.001$ ,  $d=.37$ ) on the PSS than non-exercisers. Nevertheless, there was no significant correlation between these two variables (that were correlated with each other,  $r=.46$ ,  $p<.001$ ) and the reported weekly volume of exercise. Discussion The results of this study support the contention in the literature that regular exercise has a protective role in stress and burnout. The lack of correlation between the amount of reported stress or burnout in exercising students and the best estimated volume of exercise, indicates that the fact that one exercises (the involvement itself) is more a determinant of the perceived stress and burnout than the effort invested in exercise. If this is the case, it may be stated that exercise acts as a mental aid in the mental appraisal of the challenges in the life of university students, supporting the role of the placebo effect in exercise behaviour (Szabo, 2013). References Cohen S, Kamarck T, Mermelstein R. (1983). *J health soc behav*, 385-396. Schaufeli WB, Martinez IM, Pinto AM, Salanova M, Bakker AB. (2002). *J Cross-cult Psychol*, 33, 464-481. Szabo A. (2003). *J Sports Sci Med*, 2, 77-87. Szabo A. (2013). *J Mental Health*, 22(5), 449-455. Contact szabo.atilla@ppk.elte.hu

### ACUTE EFFECTS OF YOGA ON CARDIAC AUTONOMIC RESPONSE TO AND RECOVERY FROM MENTAL STRESS

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Introduction Mental stress has been shown to be associated with the development of cardiovascular disease (Chida & Steptoe, 2010). Previous research also indicated that individuals with exaggerated cardiovascular response to mental stress had increased risk for hypertension (Carroll et al., 2003). While most studies have investigated the effects of aerobic exercise on cardiovascular reactivity, the effects of other types of exercise, such as yoga, are undetermined. The purpose of this study was to examine the acute effects of yoga on heart rate (HR) and cardiac autonomic response to and recovery from mental stress. Methods A total of 46 participants (mean age  $23.25 \pm 3.80$ ) were recruited for this study and completed two testing sessions in which participants engaged in either yoga or video watching (VW) conditions randomized for that session. After each condition, participants underwent a Stroop task and mental arithmetic task, which served as mental stressors. Electrocardiogram was used to measure HR throughout the mental stress period until 5 minutes after the end of the stress period. Heart rate variability (HRV) for both stress and recovery periods were analyzed and expressed as low frequency (LF), high frequency (HF), and the ratio of LF to HF (LF/HF). Results The results revealed that there were no significant differences in HR during mental stress and recovery periods after yoga and VW conditions. Similar for HRV, there were no significant differences in LF, HF, and LF/HF during mental stress and recovery periods after the two conditions. Discussion The results of this study showed that HR and HRV during mental stress and recovery after an acute bout of yoga was not significantly different from the VW control condition, suggesting that one bout of yoga practice was not effective in reducing cardiovascular reactivity to mental stress. Future studies may consider investigating individuals demonstrating exaggerated cardiovascular reactivity to mental stress and involve long-term practice of yoga to further examine the potential effect of yoga on cardiovascular reactivity to mental stress. References Chida, Y., & Steptoe, A. (2010). *Hypertension*, 55, 1026-1032. Carroll, D., Ring, C., Hunt, K., Ford, G., Macintyre, S. (2003). *Psychosomatic Medicine*, 65, 1058-1054. Contact ihchu@kmu.edu.tw

### FILM-INDUCED NEGATIVE EMOTIONS INTERFERE WITH CONTROL OF BREATHING DURING PHYSICAL ACTIVITY AND CAUSE HYPERVENTILATION

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Introduction Automatic control of breathing is primarily regulated by the carbon dioxide partial pressure (pCO<sub>2</sub>). pCO<sub>2</sub> remains stable at rest as well as during light and moderate physical exercise before it sharply decreases at heavy-exercise intensities (exercise-induced hyperventilation) (Brown, Miller, & Eason, 2006). However, intense negative emotional experiences of individual relevance (e.g., fear) can evoke hyperventilation without any exercise (psychogenic hyperventilation) (Niggemann, 2010). Hence, strong emotion during physical exercise might lead to interfering effects in the control of breathing. Sport injury related stimuli can elicit negative emotions and thus are expected to cause this interference effect and hyperventilation. Methods Twelve volunteers aged 23.9 (20-33) years underwent two graded exercise tests on a cycle-ergometer at intervals of one week. Individual work load started at 0.8 W/kg with increased intensity of 15 W/kg/min. Respiratory gas analysis was carried out via a breath-by-breath-system (© ZAN 600 USB). During exercise tests, participants watched either video clips with neutral emotional valence, or negative emotional video clips depicting sports injuries (order counterbalanced). Heart rate, ratings of perceived exertion (RPE; Borg, 1998), and ratings of negative emotions (10-point Likert scale) were recorded at the end of each stage. Results Negative emotions were significantly higher when watching injury-related clips ( $M_{neu} = 1.08$ ,  $SD = 0.09$ ;  $M_{inj} = 5.23$ ,  $SD = 1.94$ ). Repeated measures ANOVA across the first ten stages of exercise testing revealed a significant Emotion x Stage interaction effect for pCO<sub>2</sub> ( $F(9, 99) = 6.39$ ,  $p < .01$ ,  $\eta^2 = .37$ ). Follow-up analyses revealed that pCO<sub>2</sub> did not differ between conditions across the first stages of exercise, but then declined in the negative emotion condition resulting in significantly lower pCO<sub>2</sub> at stage ten ( $M_{neu} = 43.65$  mmHG,  $SD = 2.56$ ;  $M_{inj} = 41.84$  mmHG,  $SD = 2.93$ ). No significant effects were found for heart rate or perceived exertion, respectively. Discussion Results confirm that negative emotion interferes with control of breathing and pCO<sub>2</sub> maintenance at graded exercise. The decline of pCO<sub>2</sub> while watching aversive injury-related stimuli during graded exercising indicates hyperventilation due to psychogenic rather than exercise-induced factors. Results will be discussed with respect to underlying psychophysiological mechanisms and consequences as well as implications for sports performance and practice. References Borg G (1998). Borg's perceived exertion and pain scales. Human Kinetics, Champaign. Brown SP, Miller WC, Eason JM (2006). *Exercise Physiology*. Lippincott Williams & Wilkins, Philadelphia. Niggemann B (2010). *Pediatr Allergy Immunol* 21, 895-899

### COGNITIVE REACTIONS TO FAILURE IN HEALTHY AND UNHEALTHY PERFECTIONIST INTERCOLLEGIATE ATHLETES

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The ability to respond in an adaptive or functional manner following failure in sport is a highly desirable attribute for competitive athletes. This study used the tripartite model of perfectionism (Stoeber & Otto, 2006) to examine the degree to which healthy and unhealthy perfectionist athletes typically respond with adaptive and maladaptive cognitions following poor performances in sport. A sample of 239 male and female intercollegiate team-sport varsity athletes ( $M$  age = 20.50,  $SD = 1.99$ ) from a large Canadian university completed a self-report measure of perfectionism in sport (i.e., the Sport-Multidimensional Perfectionism Scale-2 [Sport-MPS-2]; Gotwals & Dunn, 2009).

Participants also completed three instruments designed to measure athletes' cognitive-response tendencies to poor personal performances in sport across four constructs: self-compassion, optimism, pessimism, and rumination. A non-hierarchical (K-means) cluster analysis was conducted to create groups/clusters of healthy perfectionists (i.e., high strivings and low concerns:  $n = 102$ ), unhealthy perfectionists (i.e., high strivings and high concerns:  $n = 71$ ), and non-perfectionists (i.e., low strivings:  $n = 63$ ). The seed points employed in the K-mean analysis were based on Sport-MPS-2 mean-item subscale scores taken from previously published studies that had also used cluster analysis to create groups (i.e., healthy perfectionists, unhealthy perfectionists, and non-perfectionists) that were interpreted using the tripartite model of perfectionism. A statistically significant MANOVA (Wilks Lambda = .757,  $F(8,460) = 8.582$ ,  $p < .001$ ) with follow-up univariate F-tests revealed significant between-group differences on all four dependent variables (i.e., self-compassion, optimism, pessimism, and rumination: all  $ps < .05$ ). Post-hoc t-tests (with Bonferroni corrections) indicated that healthy perfectionists, on average, experienced significantly higher adaptive cognitions (i.e., self-compassion and optimism) and lower maladaptive cognitions (i.e., pessimism and rumination) following poor performances than unhealthy perfectionists (all  $ps < .05$ ). Results indicate that coaches and sport psychologists may benefit from knowing an athlete's perfectionism profile in order to better understand (or anticipate) how the athlete might respond following personal failure in competition. Gotwals, J. K., & Dunn, J. G. H. (2009). A multi-method multi-analytic approach to establishing internal construct validity evidence: The Sport Multidimensional Perfectionism Scale 2. *Measurement in Physical Education & Exercise Science*, 13, 71-92. Stoeber, J., & Otto, K. (2006). Positive conceptions of perfectionism: Approaches, evidence, challenges. *Personality and Social Psychology Review*, 10, 295-319.

## Oral presentations

### OP-PM50 Bed Rest & Inactivity

#### ONE WEEK OF BED REST LEADS TO SUBSTANTIAL MUSCLE ATROPHY AND INDUCES PERIPHERAL INSULIN RESISTANCE IN THE ABSENCE OF SKELETAL MUSCLE LIPID ACCUMULATION

DIRKS, M.L., WALL, B.T., VAN DE VALK, B., HOLLOWAY, T.M., HOLLOWAY, G.P., GOOSSENS, G.H., VAN LOON, L.J.C.

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Short periods of muscle disuse, often necessary for recovery from illness or injury, lead to various negative health consequences. The present study investigated mechanisms underlying disuse-induced peripheral insulin resistance, taking into account muscle atrophy. Ten healthy, young males (age:  $23 \pm 1$  y, BMI:  $23.0 \pm 0.9$  kg·m<sup>-2</sup>) were subjected to 7 days of strict bed rest. Prior to and after bed rest, lean body mass (DXA) and quadriceps cross-sectional area (CSA; CT) were assessed, and VO<sub>2</sub>peak and leg strength were determined. Peripheral insulin sensitivity was measured using a hyperinsulinemic-euglycemic clamp. Additionally, muscle biopsies were collected to assess muscle lipid (fraction) content and various markers of mitochondrial and vascular content. Bed rest resulted in  $1.4 \pm 0.2$  kg lean tissue loss and a  $3.2 \pm 0.9\%$  decline in quadriceps CSA (both  $P < 0.01$ ). VO<sub>2</sub>peak and 1RM had declined by  $6.4 \pm 2.3$  ( $P < 0.05$ ) and  $6.9 \pm 1.4\%$  ( $P < 0.01$ ), respectively. Bed rest induced a  $29 \pm 5\%$  decrease in peripheral insulin sensitivity ( $P < 0.01$ ). This was accompanied by a decline in muscle oxidative capacity, without alterations in skeletal muscle lipid content or saturation level, markers of oxidative stress, or capillary density. In conclusion, one week of bed rest substantially reduces skeletal muscle mass and lowers peripheral insulin sensitivity, without affecting mechanisms implicated in high-fat diet-induced insulin resistance.

#### THE IDENTIFICATION OF FUNCTIONAL AND PHYSIOLOGICAL MARKERS ASSOCIATED WITH SHORT-TERM DETRAINING IN A YOUNG HEALTHY POPULATION

GARCIA-HORTAL, M., BRICKLEY, G., BEALE, L., DOUST, J.

*University of Brighton*

**Introduction** During the periodised training macrocycle, athletes across all sports experience phases in which training is limited or ceases entirely (Bosquet et al., 2013). To date, detraining literature has not analysed the weekly effects of training stoppage nor determined the reliability of tests used as baseline pre-detraining measurements. A comprehensive understanding of detraining processes is imperative in effective program design, especially during off-season and pre-season periods (Mujika & Padilla, 2001). Therefore, the aim of this study is to assess the change in functional and physiological markers, related to strength and power, associated with short-term detraining in a young healthy population. **Methods** With institutional ethics approval, eleven healthy participants (5 females; mean  $\pm$  SD age =  $21.6 \pm 2.9$  yr, height =  $163.2 \pm 13.3$  cm, body mass =  $68.8 \pm 32.3$  kg and 6 males; mean  $\pm$  SD age =  $21.8 \pm 4.7$  yr, height =  $175.3 \pm 7.6$  cm, body mass =  $72.2 \pm 7.6$  kg) completed a two weeks stable position (SP) to assure that the baseline values were accurate for each participant. To date, four of the aforementioned participants (1 male, 3 females) have completed four weeks of detraining (DTR). Maximal voluntary isometric contractions (MVIC) coupled with electromyography (EMG) of the vastus medialis (VM) and vastus lateralis (VL) of the quadriceps muscle, countermovement and squat jumps (CMJ, SJ), isokinetic leg press (ILP) and six-second Wingate (6sec-WAnT) tests were carried out each week during the six weeks that formed the study. **Results** All tests, except 6sec-WAnT, during the SP showed no significant difference between the three trials (MVIC:  $P = 0.165$ ; EMG VM:  $P = 0.707$ ; EMG VL:  $P = 0.538$ ; CMJ:  $P = 0.837$ ; SJ:  $P = 0.520$ ; ILP:  $P = 0.132$ ). 6sec-WAnT ( $P = 0.018$ ) showed that males were more powerful in the third test of the SP. Acute losses in strength tests (ILP, MVIC) and SJ were found in DTR (i.e. 18 and 21% decline at weeks 3 and 4 in ILP); whereas in power based tests (6sec-WAnT, CMJ) the changes were not as significant. **Discussion** These results suggest that in future studies using the same procedures, familiarisation would be crucial when using 6sec-WAnT. Preliminary results suggest that short-term detraining elicits a loss in voluntary muscle force output and the underlying mechanisms warrant further investigation (Koundourakis et al., 2014). **References** Bosquet L, Berryman N, Dupuy O, Mejaay S, Arvisasis D, Bherer L, Mujika I (2013). *Scand J Med Sci Sports*, 23(3), 140–149. Koundourakis NE, Androulakis NE, Malliaraki N, Tsatsanis C, Venihaki M, Margioris AN (2014). *PLoS one*, 9(12). Mujika, I. & Padilla, S. (2001). *Med Sci Sports Exerc*, 33(8), 1297–1303. \*Data from 4 participants is currently included. Data from ~12 participants will be included by end of June 2016.



## FUNCTIONAL AND METABOLIC ALTERNATIONS IN YOUNGER AND OLDER MEN AFTER 14-DAY BED REST WITH 14-DAY RECOVERY

PIŠOT, R.1, MARUSIC, U.1, BIOLO, G.2, MAZZUCCO, S.2, LAZZER, S.3, GRASSI, B.4, REGGIANI, C., DI PRAMPERO, P.E.3, PASSARO, A.5, NARICI, M.6, RITTWEGER, J.7, GASPARINI, M.8, PARAVLIC, A.1, SIMUNIC, B.1

1:University of Primorska (Slovenia), 2:University of Trieste (Italy), 3:University of Udine (Italy), 4:University of Padua (Italy), 5:University of Ferrara (Italy)

**Introduction:** Physical inactivity is an increasing problem of modern society and is associated with major health hazards involving loss of muscle mass and function but also changes in cardiovascular function and energy metabolic balance (Brower, 2009; Kortebein et al., 2007; Knudsen et al., 2012). Given the paucity of literature on this topic, we aimed to investigate the functional and metabolic responses to bed rest and subsequent recovery of younger and older adult men. **Methods:** Sixteen old (OM: 55-65 years) and seven young men (YM: 18-30 years) were exposed to 14-day bed rest (BR) followed by 14-day active recovery (R). Quadriceps muscle volume (QVOL), force (QF) and explosive power (QP) of leg extensors, single fiber isometric force (Fo), peak aerobic power (VO2peak), gait stride length, and three metabolic parameters, Matsuda index for insulin sensitivity, postprandial lipid curve and homocysteine plasma level, were measured before and after BR and after R. **Results:** Following BR, QVOL declined more in OM than in YM ( $P=0.031$ ), QF ( $P=0.001$ ), QP ( $P=0.001$ ) and gait stride length ( $P=0.002$ ) declined only in OM. Fo significantly declined in both YM -32.0% and OM -16.4% without significant differences between groups. VO2peak declined more in OM than in YM ( $P<0.001$ ). To the opposite, metabolic parameters showed greater decline in YM than in OM for Matsuda index ( $P=0.003$ ), while increase in AUC of triglycerides ( $P=0.013$ ) and homocysteine concentration ( $P=0.027$ ) were observed only in YM. Finally, after 14 days R, several parameters, among them QVOL, QP and VO2peak did not recover in OM, while Fo did not recover in both age groups. **Discussion:** These results are of considerable clinical relevance as they show the greater impact of inactivity on muscle mass and function in OM, while the metabolic alterations are greater in YM. Furthermore, they point to a greater difficulty of OM in regaining the pre-inactivity conditions. Finally, due to greater detrimental effect of bed rest and delayed recovery in OM our study suggests that minimizing of hospitalization periods should be of greater importance particularly for OM. **References:** Brower RG. (2009). Crit Care Med, 37(10), 422-428. Kortebein P, Ferrando A, Lombeida J, Wolfe R, Evans WJ. (2007). JAMA, 297, 1772-1774. Knudsen SH, Hansen LS, Pedersen M, Deigaard T, Hansen J, Hall GV, Thomsen C, Solomon TP, Pedersen BK, Krogh-Madsen R. J Appl Physiol, 113, 7-15

## EFFICACY OF A REACTIVE JUMP TRAINING PROGRAM DURING 60 DAYS OF BED REST

KRAMER, A., KÜMMEL, J., GOLLHOFER, A., GRUBER, M.

University of Konstanz

**Background:** In spite of extensive training regimens during long-term space missions with existing training devices, astronauts suffer from muscle and bone loss. Reactive jumps have been shown to exert very high forces on the leg muscles and bones, resulting in high strains and strain rates (Milgrom 2000). Therefore, reactive jumps seem to be a promising candidate for an effective and also efficient countermeasure. A training device that allows reactive jumps in the absence of gravitational forces has already been validated in previous studies (Kramer 2010; Kramer 2012). The aim of the present study was to evaluate if a training program using this sledge jump system (SJS) can prevent or at least greatly reduce the deteriorating effects of bed rest on the human body. **Methods:** After a familiarization and measurement phase of two weeks, 24 male participants ( $30 \pm 6$  y,  $181 \pm 6$  cm,  $77 \pm 7$  kg) were randomly allocated to the training or control group. In the following 60 days, all participants were confined to strict six-degree head-down tilt (HDT) bed rest. During this HDT phase, members of the training group had to perform reactive jumps in the SJS 5-6x per week, each training session lasting ten minutes on average. Two types of jumps were performed: series of usually 15 repetitive hops and series of 2-30 countermovement jumps. The amount and type of jumps was varied between training sessions, on average about 70 jumps were performed during each session. All the jumps in the SJS were recorded using force plates located at the bottom of the SJS. The 60 days of HDT were followed by a two-week recovery phase that included the same measurements as before HDT. **Results:** Adherence to the training sessions was 100%. The subjects in the training group were able to maintain their high initial peak ground reaction forces during the jumps throughout the 60 days of HDT: starting with  $3300 \pm 370$  N during the first training session, this level could be maintained until the last training session on HDT 60 ( $3400 \pm 440$  N). Mean countermovement jump height one day before HDT for jumps on the ground was  $43 \pm 5$  cm for the training group and  $40 \pm 3$  cm for the control group. On the first day after the end of the HDT phase, jump height was  $23 \pm 4$  cm for the control group and  $44 \pm 6$  cm for the training group. In other words, a decrease of 42% for the control group, whereas the training group even increased their jump height a bit. Note that these results refer to the first 12 subjects of the study. The results for subjects 13 to 24 will be added after the end of the second phase of the bed rest study in April 2016. **Conclusion:** Reactive jumps seem to be a very effective and efficient countermeasure for deteriorating neuromuscular performance during long-term bed rest. Further analyses of the remaining data (e.g., pQCT, VO2max) will show if it is just as effective for bone health and even the cardiovascular system. **References:** Kramer A et al (2010) J Biom 43(14),2672-7 Kramer A et al (2012) J Biom 45(10),1816-22 Milgrom C et al (2000) Br J Sports Med 34,195-9

## Oral presentations

### OP-SH19 Persons in Sport Organisations

#### ARE PROACTIVE SPORT EMPLOYEES MORE SATISFIED WITH THEIR JOB? AN INTERACTIONISM PERSPECTIVE

KUO, C.C.1, CHEN, L.H.1, CHEN, M.Y.2

1: National Taiwan Sport University (Taoyuan, Taiwan), 2: National Taiwan Normal University (Taipei, Taiwan)

**Introduction** Due to the highly competitive in the sport service market (Chanavata & Bodet, 2014), employees are ideal to be proactive to create conducive and satisfactory work experiences to conquer the environmental challenges (Li, Liang, & Crant, 2010). Nevertheless, based on interactionism hypothesis, employees with higher proactive tendency might not always lead to greater satisfaction at work because of the potential effect of situational forces. Accordingly, the present study proposed the psychological safety as an important boundary condition. **Methods** Data was collected from employees in 12 sport centers in Taiwan through a two-wave, time-lagged design. In the first wave, participants were invited to report the measures of proactive personality, psychological safety, and job satisfaction.

A follow up survey containing job satisfaction scale was distributed to participants again as second wave investigation. A total of 240 respondents completing questionnaires were retained as our final sample. In the data analysis, we conducted a hierarchical regression analysis to test our hypothesis. Results Results revealed that proactive personality significantly predicted the change in job satisfaction ( $B = .15, p < .01$ ). In addition, proactive personality and psychological safety have a significant interaction effect in predicting the change in job satisfaction ( $B = -.10, p < .05$ ). Specifically, the positive relationship between proactive personality and the change in job satisfaction was increased especially when employees who perceived lower than higher psychological safety. Discussion Although situational strength hypothesis of interactionism assumed that personality matters most in weak situations (Cooper & Withey, 2009), our findings, partly supporting this notion, suggested that proactive employees are not only beneficial from supportive environments but also unconstrained by unfavorable contexts to shape their job satisfaction over time. Overall, the current findings further provided practical implications for human resource management in sport organizations. Reference Chanavata, N., & Bodet, G. (2014). Experiential marketing in sport spectatorship services: A customer perspective. *European Sport Management Quarterly*, 14(4), 323-344. Cooper, W. H., & Withey, M. J. (2009). The strong situation hypothesis. *Personality and Social Psychology Review*, 13(1), 62-72. Li, N., Liang, J., & Crant, J. M. (2010). The role of proactive personality in job satisfaction and organizational citizenship behavior: A relational perspective. *Journal of Applied Psychology*, 95(2), 395-404. Contact chechunk@gmail.com; fjudragon@gmail.com; meiyen686@gmail.com

## INVESTIGATION OF RELATIONSHIP BETWEEN ORGANIZATIONAL COMMITMENT AND JOB SATISFACTION IN YOUTH TEAM FOOTBALL COACHES IN TURKEY

YAŞAR, M.O., SUNAY, H.

UNIVERSITY OF ANKARA FACULTY OF SPORT SCIENCES

To develop qualified football players, youth team process has a critical importance. During this process youth team coaches is the key factor. In this point of view the job satisfaction and organizational commitment levels of the youth team coaches are significant to achieve success (Topkaya, 2013). Job satisfaction is, an emotional reaction towards, comparison of the job expectation and what has been acquired the job (Sarminah, 2006). Organizational commitment is definition of employees psychological point of view and relationship between employee and organization. Both of these factors directly influences efficiency of the job. The sample of the study is consisted of 212 youth team coaches who work in Turkey. Coaches were selected by purpose sampling method. The job satisfaction survey which was developed by Spector (1985) and the organizational commitment survey which was developed by Porter et al. (1974) was used. The Cronbach Alpha value of job satisfaction survey was .80 calculated. In addition, non-parametric tests which are Kruskal-Wallis and Mann Whitney-U were used. Job satisfaction and organizational commitment levels of the coaches who participated in this study was found average. There are two remarkable results in this study. When coaches are compared by their education status, it was seen that, higher educated coaches' job satisfaction levels were detected lower. Moreover, when coaches are compared by their football club types, it was found that, professional club coaches, job satisfaction and organizational commitment levels were reached higher than amateur club coaches. It was seen that when age gets older, job satisfaction and organizational commitment levels increase. Also Hickson and Obsehgemi(1999) were found that there was a positive relationship between job satisfaction. According to Ketchan(2001), age and organizational commitment also has a positive relationship. In financial parameters, unexperienced and young coaches satisfaction levels were higher than older experienced coaches. But general results about experience parameter; as the experience gets more the job satisfaction levels increase. In Orhan's study same results were found. In parallel to these results, when experience is more, the organizational commitment level also increases. References Hickson, C., & Oshagbemi, T.(1999) The effect of age on the satisfaction of academics with teaching and research. *International Journal of Social Economics*, 26(4), 537-544. Ketchand, A. A., & Strawser, J. R. (2001). Multiple dimensions of organizational commitment: Implications for future accounting research. *Behavioral Research in Accounting*, 13(1), 221-251. Orhan, S., Savucu, Y., Zirek, O., Devocioğlu, S., & Çınar, V.(2008). Investigating the job satisfaction levels of basketball referees. *NWSA: Sports Sciences*, 3(4), 168-176. Topkaya, İ.(2013)Altyapı Antrenör Yeterlilikleri. *Spor Yayınevi*(26-32) Sarminah, S. (2006) Job Characteristics and Job Satisfaction on Turnover Intentions. *Journal of international Management Studies*, 7-11

## VOLUNTEERS, MOTIVATION AND REWARDS – A STUDY ON VOLUNTEERISM IN SPORT EVENTS

STRAALMAN, O.

Karlstad university

Background: The European Indoor Athletics Championships (iEM) were accomplished in 2013 at the Scandinavium Arena in Gothenburg, Sweden. About 600 top athletes participated and around 23.000 spectators watched the championship live. To accomplish the championships, the organizers had to procure about 800 volunteers to carry out important duties of the event. These individuals had assignments to work with competition, accreditation, security, transportation, media, communications, hosting, and support areas. The aims with this study of the volunteers in the European Indoor Athletics Championships (iEM) are to describe what kind of individual rewards volunteering in a sport event provides and how that could be theoretically explained. Method: A questionnaire was sent out to the volunteers. The questionnaire had questions about what kind of individual benefits volunteering provides and if those were related to motivation aspects of the volunteer. In all, 411 respondents (54,8% of the sample) answered the questionnaire. Of those, 234 were women and 177 were men. Results: The results shows that behavioural factors such as motivational lure for volunteer work appear regardless of gender and participation level. The first conclusion is that volunteer work has a general impact in most countries and cultures in the world. The second conclusion is that volunteering is a give-and- take relation between organizers and volunteers and especially the organizers has to ensure that it is a win - win situation. To retain volunteers to assign for further jobs requires matching between duty and personal motivation. The third conclusion is that there has to be both intrinsic and extrinsic gains that motivate volunteer work. Discussion: Motivation theory is an important foundation to explain and understand volunteering. It seems to be a persons' desire to do something for someone else that makes them participates as volunteers and to make them feel good with what they had accomplished. The respondents in the study experienced both personal and situational factors while fulfilling different goals, needs or interests. Gagné and Deci (2005) found that there has to be both internal (intrinsic) and external (extrinsic) motivation, and underpin Self-Determination Theory (SDT) as a useful tool for further analysis. References Gagné, M., & Deci, E. L. (2005). Self-determination theory and work motivation. *Journal of Organizational Behavior*, 26, 331-362. DOI: 10.1002/job.322. Contact: E-mail: owe.strahman@ped.gu.se

09:45 - 11:15

## Invited symposia

## IS-PM08 Exercise as a countermeasure against muscle atrophy: insight into the molecular mechanism/s

**AGE-RELATED CHANGES IN THE RESPONSE OF THE NEUROMUSCULAR SYSTEM TO CONTRACTILE ACTIVITY.**ALR

JACKSON, M.

*University of Liverpool*

Ageing of the neuromuscular system is associated with loss of skeletal muscle mass and degeneration of peripheral axons and neuromuscular junctions. Increased oxidative damage has been reported to occur in many tissues of older subjects and experimental models, but whether these changes play a causative role in age-related decline in function of tissues has become controversial. We have utilized a variety of approaches to determine the activities of reactive oxygen species (ROS) in skeletal muscle tissue at rest, the changes that occur in response to contractile activity and how these are modified during ageing. These data indicate that skeletal muscle tissue from older animals and man shows an increased activity of ROS at rest that is associated with increased measurements of oxidative damage, but that the ROS generated in response to contractile activity is attenuated in older animals and man. In recent comparative studies we have used an electron paramagnetic resonance-based approach to examine ROS activities in mouse sciatic nerve during ageing in comparison with skeletal muscle. Substantial age-related degenerative changes in the nerve were seen, but this was not associated with an age-related increase in oxidative damage. In contrast there was evidence for a disruption of redox signaling pathways in neurons. Our data therefore show significant differences of the effects of age on motor nerves and the muscles innervated by the nerve. Supported by the Medical Research Council and Biotechnology and Biological Sciences Research Council.

**THE EFFECT OF SHORT-TERM DISUSE AND SUBSEQUENT RETRAINING ON MOLECULAR SIGNALING AND MUSCLE SIZE IN OLD VS YOUNG ADULTS**

SUETTA, C.

*Rigshospitalet, University of Copenhagen*

Human skeletal muscle is a highly plastic tissue, which is reflected by its ability to rapidly adapt to short-term changes in habitual loading intensity. However, it has been demonstrated that elderly individuals require a prolonged recovery phase in order to return to initial muscle mass levels following short-term immobilisation. Yet, there is a paucity of studies examining the cellular mechanisms responsible for the attenuated re-growth and associated molecular signalling processes in ageing human skeletal muscle. The age-related impairment in muscle re-growth following disuse could, at least in part, reside in an impaired capacity for myogenic stem cell proliferation and activation in aged myofibres, but it is not known whether such changes are related to muscle fibre phenotype. Further, systemic factors appear to play an important role in explaining the impaired proliferative capacity of SCs cultured from old vs. young human adults. There is, however, also evidence of local mechanisms influencing satellite cell and recent data suggest a close relation between various systemic and local factors in the regulation of SC function in vivo.

**EXERCISE IN CACHEXIA: THE ROLE OF REDOX HOMEOSTASIS**

CAPOROSI, D.

*University of Rome Foro Italico*

Muscle wasting is a life-threatening condition leading to weakness and poor quality of life. It is common in most organ failure diseases and in some types of cancer. In such settings, it is known as cachexia, a complex metabolic syndrome characterized by loss of muscle with or without loss of fat mass. Beside some pharmaceutical interventions, the only promising treatment for sarcopenia or cachexia is exercise training (ExT) in combination with adequate dietary intake. This approach proven to be very efficacious in the low number of clinical trials available so far, although the inadequate understanding of its underlying biological mechanisms prevents the identification of robust biomarkers of efficacy. This presentation aims at giving an overview of the state of the art on the exercise-related molecular mechanisms able to counteract muscle wasting in cachexia. In this respect, we present results of a national multicenter research project funded by the Italian Government (PRIN2012 – prot. 2012N8YJC3) that applies a multidisciplinary, translational approach aiming at revealing the interconnection between the improvement of muscle function and performance, elicited in cachexia by exercise, and the molecular pathways relevant in muscle wasting conditions focusing on the control of systemic and muscle tissue redox homeostasis (1). Results from human and animal protocols pointed out the role of exercise in the induction of regenerative potential, as well as of HSP60 and a B crystalline (2, 3, 4), while findings from cellular models demonstrated that redox imbalance has a direct role in the c-JUN and Nrf2 mediated CRYAB gene upregulation in myogenic cells (5) and in the p38 MAPK mediated triggering of ARS-mediated apoptosis in embryonal rhabdomyosarcoma cells (6). In colon carcinoma (C26)-bearing mice, we found that wheel running leads to increased survival. Our findings correlate autophagic flux alteration and muscle wasting in cancer cachexia, thus implying a novel, regulatory role for this pathway. Since both drugs, as wheel running, affect the autophagic system and counteract cachexia, we foresee the potential use of autophagy-triggering drugs to treat cachexia in conditions in which exercise cannot be prescribed (7). 1) Vaughan et al., J Cachexia Sarcopenia Muscle (2013) 4:95–109 2) Pietrangeli et al., Front. Physiol. (2015) doi: 10.3389/fphys.2015.00399 3) Barone et al., Sci Rep (2016) DOI: 10.1038/srep19781 4) Grazioli et al., Free Radic Biol Med. (2014) 75 Suppl 1:S13–4 5) Fittipaldi et. Al, Free Rad Biol Med (2015) 86:331–342 6) Beccafico et al., Carcinogenesis. (2015) 36:1071–1083 7) Pigna et al., Sci Rep, (submitted)

## Invited symposia

### IS-PM09 A close look at skeletal muscle plasticity - the dynamics of skeletal muscle cell interactions

#### SKELETAL MUSCLE HETEROGENEITY, PLASTICITY AND 3-DIMENSIONAL ORGANIZATION

PRATS, C.

*The Panum Institute, University of Copenhagen*

Skeletal muscle is an extremely heterogenic and plastic tissue that continuously adapts to metabolic and physiologic demands. This talk will review some of the cellular and molecular mechanisms involved in skeletal muscle adaptations to physical activity/inactivity and, obesity; from muscle fibre type adaptations to dynamic rearrangement of intracellular compartments. During the last years we have collected evidence supporting a key role of intracellular compartmentalisation as a regulator of skeletal muscle metabolism and, identified obesity and physical inactivity-induced metabolic and structural alterations in skeletal muscle, which coincide with tissue insulin resistance development.

#### NON-MUSCLE CELLS IN SKELETAL MUSCLE - CO-REGULATION OR JUST FRIENDLY NEIGHBOURS?

CHAZAUD, B.

*Université Claude Bernard Lyon 1*

Adult skeletal muscle regenerates after an injury. This is possible thanks to the muscle stem cells, or satellite cells, which activate and recapitulate a myogenic program that eventually leads to the formation of new functional myofibers. There is increasing evidence that non-muscle cells play important roles in skeletal muscle regeneration, among which immune cells, and particularly macrophages, as well as vessel cells (endothelial and peri-endothelial cells) and fibroblasts. The various roles of these cell types in skeletal muscle regeneration will be presented. The role of these interactions will be discussed in the context of exercise-induced muscle damage. In light of these recent biological advances, the question of early treatment aiming at blunting inflammation after exercise-induced muscle injury will be discussed.

#### TARGETING SATELLITE CELLS TO OPTIMISE MUSCLE ADAPTATION - IS EXERCISE ENOUGH?

MACKEY, A.L., KJAER, M.

*University of Copenhagen and Bispebjerg Hospital*

This talk will address the issue of whether satellite cell activation through exercise alone is sufficient for muscle adaptation in situations where regeneration may not be complete or where full restoration of muscle mass and function is paramount, such as after periods of muscle disuse encountered during hospitalisation. The issue is that often full restoration of muscle mass is not achieved through regular rehabilitation, especially in elderly individuals, who therefore will more rapidly fall below the threshold for independent living. It has also been shown that elderly individuals are also poorer at mounting a satellite cell response during such situations. Thus it may be that pharmacological intervention is required and appropriate, at least in the short term, simply to enhance satellite cell activation. Several such agents will be considered, including non-steroidal anti-inflammatory medication, where there is ample evidence for and against a beneficial effect on muscle adaptation, and Angiotensin II receptor blockers, which is a relatively unexplored field in human skeletal muscle.

## Invited symposia

### IS-PM10 New discoveries in cellular cross-talk between skeletal muscle, its microvascular endothelium and vital organs underpin the importance of an active lifestyle

#### METABOLIC CONSEQUENCES OF IMPAIRED INSULIN AND VEGF SIGNALING IN SEDENTARY, OBESE AND AGED INDIVIDUALS

WAGENMAKERS, A.

*Liverpool John Moores University*

Introduction: A sedentary lifestyle, obesity and ageing (SLOA) impair the insulin and VEGFA induced vasodilator response of the skeletal muscle (SkM) microvasculature and reduce capillary density<sup>1</sup>. This lecture is aiming to explain the underlying mechanisms and metabolic consequences. Impaired capillary recruitment: Meal-induced increases in plasma insulin activate the insulin-signaling cascade in endothelial cells (ECs) of SkM terminal arterioles (TAs). This leads to activation of eNOS, increases in NO production and vasomotion frequency (oscillations in capillary blood flow attributable to TA dilatation) and a 50% increase in microvascular blood volume. All increases and eNOS protein expression are reduced in SLOA, while expression of ET-1 (vasoconstrictor) and superoxide production by NOX2 (quenching NO) is increased. As a result less EC surface area is recruited after meal ingestion and this limits transendothelial transport (TET) of insulin and glucose, thus reducing SkM glucose uptake and increasing post-meal glucose concentrations. Reduction in capillary density: Exercise training via the resultant VEGFA pulses leads to capillary growth. Sedentary SLOA individuals will miss these VEGFA pulses. Also the low eNOS and increased ET-1 and NOX2 expression are likely to reduce NO production during exercise (eNOS is activated by shear stress and VEGFA pulses), as angiogenesis depends on increased NO production during the exercise bouts<sup>1</sup>. TET of insulin, glucose and FA: Insulin stimulates its own TET. The mechanism involves eNOS activation and S-nitrosylation of the protein tyrosine phosphatase PTP1B leading to PTP1B inactivation and, therefore, increased insulin signaling. GLUT1 is the only glucose transporter present in SkM ECs and is insulin independent. FAT/CD36, FATP-3 and -42 mediate FA-transport across the luminal and abluminal EC-membrane. FABP-4 and -51 bind FA during transcellular EC transport<sup>1</sup>. In mice with knockouts for these FA transporter and binding proteins SkM fatty acid uptake is



reduced, while glucose uptake is increased<sup>1,2</sup>. Important is the recent suggestion in mice that increased VEGF-B release from SkM controls the expression of FATPs2 in capillary ECs and thus links endothelial FA uptake to the oxidative capacity of SkM. This mechanism may contribute to the high fat oxidation capacity during endurance exercise in trained athletes. VEGF-B KO mice showed less uptake and accumulation of lipids in SkM, and instead shunted lipids into white adipose tissue leading to obesity and insulin resistance. Interestingly trained athletes combine preferential storage of meal derived fat in SkM with the highest possible insulin sensitivity, while in SLOA individuals meal derived fats are primarily stored in adipose tissue and ectopic lipid stores and lead to obesity, inflammation, insulin resistance and atherosclerosis. References: Wagenmakers et al. J Physiol 2015. doi: 10.1113/jphysiol.2014.284513 Hagberg et al. Nature 464, 917-921 (2010)

### ROLE OF VEGF-A IN EXERCISE INDUCED CAPILLARY GROWTH AND NUTRIENT DELIVERY TO SKELETAL MUSCLE

HELLSTEN, Y., HOIER, B.

*University of Copenhagen*

Capillarization in skeletal muscle correlates well with the level of oxidative capacity of the muscle and is readily altered in relation to the level of physical activity and inactivity. At a functional level, the size of the capillary net in skeletal muscle is important for optimal exchange of oxygen and nutrients and for insulin sensitivity. The process of capillary growth, or angiogenesis, is complex and involves orchestration of a number of proangiogenic and antiangiogenic factors of which vascular endothelial growth factor-A (VEGF-A) is known to be a central proangiogenic factor. VEGF-A is stored in relatively large amounts in skeletal muscle cells in vesicle-like structures. Upon muscle contraction or passive movement the VEGF-A containing vesicles are translocated to the muscle membrane for release to the extracellular space. Accordingly, in healthy young individuals, muscle interstitial levels of VEGF-A increase markedly during exercise and passive movement. This mechanism, which is thought to be an important step in the regulation of capillary growth in skeletal muscle, is impaired in aging and life style related disease and may be one of the underlying causes of microvascular rarefaction. VEGF-A is also present in capillary endothelial cells and pericytes and recent evidence suggests that pericytes also may contribute to angiogenesis in skeletal muscle. It is clear that capillary growth and oxygen and nutrient delivery depend on an interaction of endothelial cells with skeletal muscle cells and pericytes and future research should aim at addressing the precise mechanisms underlying this cellular cross-talk.

### EXOSOMES AS MEDIATORS OF THE SYSTEMIC EFFECTS OF ENDURANCE EXERCISE.

TARNOPOLSKY, M.

*McMaster University*

Exosomes are small (30 – 110 nm) microparticles that are formed from the endosome and either fuse with lysosomes or are released to the plasma. They are known to contain a variety of proteins and nucleic acids including; mRNA, miRNA, and mitochondrial DNA; consequently, they are a form of inter-cellular communication. Skeletal muscle is known to secrete a variety of proteins and miRNA in response to contraction and the proteins have been termed, "myokines". Given that tissues other than muscle can secrete proteins and nucleic acids in response to exercise, we have coined the term "exerkines". Preliminary work from our laboratory found that acute exercise led to an increase IL-6 immunoreactivity within ~ 80 nm particles within skeletal muscle. The latter work was confirmed by showing a massive reduction in alix (an exosome marker) immunoreactivity in skeletal muscle following an acute bout of exercise. We then developed methods to isolate exosomes from other microparticles called microvesicles (100 – 1000 nm) and found that most of the known "myokines" are found within exosomes including VEGF-A and VEGF-B. We have been able to passively transfer many of the mitochondrial and exercise capacity adaptations seen with endurance exercise training to sedentary mice through 5 months of allogenic "exersome" transfusions. The latter adaptations were blocked in exercise-trained mice by inhibiting exosome release. We have also been able to allogeneically transfer exosomes from endurance exercise trained mice to confer insulin sensitivity and attenuate obesity in the sedentary high-fat fed mouse model. Collectively, our data suggest that the multi-systemic benefits of endurance exercise are mediated by inter-tissue/organ exchange of exosomes containing exerkines.

## Oral presentations

### OP-BN21 Biomechanics: Muscle & Tendon

#### ATHLETIC TRAINING AFFECTS THE HOMOGENEITY OF MUSCLE AND TENDON ADAPTATION DURING ADOLESCENCE

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**Introduction** The different temporal dynamics in the adaptation of muscle and tendon can result in an imbalanced development of muscle strength and tendon mechanical properties in adults (Kubo et al., 2011) and recent evidence suggests that this might affect adolescent athletes as well (Mersmann et al., 2014). To date, however, no detailed information exists on the time-course of muscle-tendon unit adaptation during adolescence and the effect of athletic training. Consequently, this issue was addressed in the present longitudinal study. **Methods** Twelve elite athletes (A; 16±1 yrs) and eight age-matched controls (C; 16±1 yrs) participated in five ultrasound-dynamometry sessions over one year in three-month intervals. Knee extensor muscle strength was measured combining dynamometry, inverse dynamics and electromyography. Patellar tendon mechanical properties, derived from the force-elongation relationship during isometric knee extension contractions, were assessed integrating ultrasonography. A linear mixed-effects model (LMM) was used to analyse time-dependent changes of muscle and tendon properties and the mean absolute residuals (RES) to the respective model fit served as a measure of non-linearity of parameter development. Homogeneity of the development of tendon force and stiffness (in terms of uniformity in direction and relative magnitude) was investigated by calculating the cosine similarity (CS) of the relative changes between measurement sessions. **Results** The increases in muscle strength (~11%) and tendon stiffness (~14%) over time were significant (p<0.01) in both groups. However, the non-linearity of the development of muscle strength was greater (RES A: 17±7 Nm, C: 6±2 Nm, p<0.05) and the homogeneity of changes of tendon force and stiffness was lower in athletes compared to controls (CS A: -0.02±0.5, C: 0.5±0.4, p<0.05). Further, the athletes demonstrated greater maximum tendon strain (A: 7.6±1.7 %, C: 5.5±0.9 %, p<0.05) and greater non-linearity of tendon strain over time (RES A: 0.9±0.4, C: 0.3±0.1, p<0.05). **Discussion** The results of the present study provide evidence that

athletic training in adolescence may disrupt the homogeneous development of muscle and tendon. The non-uniform adaptation increases the demand on the tendon of adolescent athletes and results in episodes of individual excessive strain with potential implications for tendon injury. References Kubo K, Ikebukuro T, Yata H, Tsunoda N, Kanehisa H. *J Strength Cond Res.* 2010 Feb;24(2):322–31. Mersmann F, Bohm S, Schroll A, Boeth H, Duda G, Arampatzis A. *Scand J Med Sci Spor.* 2014 Aug 27;24(4):E283–9. Contact: falk.mersmann@hu-berlin.de

### **PREFERRED VERSUS NON-PREFERRED LEG DIFFERENCES IN MEDIAL GASTROCNEMIUS FASCICLE LENGTH ARE NOT GREATER IN HIGH- AND LONG-JUMP ATHLETES AS COMPARED TO CONTROL SUBJECTS.**

AELES, J., LENCHANT, S., VANLOMMEL, L., VANWANSEEL, B.

*KU Leuven*

**Aim:** To evaluate the effect of long-term training on muscle architecture a comparison was made between preferred (Pf) and non-preferred (NPf) leg fascicle lengths in athletes that have clear differences in amount of loading between legs and in control subjects. We hypothesised that these athletes would show greater differences in fascicle lengths between legs than the control subjects. **Methods:** 16 well-trained male and female athletes (high-jump and long-jump) and 9 control subjects were included. Muscle architecture (i.e. fascicle length, pennation angle, muscle thickness) data was collected for the Medial Gastrocnemius muscle in various conditions (i.e. 90° ankle angle, tendon-slack length (TSL) angle, during passive rotations and ankle joint plantar flexion MVC) using ultrasonography (B-mode; 30 Hz). In this abstract the results are restricted to fascicle length data at TSL angle. TSL angle was defined for each subject individually as the ankle joint angle at which the fascicles are at a length where tendon slack has been taken up and thus force from muscle fascicles is directly transferred to the segment. The intra-researcher reliability showed a low error ( $0.93 \pm 0.36$  mm). Subjects were asked about their preferred leg for jumping and a two-way ANOVA was used to test for main and interaction effects of the difference in Pf and NPf for the two groups, gender and track event. Significance level of  $p < 0.05$  was used. **Results:** 4 control subjects reported not to have a preferred jumping leg. Athletes had longer fascicle lengths ( $L_f = 57.63 \pm 6.96$  mm) than control subjects ( $L_f = 52.27 \pm 5.30$  mm) when both legs for each subject were used in the analysis. A difference was found between Pf and NPf for all subjects combined ( $n = 21$ ; mean difference:  $2.31 \pm 3.87$  mm;  $p = 0.013$ ). No difference ( $p = 0.122$ ) was found between athletes (mean difference:  $2.80 \pm 3.56$  mm) and controls (mean difference:  $0.76 \pm 4.04$  mm) in fascicle length difference between Pf and NPf. Visual inspection of the data showed that even the 4 control subjects with no preferred jumping leg showed large differences between both legs in fascicle lengths. **Discussion:** Although high- and long-jump athletes report to have a clearly preferred leg for jumping and loading during training is higher on the jumping leg, this does not result in greater fascicle length differences in that leg as compared to control subjects. This may indicate that fascicle length does not necessarily change more under this long-term training but that other parameters (for example pennation angle, tendon stiffness) might be more subjective to change.

### **RATE OF FORCE DEVELOPMENT AND ELECTROMECHANICAL DELAY ARE NEGATIVELY IMPACTED BY 6 WEEKS OF STRETCH TRAINING**

BRAY, N.W., SIMPSON, C.L., JAKOBI, J.M.

*University of British Columbia - Okanagan*

**Rate of force development and electromechanical delay are negatively impacted by 6 weeks of stretch training** Bray, N.W., Simpson, C.L., Jakobi, J.M. University of British Columbia Okanagan (Kelowna, Canada) **Introduction** Previous literature has shown a negative impact on rate of force development (RFD) and electromechanical delay (EMD) of a maximal voluntary contraction (MVC) that follows acute bouts of static stretching (Costa et al., 2010, Esposito et al., 2011). It is unknown whether chronic stretch training similarly impacts the neural and mechanical components of force development. The purpose of this study was to evaluate the effects of 6 weeks of chronic stretch training of the plantar flexors and Achilles tendon on RFD and EMD of plantar flexion MVCs. **Methods** Five days per week for 6 consecutive weeks, the non-dominant leg of 11 males (age  $22 \pm 3$  years) was rotated to maximal dorsiflexion and passively stretched against a progressively increased load (20-60% MVC) for 3 minutes. At baseline, three weeks, six weeks and one week post training electromyography (EMG) was collected from the lateral and medial gastrocnemius and soleus while plantar flexor force was measured on a dynamometer with the ankle angle set to 10° of dorsiflexion. Supramaximal stimuli was administered during contraction to assess voluntary activation. EMD, RFD, EMG and the H/M Ratio (H-reflex/M-wave) were assessed from the force and EMG tracings. **Results** Thirty sessions of stretch training of the plantar flexors and Achilles tendon resulted in a significant slowing of the RFD (time main effect:  $F(3,102)=2.280$ ,  $p=0.04$ ) from baseline at week 6 ( $p=0.01$ ) and post training ( $p=0.02$ ). The EMD of MVC increased (time main effect:  $F(3,57)=3.354$ ,  $p=0.03$ ) post training when compared to baseline ( $p=0.006$ ) and week 3 ( $p=0.05$ ). There was a time main effect ( $F(1,632,386.888)=11.617$ ,  $p<0.001$ ) for normalized EMG as the amplitude decreased from baseline at week 3 ( $p=0.001$ ), week 6 ( $p<0.001$ ) and post training ( $p=0.006$ ). There were no interactions or main effects for H/M ratio. There were no changes in the control leg ( $p>0.08$ ). **Discussion** Six weeks of progressively loaded chronic stretch training slowed the RFD and normalized EMG while increasing EMD of the plantar flexors during plantar flexion MVC. These results suggest that chronic stretch training interrupted activation patterns of the plantar flexors and slowed signal transmission in the muscle while leaving neural mechanisms, reflex activity and voluntary activation, unaffected. Meaning, alterations in RFD and EMD post-intervention are the result of mechanical adaptations in the muscle-tendon unit (MTU). **References** Costa, P. B. et al. (2009). *Eur J Appl Physiol*, 108(2):301-310. Esposito, F. et al. (2010). *Eur J Appl Physiol*, 111(3):485-495. Contact nick.w.bray@gmail.com

### **THE ACUTE EFFECTS OF DYNAMIC STRETCHING ON THE SENSORIMOTOR AND MECHANICAL PERFORMANCE OF THE TRICEPS SURAE MUSCLES.**

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**Introduction** Dynamic stretching (DS) is commonly used in warm-up routines prior to athletic activities. Even though several positive effects of dynamic stretching have been reported, the effects on different muscle contraction modes and proprioceptive ability are still unclear. The present study aims to determine whether acute responses to different dynamic stretching velocities affect the maximum voluntary torque and proprioceptive performance of the ankle plantarflexors. **Methods** A repeated measures experimental design was used where 18 healthy university students and staff (9 male and 9 female) (age =  $28.33 \pm 4.75$  years, height =  $1.73 \pm 1.00$  m, mass =  $70.58 \pm 11.38$  kg) were randomly assigned into slow dynamic stretching at 50 b/min (SDS) and fast dynamic stretching at 100 b/min (FDS). Outcome measures were assessed pre- and post-2 minutes after both interventions using an isokinetic dynamometer and ultrasonography.

Outcome measures included maximum isometric torque at neutral ankle position (90°), maximum concentric and eccentric torque through the available ankle range of motion, and sensorimotor indices such as a force matching task and a joint position sense of the ankle at neutral position. Medial gastrocnemius fascicle length was calculated at passive maximum dorsiflexion angle. Results A mixed model analysis of co-variance (ANCOVA) for interaction of acute responses demonstrated that neither conditions, SDS or FDS elicited any improvement in ankle passive flexibility compared to baseline performance levels ( $F(1,32) = 2.763$ ;  $p = 0.106$ ). Preservation of strength in isometric ( $F(1,32) = 0.006$ ;  $p = 0.937$ ), concentric ( $F(1,32) = 2.897$ ;  $p = 0.098$ ) or eccentric ( $F(1,32) = 0.926$ ;  $p = 0.343$ ) contractions and sensorimotor performance (force ( $F(1,32) = 0.003$ ;  $p = 0.959$ ) and positional ( $F(1,32) = 0.011$ ;  $p = 0.919$ ) errors) in DS has been demonstrated. Passive muscle fascicle length did not show any change from pre- to post stretch for both interventions ( $F(1,14) = 0.075$ ;  $p = 0.788$ ). Note: Only 8 participants in the analysis. Discussion The findings in the current study indicate that an acute bout of DS of either velocity does not lessen a person's mechanical and sensorimotor capability to perform and control movements effectively. Thus DS is not contraindicated for inclusion in a warm-up session. Contact George.Pamboris@brunel.ac.uk

## POTENTIATION OF THE FIRST AND SECOND PHASES OF THE M-WAVE AFTER VOLUNTARY CONTRACTIONS OF DIFFERENT DURATIONS AND INTENSITIES IN THE TIBIALIS ANTERIOR

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**Objective:** To investigate the extent and time-course of potentiation of the muscle compound action potential (M wave) after conditioning contractions of different durations and intensities. **Methods:** M-wave potentiation was studied in the tibialis anterior of 11 young subjects. M waves were evoked before and after isometric maximal voluntary contraction (MVC) of different durations (1, 3, 6, 10, 30 and 60 s), and after 4-s contractions of different intensities (10, 30, 50, 70, and 90% MVC). The amplitude, area, and duration of the first and second phases of the M wave, together with the median frequency (F<sub>median</sub>) and muscle fibre conduction velocity (MFCV) were measured. For each parameter, potentiation was assessed as the ratio of the values measured after and before the conditioning contraction. **Results:** Regardless of the duration and intensity of the conditioning contractions, the amplitude of the M-wave first phase was not potentiated, whereas the second phase underwent a marked increase. The potentiation of the M-wave second phase augmented progressively with contraction intensity from 30% to 70% MVC and was similar for MVC durations ranging from 1 to 10s. After these conditioning contractions, the duration and area of the first and second phases was significantly decreased ( $P < 0.05$ ), whereas MFCV and F<sub>median</sub> were increased ( $P < 0.05$ ). Changes in MFCV after the contractions were correlated with those in M-wave second phase amplitude ( $r^2 = 0.42$ ;  $P < 0.05$ ) and F<sub>median</sub> ( $r^2 = 0.53$ ;  $P < 0.05$ ). For all the studied parameters, the greatest changes occurred 1 s after each contraction and these changes were abolished within 30 s following the conditioning contraction. Interestingly, these changes were observed at a time when muscle architecture did not differ from the pre-contraction conditions. **Conclusions:** Our study indicates that only the amplitude of the M-wave second phase (but not the first phase) was enlarged after conditioning contractions shorter than 60s. In view of the unequal degree of potentiation for the first and second phases and the rapid recovery of M-wave characteristics after a contraction, it is unlikely that the enhanced electrogenic Na<sup>+</sup>-K<sup>+</sup> pumping could account solely for M-wave potentiation. In a wider perspective, the results provide further support to the idea that only the amplitude of the M-wave first phase, but not the second, can be used reliably to monitor possible changes in membrane excitability

## STATIC STRETCHING INFLUENCES STRETCH REFLEX AND HAVE NO EFFECTS ON NEURONAL REFLEX PATHWAYS OR CORTICAL ACTIVATION

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**Do not insert authors here!** Introduction In sport and rehabilitation, muscle stretching is a common practice known to induce several short and long term adaptations. Some of these, as range of motion (Radford 2006) muscular performance (Behm 2011) and morphological parameters (Konrad 2015) have been widely studied. Compared to these topics, the neural implications of muscle stretching have been certainly underinvestigated. In the present work we examined the effects of 60 seconds of triceps surae static stretching (SS) on stretch reflex (SR), H reflex (HR) and motor evoked potentials (MEP) **Methods** Eight individuals took part in the study. Measurements were always performed with the volunteers sitting on a dynamometer chair, leg fully extended at knee joint and ankle joint at 10° plantarflexion (PF) (neutral ankle position at 90°). Baseline measurement consisted on averaging 15 HR, 15 SR and 30 MEP responses; the same procedures were repeated immediately, five and ten minutes after 60 seconds control time during which the subjects remained seated with the knee extended and the ankle at 10° PF. Following baseline and control recordings measurements were further repeated immediately, five and ten min after 60 seconds SS at maximal individual dorsiflexion. **Results** SR reflex resulted strongly inhibited immediately after stretching (-78%) and it did not recover to baseline values neither at 5 (-56%) nor 10 min (-60%) after termination of stretching. However significant results in comparison to control were only found at immediate ( $P = .0008$ ) and 10 min after ( $P = .0028$ ) stretching. HR and MEPs did not significantly change. **Discussion** The results of the present work seem to indicate that SS only influences muscle spindles sensitivity, with no effects on neuronal reflex pathways or cortical activation. Inhibition of the SR reflex can be attributed to formation of slack within the spindles. Results related to HR and MEP are partially in agreement (Gyssard 2001) and partially in disagreement (Olivieri 2012) with literature. This controversy can be attributed to the time delay between the end of the stretching and the termination of the measurements. In fact, due to the protocol, the values reported are an average value of several reflexes collected within 150 seconds from the termination of the conditioning manoeuvre. **References** Radford JA, Burns J, Buchbinder R, Landorf KB, & Cook C (2006). Br J Sports Med., 40, 870-875. Behm DG & Chaouachi A (2011). Eur J Appl Physiol., 111, 2633-51. Konrad A, Gad M, & Tilp M (2015). Scand J Med Sci Sports., 25, 346-355. Guissard N, Duchateau J, & Hainaut K (2001). Exp Brain Res., 137, 163-169. Oliveri M, Caltagirone C, Loriga R, Pompa MN, Versace V and Souchard P (2012). Neurosci Lett. 530(1): 7-11. Contact francesco.budini@uni-graz.at

## Invited symposia

### IS-BN07 INNOVATIVE TECHNOLOGY FOR ANALYZING, IMPROVING AND ENCOURAGING ATHLETES' PERFORMANCE

#### VIRTUAL REALITY TECHNOLOGY: HOW CAN IT HELP US UNDERSTAND DECISION-MAKING IN SPORT?

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To properly understand expertise and decision-making in sport we need a methodology that can adequately and accurately recreate the perception/action cycle and allow us to measure and understand decision-making from the player's perspective. In other words, we need to use technology that allows us to recreate an athlete's (egocentric) 3D perspective of an unfolding sports related event that can be updated in real time (Bideau et al, 2010). At the same time it has to also offer the possibility of precisely controlling the perceptual information presented to the observer immersed in the environment and reliably reproduce these conditions across trials. The experience has to also be interactive, so that we can record how the observer interacts or responds to the information presented in the environment. Immersive, interactive virtual reality technology offers an exciting new way of studying decision making in sport where the perception/action cycle is maintained (Craig, 2014). The versatility of this technology means it can be easily applied to many different sports (e.g. rugby (Brault et al, 2012), soccer (Dessing & Craig, 2010), cricket (Dhawan et al, 2015)). In this talk I will present different examples from different sports and show systematically how the dynamics of the visual information presented to players influences decisions about when and how to act. I will also explore how an in-depth analysis of the movement of a player as an event unfolds provides valuable insight into expert/novice differences in the decision-making process (Craig & Watson, 2011). References Bideau B, Kulpa R, Vignais, N, Brault, S, Multon, F & Craig CM, (2010) Virtual reality, a serious game for understanding performance and training players in sport. *IEEE Computer Graphic Applications*, 30, 14-21. Brault, S, Bideau, B, Kulpa, R & Craig, C (2012) Detecting deception in movement: The case of the side step in rugby. *PloS ONE*. Doi: 10.1371/journal.pone.0037494 Craig, C & Watson, G (2011) An affordance based approach to decision making in sport: Discussing a novel methodological frame work. *Revista de Psicología del Deporte*, 20, 2, 689-708. Craig CM. (2014) Understanding perception and action in sport: How can virtual reality technology help? *Sports Technology*, 6, 161-169. Dhawan, A., Cummins, A., Sprafford, W., Dessing, J.C. & Craig, C. (2016) Development of a Novel Immersive Interactive Virtual Reality Cricket Simulator for Cricket Batting,. *Proceedings of the 10th International Symposium on Computer Science in Sports (ISCSS)*, Springer, pp203-210.

#### ADVANCED TECHNOLOGIES FOR BETTER PERFORMANCE AND INJURY PREVENTION IN SNOW SPORTS

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Snow sports and in particular skiing and snowboarding are expensive entertainments not only because of the necessary investment in equipment. It may surprise that -in spite of this- an estimated total of 350 million people worldwide are performing these sports. Not only this considerable number of participants and the economic power of the subsequent sporting goods (and tourist) market justify big efforts in research and development. Even more important however seems the prevention of snow sports related injuries. Against this background it is clear that innovative technologies are not only a stimulation for additional market shares in this segment. They also offer a chance to improve protection by new and better safety gear. The talk will explain the background, illustrate the current state of research and finally formulate visions in this field. This will be done by giving five examples of our and other researchers' work: 1) Digital skiing coach for faster learning and better performance. 2) Prevention of jump-landing accidents in snow parks 3) Prevention of deep burying in an avalanche and of alpine ski race injuries 4) Prevention of overloads of artificial hip joints in skiing 5) Prevention of knee injuries by mechatronic ski bindings While the first three examples have almost achieved the state of market introduction, the fourth and fifth are still in the phase of investigation with special focus on biomechanical issues. With explaining these examples, this talk will also give an impression on actual measurement technologies applied under difficult boundary condition, such as skiing.

#### THE USE OF PERFORMANCE MEASUREMENT SYSTEMS FOR BOTH ELITE AND RECREATIONAL ATHLETES

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*Aalborg University*

Introduction Classical biomechanical measurement methods have long been validated and provide valid results for performance testing of athletes. They are typically applied in laboratory settings to identify factors which improve movement execution. In conjunction with modelling approaches, principles for human performance can be derived, suggestions for alterations may be examined to further optimize sports techniques and potentially reduce overloading or injury risks. Recent advances on camera and sensor performance, miniaturization, wireless technology, batteries, and modern communication systems have vastly broadened the spectrum for applications in, but most importantly outside, the laboratory. These developments offer new perspectives for testing in the sports environment including real-time feedback to athletes which can be immediate or continuous. The data provided by such approaches may cover a multitude of situations or a whole sports performance session. However, the nature of the new sensor information collected may differ substantially from laboratory-based evaluations providing new metrics for movement analysis. We are currently in a transition phase where we need to explore these new metrics and relate them back to existent knowledge. Example Applications In this symposium, we will present how our earlier ambitions of providing feedback from laboratory tests have developed to field-based assessments that we contend afford a substantial step forward in the improvement of performance. Applications include Cricket, Rowing, Skiing, Soccer, Running and Sprinting. Discussion There is no doubt that these new technologies will provide a much greater ecological validity than laboratory-based measurements. Based on the examples presented, current and future applications as well as fundamental strengths and limitations will be discussed in a discipline specific context. It will be exciting to see how we will move towards even more comprehensive field-based athlete assessments.



## Invited symposia

**IS-BN08 THE SEQUENCE OF INJURY PREVENTION WITHIN AN INTERNATIONAL SPORT FEDERATION - ELITE ALPINE SKI RACING AS AN EXAMPLE****INJURY DATA FROM THE FIRST SIX SEASONS <2006-2012> OF THE FIS INJURY SURVEILLANCE SYSTEM IN WORLD CUP ALPINE SKIING**

STEENSTRUP, S.

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FIS established in collaboration with the Oslo Sports Trauma Research Center (OSTRC) a continuous injury reporting system for all FIS events, the FIS Injury Surveillance System (ISS), prior to the 2006/07-season. The objective of the FIS ISS is to provide data on injury trends in international skiing and snowboarding at the elite level with the long-term goal of reducing injury risk. During the 2006/07-season, Flørenes et al. (2011) investigated in a methodological study which method would produce the most complete and accurate record of injuries to World Cup (WC) skiers. They found that retrospective interviews with athletes/coaches gave the most complete picture of injuries in this setting. Therefore, retrospective interviews are conducted by physicians or physiotherapists from the OSTRC at the WC finals at the end of each winter season. All athletes who are present in person are interviewed, while coaches or medical staff are interviewed if the athlete is not present (due to injury or for other reasons). Athletes, coaches and medical staff are asked to recall any acute injury requiring medical attention, occurring in training or competition during the WC season. Injury reporting from the first six (2006-12) seasons of the FIS ISS showed that the risk of injury among WC alpine skiers was even higher than expected. The most frequently injured body part was the knee, and over 50% of these knee injuries were severe (Flørenes et al. 2009). Bere et al. (2014) reported that men had a higher rate of injury than women. These sex differences were even more pronounced during WC races. However, there was no sex difference in the risk of knee or ACL injuries (Bere et al. 2014). The injury rate was highest in downhill (17.2 injuries per 1000 runs), followed by super-G (11.0), giant slalom (9.2) and slalom (4.9) (Flørenes et al. 2009). Based on the high injury rates and severity of these injuries, FIS initiated several steps to improve athlete safety in the following seasons. References: Bere T, Flørenes TW, Nordsletten N, Bahr R. Sex differences in the risk of injury in World Cup alpine skiers: a 6-year cohort study. *Br J Sports Med* 2014; 48:36-40 Flørenes TW, Bere T, Nordsletten L, Heir S, Bahr R. Injuries among male and female World Cup alpine skiers. *Br J Sports Med*. 2009 Dec;43(13):973-8. Flørenes TW, Nordsletten L, Heir S, Bahr R. Recording injuries among World Cup skiers and snowboarders: a methodological study. *Scand J Med Sci Sports*. 2011 Apr; 21(2):196-205.

**EQUIPMENT REGULATION AS A PREVENTION MEASURE FOR ACUTE KNEE INJURIES IN ALPINE SKI RACING**

KRÖLL, J., SPÖRRI, J., GILGIEN, M., SCHWAMEDER, H., MÜLLER, E.

*University of Salzburg*

Within the classification of severe injuries, the most frequently injured body part was the knee (62,3%),[1] with a rupture of the anterior cruciate ligament (ACL) as being the most frequent diagnosis.[2] The majority of knee injuries occurred while the skier was still skiing the course (83%).[3] The so-called self-steering effect of the ski, which enables athletes to perform turns with high amount of carving, favours a 'catch of the edge' in the event of an out-of-balance situation. As a result, the athlete is unable to control the ski and the ski's behaviour becomes unpredictable.[4] In such cases, the skis' behaviour is perceived to be aggressive at the ski snow interaction, which has been suggested by expert stakeholders to represent one of the main contributors to typical mechanisms of knee injuries.[5] Consequently, efforts were made to (i) design, (ii) evaluate and (iii) finally implement equipment which reduces the risk of severe knee injuries: (i) By reducing the self-steering effect of the equipment, a reduction of the aggressiveness at the ski snow interaction was hypothesised, particularly in out-of-balance situations. Potential equipment interventions were ski sidecut radius and standing height of the athlete.[5] (ii) Across several independent field experiments the effect of different equipment interventions on relevant biomechanical variables were investigated. It was for instance experimentally shown, that skiing on skis with greater sidecut radius results in an increased ski turn radius and, therefore, provides evidence for reduced self-steering of the ski.[6] Another study depicted that skis with greater sidecut radius potentially reduce the kinetic variables related to, as well as the athletes' perception of, aggressive ski behaviour.[7] (iii) However, it was also shown that skis with a substantially greater sidecut radius might lead to a significant loss of attractiveness for spectators.[7] Therefore, potential benefits (injury prevention) and costs (attractiveness) have to be weighed against each other when implementing new specification on equipment within the International Ski Federation's (FIS) competition rules. References 1. Flørenes TW, et al. *Br J Sports Med* 2009;43:973-8. 2. Pujol N, et al. *Am J Sports Med* 2007;35:1070-4. 3. Bere T, et al. *Scand J Med Sci Sports* 2014;24:667-77. 4. Bere T, et al. *Am J Sports Med* 2013;41:1067-73. 5. Spörri J, et al. *Br J Sports Med* 2012;46:1059-64. 6. Spörri J, et al. *Br J Sports Med* 2016;50:14-9. 7. Kröll J, et al. *Br J Sports Med* 2016;50:20-5.

**BACK OVERUSE INJURIES IN ALPINE SKI RACING – WHAT DO WE KNOW AND HOW TO PREVENT THEM?**

SPÖRRI, J.1, KRÖLL, J.1, FASEL, B.2, AMINIAN, K.2, MÜLLER, E.1

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Overall, this talk aims to (1) provide an overview of what is known about back overuse injuries in alpine ski racing, and (2) add (new) data/perspectives on how to prevent them. The back is one of the most vulnerable body parts for overuse injuries, particularly in the sport of alpine ski racing.[1] As early as adolescence, competitive skiers have a significantly higher rate of anterior endplate lesions than age-matched controls.[2] These types of spine deteriorations are known to increase the risk of developing low back pain at follow-up.[3] Specifically, the strongly forward/sideward bent and twisted postures of the spine while skiing are considered a major cause of back overuse injuries.[4] Combined with loads of up to 2.9 times body weight, these postures might lead to adversely high spinal torques.[4] Therefore, prevention measures should aim to control/reduce the magnitude of frontal bending, lateral bending and torsion in the trunk, while avoiding an immoderate exposure to high peak loads during skiing.[4] By means of three biomechanical field experiments, we investigated the effects of different equipment and course setting interventions on the aforementioned back loading relevant variables. Briefly stated, in both giant slalom and slalom, decreased standing height due to the ski-plate-binding-boot unit can indirectly be associated with decreased overall back loading (unpublished data), while increased gate offset might primarily help to avoid adverse back

loading patterns in slalom.[5] Alterations in sidecut had no effect on back loading relevant variables.[4] However, whether the investigated measures are effective to prevent back overuse injuries in alpine ski racing remains to be verified by epidemiological studies. References 1. Hildebrandt C, Raschner C. (2013). Traumatic and overuse injuries among elite adolescent alpine skiers: A two-year retrospective analysis. *Int SportMed J*, 14(4), 245-55. 2. Rachbauer F, Sterzinger W, Eibl G. (2001). Radiographic abnormalities in the thoracolumbar spine of young elite skiers. *Am J Sports Med*, 29(4), 446-9. 3. Ogon M, Riedl-Huter C, Sterzinger W, et al. (2001). Radiologic abnormalities and low back pain in elite skiers. *Clin Orthop Relat Res*, 390, 151-62. 4. Spörri J, Kröll J, Haid C, Fasel B, Müller E. (2015). Potential mechanisms leading to overuse injuries of the back in alpine ski racing: A descriptive biomechanical study. *Am J Sports Med*, 43(8), 2042-8. 5. Spörri J, Kröll J, Fasel B, Aminian K, Müller E. (2016). Course setting as a prevention measure for overuse injuries of the back in alpine ski racing: A kinematic and kinetic study of giant slalom and slalom. *Orthop J Sports Med*, 4(2), 2325967116630719. Contact: joerg.spoerri@sbg.ac.at

## **INJURY RATE AND INJURY PATTERNS IN FIS WORLD CUP ALPINE SKIING: HAVE THE NEW SKI REGULATIONS MADE AN IMPACT?**

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*Norwegian School of Sports Sciences*

Background: New regulations for ski equipment were implemented prior to the 2012/2013 season in the International Ski Federation (FIS) Alpine World Cup (WC). Objective: To investigate the effect of the new ski regulations on the rate and pattern of injuries by comparing data before (2006–2012) and after (2012–2015) the implementation. Methods: Injuries were recorded on the basis of the FIS Injury Surveillance System (FIS ISS) through retrospective interviews at the end of each of the nine WC seasons. All acute injuries that required medical attention were registered. Exposure was calculated on the basis of the official result lists. Results: The absolute injury rate (injuries/100 athletes/season) was lower in the three seasons after the new ski regulations compared with the six seasons before (risk ratio (RR) 0.74, 95% CI 0.63 to 0.87). This was also the case for the relative injury rate (injuries/1000 runs) (RR 0.76, 95% CI 0.59 to 0.98). However, these changes were only evident for male skiers, not for female skiers. There was a lower absolute injury rate for upper body injuries (RR 0.56, 95% CI 0.43 to 0.77), while no difference was found for lower extremity injuries (RR 0.84, 95% CI 0.70 to 1.01). Conclusions: We found a lower rate of injuries in the three seasons after the new ski regulation compared with the six seasons before. However, the ability to draw conclusions on the effects of the equipment change in subgroups of sex, discipline or body part is restricted by the limited statistical power.

## **Invited symposia**

### **IS-SH07 TEAM SPORT AND ACCULTURATION DYNAMICS IN MULTICULTURAL SOCIETIES**

#### **TEAM SPORT AND ACCULTURATION DYNAMICS IN MULTICULTURAL SOCIETIES – THEORETICAL FRAMEWORK**

SANCHEZ, X., MORELA, E., HATZIGEORGIDIS, A.

*University of Cumbria, Lancaster*

Sport has been recognised as an important socialising agent given the large number of participants it attracts. Team sports bring together individuals from different backgrounds and thus can, potentially, smooth social and cultural barriers. Nevertheless, sport participation is not per se an effective instrument towards the goal of integration. In fact, team sports may reinforce existing ethnic/cultural identities; individuals may not seek to socialise with other 'group' members but rather find shelter within a group of similar ethnic/cultural background, strengthening their own identity. Therefore, organised attempts to promote integration are required whereby sporting environments specifically designed to address the objective of integration are developed. The present symposium provides an overview of our ongoing research programme on team sports and acculturation. In the present talk we discuss a theoretical framework to examine the role of team sports in the acculturation process. Research on the role of sport as a social integration agent in multicultural societies has been scant. The adaptation of relevant theoretical frameworks to sport shall help the development of systematic research and enhance our understanding on the role of sport in the acculturation process. This presentation addresses the theoretical approach we have adopted in our research programme. Acculturation is a two-sided process, involving both the incoming population and their non-dominant culture, and the host population and their dominant culture. The preferences but also the fit between attitudes and strategies adopted by these two parties determine the outcome of the acculturation process. The two-dimensional model of acculturation (Berry, 1997) describes the acculturation strategies of the ethno-cultural groups and the larger society. For both its versions (non-dominant/-dominant culture), the model is based on the interaction of individuals' desire to (a) preserve their cultural heritage and identity, and (b) interact and seek relationships with other groups. Buhris et al. (1997) extended this model by considering the fit between the goals of the two populations. The interactive acculturation model suggests that the interaction of these goals can lead to consensual, conflictual, or problematic acculturation. Based on the conceptualization of these models our currently ongoing research line sheds some light onto the role of team sports in the acculturation process of young migrants.

#### **TEAM SPORT AND ACCULTURATION IN MULTICULTURAL SOCIETIES: THE PERSPECTIVE OF THE HOST POPULATION**

HATZIGEORGIDIS, A., MORELA, E., SANCHEZ, X., ELBE, A.M.

*University of Thessaly*

The process of acculturation is of fundamental importance for both intergroup relations and migrants' adaptation to the society of settlement. Sport has been considered as an appropriate context for promoting cultural contact and integration. Research on the role of sport as an integrative agent is scant and has mainly focused on migrant populations. Considering that acculturation is a two-way process involving both the migrant and the host populations, research investigating the perspective of the hosts will enhance our understanding of the acculturation process. The purpose of the present study was to explore acculturation attitudes of adolescents from the host population as a function of sport participation, and to investigate the role of motivational environment, within those participating in team sports. Participants were 626 Greek adolescents high school students (316 girls and 314 boys), with a mean age of 13.88 (S.D. =1.01). Among

them, 175 were athletes competing in team sports. Participants completed questionnaires assessing acculturation attitudes and variables describing the motivational environment of their sport team. Analysis of variance revealed that athletes scored higher than non-athletes on attitudes towards multicultural contact. A structural equation path model was tested to test the degree to which motivational environment could predict host community acculturation attitudes. The analysis revealed that a motivational environment characterised by a mastery oriented climate, supportive of the needs of autonomy, competence, and relatedness, was positively linked to multiculturalism attitudes, whereas a motivational environment characterised by performance oriented climate and controlling coaching behaviour was negatively linked to multiculturalism attitudes. The findings provide useful insights for the perspective of the host population regarding migrants' acculturation and the role of the sport environment for the promotion of integration. The present study encourage further research onto the role of sport for the effective acculturation of migrants that can help inform interventions and contribute to the development of appropriate policies.

### TEAM SPORT INTERVENTIONS PROMOTING INCLUSION OF MIGRANTS IN THE SCHOOL SETTING

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(1) University of Copenhagen (2) University of Groningen (3) Cumbria University

Today's school environments are getting increasingly culturally diverse and educational institutions are faced with the important question of how cultural diversity in school environments can be utilized in a positive manner. This lecture will present the results of a team sport based intervention aimed at promoting inclusion as well as the students' identification with their school class and Danish society. This intervention study was conducted in 7th, 8th and 9th grade multicultural physical education (PE) classes (n=132) at a school in Silkeborg, Denmark. For this purpose, specific teaching methods focusing on cooperation and aiming at creating an inclusive PE environment were developed, implemented and evaluated. More specifically, lesson plans were directed towards the promotion of a mastery motivational climate within PE classes. A mastery motivational climate is believed to translate into an increase in students' perceived feelings of school class inclusion, school class identification and/or identification with Danish society as a whole. Research has identified six specific sport contextual teaching structures as being salient to the development of a mastery climate in classrooms (Ames, 1992). These TARGET structures are connected to both the content of each lesson (Task, Authority, Grouping, and Time) and specific teaching behaviors which are to be executed during each lesson (Evaluation and Reward). Both quantitative as well as qualitative data were collected from both the intervention as well as the control classes. Results indicated that the intervention group experienced an increase of mastery climate as well as higher levels of perceived inclusion. The present study indicates that implementation of team sport activities conducted within a mastery motivational PE class climate can be a way forward in order to positively deal with cultural diversity in the school environment.

## Invited symposia

### IS-SH08 THE CULTURES OF BOXING

#### BOXING AND URBAN CULTURE

LEWANDOWSKI, J.

*University of Central Missouri*

Professional boxing may not be an exclusively urban sport, but at least in the US, it is a quintessentially urban one. For US-based boxing clubs are not merely physical places typically located within cities. More fundamentally, boxing clubs in the US characteristically constitute part of a physically precarious but historical and socio-economically durable landscape of deprivation, disrespect, and disorder commonly known as the 'the hood'. Given the distinctly urban inflection of US boxing, one needs to understand how the attitudes and choices of urban boxers intersect with the larger forces and constraints that define 'the hood' and inform the culture of boxing in America. Drawing on several years as an active member of a Kansas City boxing gym, in this presentation I seek to explore some of the complex ways in which various forces and constraints of life in 'the hood' shape the reflexive agency and self-understandings of those individuals who opt to pursue a professional boxing career in the States.

#### BOXING: THE ART OF FIGHTING

NEAD, L.

*Birkbeck University of London*

The aesthetics and visual cultures of sport are strangely neglected within the arts and humanities. It is hard to understand why or to account for this lacuna. Whilst the financial, social and cultural power of sport is fully acknowledged, the place that beauty, ugliness and visual impact play in the exercise of that power remains relatively under theorised or historicised. Perhaps as much as any other sport, boxing has held a particular and enduring fascination for visual artists, including sculptors, painters, photographers and filmmakers. This paper will argue that, unlike other sports that celebrate an idealised male body, boxing images disseminate a different image of masculinity, which represents the physical and emotional pain of defeat and the wounded, damaged body. Using a small number of case-studies, from across a broad chronological period, the paper will examine this subject matter and just what constitutes the visual power of the image in this context. It will suggest that the image of the wounded boxer does offer a type of male beauty, but one that can only be taken on with enormous difficulty by female athletes for whom the battered body tests the limits of mainstream femininity to their utmost.

#### BOXING: FROM MALE VOCATION TO NEUROTIC MASCULINITY

SCOTT, D.

*Trinity College Dublin*

Do not insert authors here This paper explores the cultural significance of boxing in its relationship to concepts and practices of masculinity as they have emerged in writing from the time of the mid-18th century revival of the sport in England. Focussing on key moments of

change in boxing's significance in relation to male vocation, the paper will in particular investigate the extent to which literary and cultural responses to the sport cast light on the crisis masculinity has undergone since the start of the 20th century. Changing attitudes to boxing will thus be interpreted as symptoms of modification in the concept and practice of manliness, successively from boxing as rite of passage, as profession or occupation, as idea, as fantasy, and finally as image or neurosis. Early modern European literary writers as diverse as Maurice Maeterlinck, Arthur Cravan, Robert Musil, and Malcolm Lowry together provide evidence of symptoms that will subsequently be clarified in the light of contemporary American authors, whether of fiction (Chuck Palahniuk), or of socio-psychological study (Gerald Early, Carlos Rotella). The paper will close by briefly connecting the modern figure of the boxer as 'man without qualities' with the figure of the contemporary 'golden boy', showing how both manifest essential features of neurotic masculinity.

## Invited symposia

### IS-EX03 JSPFSM-ECSS Exchange Symposium: Genetics of sports performance and its applications to health science

#### GENETICS OF SPORTS PERFORMANCE IN ASIAN ATHLETES

FUKU, N.

*Juntendo University*

A number of familial and twin studies have assessed the relative contribution of genetic and environmental factors to physical performance or its-related traits and have estimated that there is a significant genetic component to their phenotypes. In addition, aerobic capacity has been found to have stronger maternal inheritance than paternal. These findings indicate that functional differences in maternally inherited mitochondrial DNA (mtDNA)-encoded proteins involved in oxidative phosphorylation as well as nuclear DNA polymorphisms affect aerobic performance. To date, over 100 genes in both nuclear DNA and mitochondrial DNA (mtDNA) have been reported to be associated with physical performance. However, most studies have been reported in European populations. In the Asian population, only 5 genetic loci have been linked to physical performance, including angiotensin I-converting enzyme,  $\alpha$ -actinin-3, insulin-like growth factor 2, and ciliary neurotrophic factor receptor nuclear genetic polymorphisms and mtDNA polymorphisms (mitochondrial haplogroups). We recently investigated the association between the ACTN3 R577X polymorphism and elite Japanese athlete status in a large cohort of Japanese track and field athletes and controls. We found that sprinters with the RR+RX genotype had faster personal best times for the 100-m event than those with the XX genotype. Interestingly, all 7 male sprinters who had achieved the London 2012 Olympic qualifying standard for the 100-m event (B standard: 10.24 s) possessed the RR or RX genotypes, which was not observed in those qualifying for the 400-m event. Interestingly, the ACTN3 R577X polymorphism accounted for 12% of the variability in the personal best times for the 100-m run. However, there is not enough evidence to explain, in detail, the relationship between genetic factors and elite athlete status. Current studies of athletic performance-associated polymorphisms, which were previously identified through candidate gene-association studies, have revealed the polygenic profile for determining athletic performance; however, additional studies are needed to explain the genetic component. The strong genetic contributions to physical performance and/or its-related traits indicate the possibility of using genetic approaches to individualize training approaches for enhancing competitive abilities in sports or even to help select appropriate athletic events by using genetic screening for extending the personal limit of athletes (i.e., talent identification and/or talent transfer to other events). Further studies in sports science should include more detailed analyses of genetic polymorphisms detected in both mtDNA and nuclear DNA. Investigators in the field of sports science are now focusing on more detailed analysis of genetic polymorphisms, e.g., genome-wide association studies (GWAS) or whole genome sequencing. In this symposium, I will introduce the evidence of genetic polymorphisms to determine physical performance in Asian athletes from both candidate gene-association studies and GWAS.

#### GENOME-WIDE ASSOCIATION STUDIES INVOLVING RUSSIAN ENDURANCE AND POWER/STRENGTH ATHLETES

AHMETOV, I., ISCHENKO, D., KULEMIN, N., POPOV, D., KOSTRYUKOVA, E., ALEXEEV, D., EGOROVA, E., GABDRAKHMANOVA, L., LARIN, A., GENEROZOV, E., PAVLENKO, A., AKIMOV, E., VINOGRADOVA, O., GOVORUN, V.

*Volga Region State Academy of Physical Culture, Sport and Tourism*

Humans vary in their ability to achieve success in sports and this variability majorly depends on genetic factors. In the past 19 years, at least 156 genetic markers (located within almost all chromosomes and mtDNA) were found to be linked to elite athlete status (94 endurance-related genetic markers and 62 power/strength-related genetic markers). Importantly, 42 markers were identified within the last two years by performing genome-wide association studies (GWASs) of athletes from Canada, Finland, Germany, Jamaica, Japan, Russia and the USA. GWAS is a new approach that involves rapidly scanning millions of markers across the complete sets of DNA by microchips of many people to find DNA polymorphisms associated with a particular trait. In our first study involving Russian athletes, we examined the association between 1,140,419 SNPs and relative maximal oxygen consumption rate (VO<sub>2</sub>max) in 80 international-level Russian endurance athletes, and identified six suggestive 'endurance alleles' (with  $P < 10^{-5}$ - $10^{-8}$ ) which were replicated both in female and male subgroups. To validate obtained results, we further performed case-control studies by comparing the frequencies of six SNPs between 218 endurance athletes (or 100 elite endurance athletes) and opposite cohorts (192 Russian controls and 230 Russian power athletes). It was assumed that the 'endurance allele' should be under-represented in at least one opposite cohort (Russian controls or Russian power athletes) when compared to endurance athletes. This approach resulted in the remaining three SNPs (NFIA-AS2 rs1572312 C, TSHR rs7144481 C, RBFOX1 rs7191721 G) associated with endurance athlete status (Ahmetov et al. 2015). One of the most interested genes, namely NFIA-AS2, is involved in the regulation of expression of the nuclear factor I A (NFIA) gene (transcription factor that induces erythropoiesis). We also found that the NFIA-AS2 C allele was associated with high level of hemoglobin, high number of reticulocytes and erythrocytes. In another study, the comparison of genetic profiles of 492 elite Russian power/strength and 227 endurance athletes and controls revealed that the rare DMD rs939787 T allele was over-represented in power/strength athletes (25.0%) compared to endurance athletes (8.8%;  $P = 3.9 \times 10^{-9}$ ) and controls (16.3%;  $P = 0.0354$ ), indicating that the DMD T allele is favourable for power/strength performance (Naumov et al. 2014). The dystrophin (DMD) gene is a large, rod-like cytoskeletal protein which is found at the inner surface of muscle fibers. Future research including multicenter GWASs and whole-genome sequencing in large cohorts of athletes with further validation and replication will substantially contribute to the discovery of large number of the causal genetic variants (mutations and DNA polymor-



phisms) that would partly explain the heritability of athlete status and related phenotypes. References Ahmetov et al. Biol Sport 2015;32:3-9. Naumov et al. Eur J Hum Genet 2014;22(Suppl. 1):502.

## FITNESS-RELATED GENES AND EXCEPTIONAL LONGEVITY

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*Universidad Europea*

The oldest old population ( $\geq 85$  years) is rapidly expanding among westerners. However, advanced aging comes at a price, i.e., it is associated with an increased risk of loss of functional independence. In this regard, centenarians (people aged 100+ years) are the paradigm of healthy aging, as they have usually postponed (or even avoided, in some cases) major age-related diseases, as well as the onset of disability, until they were well into their nineties. Thus, the search for the gene variants that might influence the likelihood of reaching exceptional longevity (EL, i.e., becoming a centenarian) might help identify targets of "anti-aging" interventions. In old people, functional independence is highly dependent on physical fitness, which in turn is determined by several phenotypes such as mainly cardiorespiratory fitness and muscle performance. Aging is inevitably associated with a decline in muscle mass and function, i.e., sarcopenia, with an acceleration of this process increasing the risk of mortality. Thus, those gene variants that can be associated with preservation of muscle mass/function at advanced ages, e.g., the K153R polymorphism in the myostatin (MSTN) gene or the I/D polymorphism in the angiotensin converting enzyme (ACE) as well as other genetic variations linked with muscle aerobic capacity (e.g., the R577X mutation in the  $\alpha$ -actinin-3 [ACTN3] gene), might also influence the likelihood of reaching EL. Here we summarize current body of knowledge regarding the possible influence of fitness-related genotypes and EL in different cohorts of various ethnic backgrounds. Interestingly, some genes might have a pleiotropic effect, as the theoretically 'unfavorable' allele in midlife (e.g., the D-allele of the ACE gene) might play a protective role at the end of the human lifespan.

## Oral presentations

### OP-BN05 Sport Technology: Equipment 2

#### TRANSFER OF FORCE-VELOCITY CHARACTERISTICS AND MUSCLE POWER IN BMX RACERS

GROSS, M.1, LÜTHI, G.1, GROSS, T.1,2

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**Introduction** In competitive BMX racing, a fast start is crucial for success and requires good explosive strength through a wide movement velocity range. On the bike, and especially on the supercross starting ramp used in international competitions, technical demands increase compared to movements typically used for force-velocity (F-v) assessment, like jumping. This study investigated the transfer of F-v characteristics from jumping to two on-bike conditions varying in speed and technical difficulty, and their influence on starting speed. **Methods** Muscular power and F-v characteristics (Pmax: peak of P-v relationship; F0, v0, sF-v: intercepts and slope of F-v relationship) were obtained using squat jumps with various additional loads. Pedaling power and torque-cadence (T-Cad) characteristics (Pmax: peak of P-Cad relationship; T0, Cad0, sT-Cad: intercepts and slope of T-Cad relationship) were obtained with a modified, crank-based powermeter, under two conditions: • self-initiated sprint to maximum speed on flat ground • simulated supercross race start with randomized gate. Various correlation analyses and t-tests were performed. **Results** • Data were collected from 13 junior or senior national team pool riders. • Absolute Pmax jumping and sprinting were highly correlated, as were absolute F0 and T0. Among other F-v characteristics, and when normalized to body weight, no significant correlations were observed. • Absolute F0 was highly correlated with mean P and v over the first 30 m while sprinting. When F-v characteristics were normalized, the only significant correlation was between F0 and vmean. • Mean P and v on the starting ramp were highly correlated. Ppeak and Pmean for sprints and starts were highly correlated and values did not differ significantly between the two conditions. • For all T-Cad characteristics, significant correlations between sprinting and starting were revealed. However, all values differed significantly between the two conditions. • In absolute terms, all T-Cad characteristics correlated significantly with mean P and v on the starting ramp. When normalized, T0, Cad0 and Pmax correlated significantly with both mean P and v, however sT-Cad did not. **Discussion** In this study, nationally selected BMX racers could transfer muscular power quite well from simple jumping to complex sport-specific tasks. This confirms that good overall explosive strength is beneficial for pedaling power and most importantly, mean starting speed. However, neither F nor v confines of the F-v profile seemed to be limiting for sprint or start P and v, as the transfer of F-v characteristics was not uniform (involves additional skill). On the other hand, transfer of F-v characteristics from sprints to starts was rather uniform. Finally, since Pmax correlated most strongly of the T-Cad characteristics to mean starting v, whereas normalized sT-Cad did not, a preferable tendency toward particularly steep or flat T-Cad profiles is not apparent. Rather, absolute cycling peak P and Cad0 of around 250 rpm seem to be the most crucial determinants of starting speed.

#### IT IS REALLY A GRADUAL COMPRESSION IN THE COMPRESSIVE GARMENTS?

APARICIO, I.1,2, JULIÁN-ROCHINA, I.3, BLANES, M.2, TORMO-MAICAS, V.3, PÉREZ-SORIANO, P.2

*UNIVERSITY OF VALENCIA*

**Introduction** Compressive stockings (CS) are widely used in sport. However it is unknown the best compression parameters. Most of the studies have not measured interface pressure (pressure) applied by the sports garments being investigated (Dirler & Halson, 2013). Pressure applied by sport CS is affected by garment type, size and posture. (Brophy-Williams et al, 2015). The objective of the study is to determine the interface pressure (pressure) applied using two CS: medium compression (MCS) and strong compression stocking (SCS), in three conditions: before, while and after the running test. **Methods** 10 male runners (age  $35 \pm 5$  years) carried out 2 laboratory tests (1.without any stocking; 2.MCS in a leg and SCS in the other leg, in a randomized way). At each test participants ran for 35 minutes on treadmill (5 min at 8km/h + 30 min at 75% of their maximal aerobic speed, previously measured in an incremental running test). Pressure was measured by Pico Press® in four regions (two on the maximum perimeter of the calves, one on the external supramalleolar and one on anterior tibial area). Measurements were taken in static before and after test and in dynamics, every 5 minutes of running. The factor 'compression type' was analyzed by the T test. The factor 'running' by the U test of Mann-Whitney. The factor 'sensors' by ANOVA and the

post-hoc Tukey test. ( $P < 0.05$ ) Results In static, all pressure sensors reported lower parameters after running test ( $p < 0.001$ ). Mean pressure was greater in MCS ( $20.95 \pm 6.17$  mmHg) compared to SCS ( $18.98 \pm 6.08$  mmHg) ( $p < 0.05$ ). In both conditions MCS ( $p < 0.05$ ) and SCS ( $p < 0.001$ ), pressure was higher in proximal than distal sensors. In dynamic mean pressure was greater in proximal sensor ( $p < 0.001$ ) at both "compression type". Discussion The optimal method of applying compression to increase blood flow is by highest pressure exerted at the distal end of the limb decreasing to a lower pressure at the proximal end of the limb (Bochmann et al, 2005). Manufacturer of studied CS exposes their gradual decreasing compression In contrast with our results that, CS pressure is higher in the proximal than the distal area (MCS and SCS) in dynamic and static conditions. It is important to reconsider the principles used to predict the final compression in these garments. Exercise showed mechanical fatigue characteristics of the CS evaluated on the calf muscle, or maybe it is due to changes in the behaviour of the muscle. This lower pressure at the end of the test is important to take into account by manufacturers. In conclusion, although CS exert different pressures, optimal pressure to induce the greatest increase in venous flow is yet to be determined, and it is also interesting to know if companies measure the pressure. Bibliography: Brophy-Williams, N. et al. Journal of Sports Sciences, 2015. Vol. 33, no. 13, 1403-1410. Driller, M.W., & Hanson S.L. Journal of Science and Cycling, 2013, 2(1), 45-50. Bochmann, R.P. et al. Journal of Applied Physiology, 2005, 99(6), 2337-2344. Contact: i.aparicio.gibb@gmail.com

## EFFECTS OF CALF COMPRESSION SLEEVES ON PHYSIOLOGICAL AND BIOMECHANICAL ADAPTATIONS TO TRAIL RUNNING

KERHERVÉ, H.1, SAMOZINO, P.1, DESCOMBE, F.2, PINAY, M.1, MILLET, G.Y.3, PASQUALINI, M.4, RUPP, T.1

1.LIBM, University Savoie Mont Blanc, Chambéry, France; 2.Medipôle, Challes-les-Eaux, France 3.NMFL, University of Calgary, Canada; 4.Thuasne, St-Etienne, France.

Introduction Calf compression sleeves (CS) are increasingly used in off-road exercises, however, no analyses have been conducted so far on the impact of wearing CS on simultaneous physiological and biomechanical adaptations during prolonged (>2 h) outdoor trail running. The aim of this study was therefore to analyse whether CS may modify muscle oxygenation, running biomechanics and performance during a prolonged trail running. Methods Fourteen healthy trained males ( $21.7 \pm 3.0$  yr,  $180 \pm 5$  cm,  $72 \pm 7$  kg) took part in a randomised, cross-over study consisting in two identical 25-km trail running sessions (positive elevation change of 1020 m), >3 weeks apart (same weather conditions). One trial was performed with degressive CS (UP®, Thuasne®,  $23 \pm 2$  mmHg) and the other with control sleeves (CON, <4 mmHg). Oxygenation of the medial gastrocnemius muscle (Mox) was monitored continuously by portable near-infrared spectroscopy (Portalite, Netherland). Biomechanical parameters as ground-contact (Tc) and aerial (Ta) times, duty factor ( $DF = Tc / (Tc + Ta)$ ), leg stiffness (Kleg) and peak force applied to the ground (Fmax) were determined at 12 km.h<sup>-1</sup> using an 8-m long optical system (Optojump, Italy) at the beginning, during, and at the end of both sessions. Exercise-induced Achilles tendon pain (PAT) and delayed onset calf-muscles soreness (DOMS) were assessed using visual analogue scales. Results Mox increased significantly in CS compared to CON at baseline and immediately after exercise ( $P < 0.05$ ), without any difference in deoxygenation kinetics during the run, irrespective of the slopes (e.g. downhill or uphill sections), and without any significant change in run times ( $\sim 0.9\%$ ). Tc and DF were significantly lower in CS vs. CON and Fmax and Kleg were higher in CS at the beginning and throughout the run. CS and CON induced significant DOMS (> 6 on a 10-cm scale) with no difference between conditions, but PAT after the trial was significantly lesser in CS than CON ( $P < 0.05$ ). Discussion Calf compression did not modify the 'metabolic' state of the muscle during prolonged trail running and exercise-induced DOMS, but minimized Achilles tendon pain at the same level of performance. For the first time, we provided evidence that running mechanics at the beginning and throughout the run are strongly affected by CS. Future research should explore the relationship between such optimisation of the fatigue-induced stride parameters, the reduced pain over the Achilles tendon and performance over longer and/or repeated (chronic) trail running events. Contact thomas.rupp@univ-smb.fr

## EFFECTS OF A NEW RUNNING SHOE DESIGN ON THE LANDING PATTERN AND ENERGY LOSS

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Introduction Minimalist running shoes have an increased popularity as it may simulate barefoot running (Altman and Davis, 2012; Pohl et al., 2008; Squadrone and Gallozzi, 2009) and reduce running economy (Cheung and Ngai, 2015). A newly designed minimalist with lug platform claims to promote running performance by simulating barefoot running mechanics and lowering the energy loss during impact. This study sought to compare the landing pattern, vertical loading rates, energy loss, and initial vertical body stiffness in a group of habitual shod runners who ran with this new footwear model. Methods Fifteen habitual shod runners conducted two 10-minute treadmill running bouts with their usual running shoes and the minimalists with lug platform in a randomized order. Kinematics and kinetics data were collected from last 20 consecutive steps of each trial. Heel-strike ratio, vertical average (VALR) and instantaneous (VILR) loading rates, energy loss, and initial vertical body stiffness were compared between two shoe conditions using paired-t tests. Results Runners demonstrated significant lower heelstrike ratio while running in minimalists with lug platform than usual shoes (Cohen's  $d = 0.62$ ;  $p = 0.032$ ). However, only one out of 15 participants completely modified the landing pattern with the minimalists. VALR and VILR between two footwear conditions showed no significant difference (Cohen's  $d = 0.30-0.36$ ;  $p = 0.191-0.258$ ). Initial vertical body stiffness (Cohen's  $d = 0.67$ ;  $p = 0.032$ ) and energy loss (Cohen's  $d = 0.57$ ;  $p = 0.044$ ) were found greater when running in minimalists with lug platform than in traditional running shoes. Discussions Minimalists with lug platform promote non-heelstrike landing but not lead to lower vertical loading rates. Interestingly, the new shoe design does not enhance energy exchange. Instead, it leads to a greater energy loss than traditional running shoes, which could be explained by a higher initial vertical body stiffness. References Altman, A.R., Davis, I.S., 2012. Gait Posture 35, 298–300. Cheung, R.T., Ngai, S.P., 2015. J. Sci. Med. Sport. Pohl, M.B., Mullineaux, D.R., Milner, C.E., Hamill, J., Davis, I.S., 2008. J. Biomech. 41, 1160–1165. Squadrone, R., Gallozzi, C., 2009. J Sports Med Phys Fit. 49, 6–13.

## Oral presentations

### OP-PM22 Soccer Fitness Parameters

#### FITNESS PARAMETERS IN PROFESSIONAL FOOTBALL PLAYERS AMONG DIFFERENT DIVISIONS

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The purpose of the study was to determine aspects of fitness that differentiate first division professional football players from players of second and third divisions in Cypriot football leagues. **METHODS:** Four hundred and twenty seven professional male football players (age  $=25 \pm 5$  years) performed an isokinetic knee test using the Humac Norm dynamometer at two angular velocities ( $60^\circ\text{s}^{-1}$ ,  $300^\circ\text{s}^{-1}$ ). On a different occasion, they performed an incremental cardiopulmonary exercise testing (CPET) on a treadmill. Furthermore, anthropometric and flexibility (sit and reach) measurements were recorded. **RESULTS:** Results were analyzed using one-way ANOVA, between subjects design revealing significant effects for division. Tukey's HSD tests demonstrated that players from division 1 scored significant higher on maximal oxygen consumption ( $\text{VO}_2 \text{ max}$ ) and lasted significantly longer on the treadmill than participants of division 2 and 3 ( $p < 0.05$ ). Similar findings were demonstrated when division 2 was contrasted against division 3 players. Marginal or no significant differences were recorded among players from the three different divisions on anthropometric measurements, flexibility and isokinetic parameters (muscular strength and muscular endurance). The marginal differences observed were mainly between first and third division players. **CONCLUSION:** The findings of this study clearly demonstrated that cardiovascular fitness as determined by CPET is the most important fitness parameter that differentiates professional football players who play at a more advanced championships. Although, strength and muscular endurance of the knee joint as well as low back- hamstring flexibility parameters are crucial for performance and injury prevention in football, they appear to be similar in players from smaller divisions too.

#### AGE RELATED EFFECT ON YO-YO TEST PERFORMANCE AND HEART RATE ANALYSIS ON TURKISH SOCCER REFEREES

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**INTRODUCTION** Referees are responsible apply the rules for such as played on lounge area and sport large areas and while maintaining the compliance with the rules of players. Moreover, during the match play for the success of the referee, they must maintain competences to meet the physical and physiological demands and the competence to make decisions under intense pace for high level (Helsen and Bultynck, 2004). Also elite soccer referees, because of their careers later in life manage more high level match, it is more important that their physical and physiological competence. In several studies (Castagna, et al., 2005) regarding of game action profile of football referees and physiological effect on the evaluation of the game, it is reported that the referees are done an average of 2200 meters high intensity running in a match. This results are explained that the importance of running distance on YO-YO IRL1 test performance during to their all career and also it reveals the importance of performing at a high level until the end of the their years (Weston, et al. 2010). The aim of this study was to investigate the effect of ageing on fitness performance on elite-level soccer referees. **METHODS** 131 elite level and national soccer referees (age range 27–45 years) are participated in study. All referees are performed YO-YO IRL1 (Yo-Yo Intermitent Test Recovery Level 1) (Bangsbo, et al., 2008). All polar datas are recorded every each 1 seconds (HRload, MaxHR, Mean HR and After 1 minute recovery) (polar team system, Polar electro, Finland). Data are presented as mean and SD. Comparisons between more than 2 means were performed using one-way analysis of variance. Post hoc testing was carried out using Tukey's test. Relations between variables of interest were detected using Pearson's correlation coefficient ( $r$ ) ( $p < 0.05$ ). **RESULTS** Advancing age, it is seen that all physical and physiological results are development. It is reported that there is statistically significant difference in HRmax and HRmean ( $p = 0.00$ ), but there is no statistically significant difference HRload ( $p = .874$ ) and after 1 minute recovery heart rate ( $p = .541$ ). ( $p < 0.05$ ). On YO-YO IRL1 test running distance is better on elderly referees than young, average ve old referees but it is not seen statistically significant difference ( $p = .88$ ). According to correlation analysis, there is negative correlation between body fat and YO-YO IRL1 test ( $r = -.341$ ) ( $p < 0.05$ ) **DISCUSSION** Physiological values are better when they are advancing age. So it reveals that the importance of involve in systematic training program when they are younger. Thus, aerobic and anaerobic be able to meet demands for a match at a younger age. **REFERENCES** Bangsbo J, et.al. 2008 Sports Medicine: 38 (1): 37-51. Castagna and D'Ottavio, S., 2005, Journal of Strength & Conditioning Research; 19- 4, 805-809, Helsen W, Bultynck J., 2004 Journal of Sports Sciences, 2004, 22:179–189. Weston M, et.al. 2010 Journal of Science and Medicine in Sport, 13(1): 96-100.

#### INFLUENCE OF THE NUMBER OF PLAYERS DURING SAME- VS. MIXED-GENDER FOOTBALL SESSIONS ON HEART RATE FOR 12 TO 16-YEAR-OLD SCHOOL CHILDREN

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**Introduction** Recently, football has been established as a health promoting and performance enhancing activity in several populations (1). Nevertheless, the physiological demands of football played as small or large-sided games in school children is not known, as well as the intensity of various types of small-sided games played as same gender or mixed genders for girls and boys. This study aim was to compare the physiological demands of football sessions for 12-16-year-old school children using small-sided (2v2 and 4v4) and large-sided games (12v12) in same gender and mixed gender game formats. **Methods** A total of 134 pupils (50 girls and 84 boys) were randomly assigned to same gender and mixed genders game formats, and each of the gender groups played 2x15 min artificial turf football games 2v2, 4v4 and 12v12, on separate days in a random order, using the same area per player and length to width ratio. Heart rates (HR) were determined for all game formats. **Results** Higher mean HR was found in 2v2 and 4v4 games compared to 12v12 for girls in mixed gender games ( $77 \pm 10\%$  ( $\pm \text{SD}$ ) and  $73 \pm 12\%$  vs.  $63 \pm 11\%$  HRpeak;  $p < 0.01$ ), as well as for boys playing same gender ( $81 \pm 6\%$  and  $79 \pm 5\%$  vs.  $73 \pm 9\%$  HRpeak;  $p < 0.05$ ) and mixed gender games ( $76 \pm 9\%$  and  $77 \pm 8\%$  vs.  $69 \pm 8\%$  HRpeak;  $p < 0.05$ ). Correspondingly, more time was spent with HR above  $80\%$  HRmax in 2v2 and 4v4 games compared to 12v12 for girls in mixed gender games ( $42 \pm 34\%$  and  $37 \pm 36\%$  vs.  $9 \pm 19\%$ ;  $p < 0.01$ ), as for boys playing same gender ( $50 \pm 27\%$  and  $43 \pm 24\%$  vs.  $24 \pm 29\%$ ;  $p < 0.05$ ) and mixed gender games

( $38 \pm 35\%$  and  $38 \pm 32\%$  vs.  $20 \pm 19\%$ ;  $p < 0.05$ ). Discussion In accordance with previous studies (2-4), these study results showed that HRs are high for school children playing small-sided games. Furthermore, the present study revealed that when girls are playing mixed gender games and when boys are playing mixed as well as same gender games, the aerobic exercise intensity is much higher during small-sided games 2v2 and 4v4 compared to large-sided games (12v12). References 1. Bangsbo, J. et al. (2015). Br J Sports Med, 49(9), 568-76. doi: 10.1136/bjsports-2015-094781. 2. Bendiksen, M. et al. (2014). Eur J Sport Sci, 14(8), 861-869. doi: 10.1080/17461391.2014.884168. 3. Krstrup, P. et al. (2014). Scand J Med Sci Sports, 24 (Suppl 1), 4-9. doi: 10.1111/sms.12277. 4. Randers, M. et al. (2010). Scand J Med Sci Sports, 24 (Suppl 1), 17-26. doi: 10.1111/sms.12255. spovoas@ismai.pt

## FAT OXIDATION RATES IN PROFESSIONAL FOOTBALL PLAYERS

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**Introduction** The rates of maximal fat oxidation (MFO) and the exercise intensity at which it occurs (FATMAX), has been reported in obese, sedentary, lean and endurance trained populations. To date there are no data available describing fat oxidation rates in professional football players. **Methods** During pre-season medical testing (2014 – 2015 season) 28 players (age  $24 \pm 4$  y; body mass  $74.3 \pm 6.1$  kg; stature  $178.8 \pm 7.0$  cm; body fat  $13.8 \pm 2.6$  %) from the professional football team at FC Barcelona completed a FATMAX test. Performed in a fasted state ( $> 5$  h) on a treadmill, the test started at 5 km/h at a gradient of 1% for 3 min. The speed increased to 8 km/h and, thereafter, increased by 2 km/h until a respiratory exchange ratio (RER) of 1 was reached. The speed then remained constant and the gradient was increased by 1% every 1 min to determine peak oxygen uptake (VO<sub>2peak</sub>). Respiratory gas measurements (VO<sub>2</sub> and VCO<sub>2</sub>) and heart rate (HR) were measured continuously. Stoichiometric equations [1] were used to calculate fat oxidation rates during each 3 min stage of the test to determine MFO. Heart rate max (HRmax) and VO<sub>2peak</sub> were measured in order to calculate FATMAX. **Results** The average MFO of professional football players was  $0.75 \text{ g} \cdot \text{min}^{-1} \pm 0.18$ . The lowest absolute MFO rate was  $0.45 \text{ g} \cdot \text{min}^{-1}$ , whereas the highest MFO measured was  $1.18 \text{ g} \cdot \text{min}^{-1}$ . FATMAX occurred at an average exercise intensity of  $51 \pm 7\%$  VO<sub>2peak</sub> (range 27 – 60% VO<sub>2peak</sub>), equating to  $66\% \pm 5$  of maximal HR (range 56 – 77% maximal HR). **Conclusion** Our results show that, on average, professional football players have a high capacity to oxidise fat during exercise. However, there is a wide range in MFO and the exercise intensity at which it occurs, potentially emphasizing the importance of personalized nutrition strategies. Further investigation is required to determine the importance and the implications of accounting for substrate oxidation rates, and their interaction with exercise intensity, with regard to football specific training, performance and nutrition recommendations. Contact rebecca.randell@pepsico.com [1] Brouwer E. N. Acta Physiol Pharmacol Neerl. 1957;6:795-802

## DIAGNOSTIC OF THE HIGH-ENERGY SYSTEM IN FEMALE SOCCER

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**Introduction:** Despite of several diagnostic tools in sport, test results do not determine team line-up. There are obviously factors influencing match performance that cannot be measured yet. Nevertheless, diagnostics are essential for systematic training and its evaluation. In female soccer, a lack of money is responsible for insufficient testing. A sprint test with changes in direction is a typical test for team sport attendees and does not require an expensive setup. The aim of the current study was to modify a common sprint test setup by adding information about the speed profile. This could allow assumptions about the demands on the energy system and lower limb strength. **Methods:** 26 female soccer players (playing in second or third German league) participated voluntarily in this study. As pretests, a field level test protocol, a treadmill ramp test protocol and a Counter-Movement-Jump (CMJ) were conducted. After a warm-up the participants performed an 80 m sprint with two changes in direction of 180 degrees. A LAVEG laser gun was used to gauge the speed profile and the alactice time was determined based on the model of Heck and Schulz (2002). Further parameters measured were heart rate, blood lactate concentration, maximal velocity and interims of the sprint. **Results:** The analysis showed a correlation between the interims of the sprint and the generated W/kg in the CMJ. A linear regression showed that at least 30 % of the variance of the sprint interims could be explained by the generated W/kg. In addition large differences between the alactic time could be observed. **Discussion:** The influence of the physical precondition seems to play a significant role concerning the sprint performance. Adapting a common sprint test protocol could easily help diagnosticians to get more information at lower expenses. Future research may enable scientists to identify different types of athletes concerning especially the use of the energy system. Therefore they could provide more appropriate training recommendations for coaches. **References:** Heck, H., Schulz, H. (2002). Deutsche Zeitschrift für Sportmedizin, 53, 202-212. Contact: a.woerdehoff@dshs-koeln.de

## SEQUENCING EFFECTS OF BALANCE AND PLYOMETRIC TRAINING ON PHYSICAL PERFORMANCE IN YOUTH SOCCER ATHLETES

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**Introduction** While there seems to be an advantage for including balance exercises within strength or power training programs (Chaouachi et al. 2014), it is not known whether the sequencing of balance and plyometric training has additional training benefits in youth. The objective was to examine the effect of sequencing balance and plyometric training on the performance of 12-13-years-old athletes. Based on a similar study (balance and strength) conducted with young adults (Bruhn 2006), it was hypothesized that balance training prior to plyometric training would provide greater gains in balance, power, sprint and agility performance. **Methods** Twenty-four young elite soccer players trained twice per week for eight weeks either with an initial four weeks of balance training followed by four weeks of plyometric training (BPT) or four weeks of plyometric training proceeded by four weeks of balance training (PBT). Testing was conducted pre- and post-training and included medicine ball throw, horizontal and vertical jumps, reactive strength, and leg stiffness, agility, 10, 20, 30-m sprints, Standing Stork-balance and Y-Balance-Test. **Results** Results indicated that BPT provided significantly greater improvements with reactive strength index, absolute and relative leg stiffness, triple hop test and a trend for the Y balance test ( $p=0.054$ ) compared to PBT. While all other measures had similar changes for both groups, the average relative improvement for the BPT was 22.4% ( $d=1.5$ ) versus 15% ( $d=1.1$ ) for the PBT. BPT effect sizes were greater with 8 of 13 measures. **Discussion** Behm et al. (2008) recommended that balance training should precede plyometric training since balance and coordination are immature in children, and balance



is essential for optimal performance and the prevention of athletic injuries. Bruhn et al. (2006) suggested that in young-adults, balance training could have a preconditioning effect on subsequent resistance training. The present study provides experimental data corroborating this recommendation. Since the adolescent growth-spurt can adversely affect balance, coordination, and movement patterns, initially implementing balance training can improve anticipatory postural adjustments and motor coordination, possibly decreasing the likelihood of injuries from unstable landings and positions. Based on the present findings, it would be more effective for coaches and fitness conditioning professionals to institute at least four-weeks of initial balance-training prior to plyometric training for their youth-athletes. The balance training should progress from less demanding stationary activities to more complex dynamic balance activities. Such a program should enhance the subsequent plyometric training adaptations. References Behm DG, Drinkwater EJ, Willardson JM, Cowley PM. *Appl Physiol Nutr Metab* 35: 11-14, 2010. Bruhn, S, Kullmann, N, Gollhofer, A. *Int J Sports Med* 27:401-6, 2006. Chaouachi A, Othman, AB, Hammami, R, Drinkwater, EJ, Behm, DG. *J Strength Cond Res* 28: 401-12, 2014.

## Oral presentations

### OP-PM78 Coaching: Coaches

#### EPISTEMOLOGICAL BELIEFS OF PROSPECTIVE TURKISH COACHES

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**Introduction** Beliefs that individuals hold about knowledge and knowing, or what has been termed "personal epistemology" (EB), are related to learning and achievement in complex ways (Hofer, 2000). It is important to understand EB of individuals in order to explicate their perception through learning and knowledge which are basic components of educational process. It even becomes more important for educators such as physical education teachers and coaches, as they are not only active learners but also source of knowledge for their athletes or students. Grecic & Collins, lastly highlighted importance of EB in coaching process. **Method** The participants of this study was 124 students of coaching education programs of 3 different universities in Turkey. Schommers'(1990) ,5-Likert type, , Personal Epistemological Belief Questionnaire was used as data collection tool. Turkish version of questionnaire consisted of 3 subscales, like original questionnaire. The first factor of the scale, depends on effort (LDE) , consists of 18 items. The second factor, depends on ability (LDA) , consists of 9 items. s. Additionally, the low average scores of the factors were evaluated as non-developed epistemological belief and the high average scores were evaluated as developed beliefs on that sub-scale. **Results** Independent Samples t-test results indicated that there is no significant differences between male and female prospective sport coaches for all three factors ( $p > .05$ ). Similarly, independent samples t-test results indicated no difference between EBs of prospective coaches with coaching experience and no experience ( $p > .05$ ). EB of prospective were also in significant in terms of their class level in all three factors. ( $p > .05$ ). Dependent samples t-test results indicated that prospective coaches have significantly developed EB in LDE subscale comparing to EB in LDA subscale. **Discussion** The reason of similarities between coaching education students might caused by their insufficient experiences in coaching profession. As almost all of them have little or no experiences in the field and they have the same educational background, their epistemological beliefs are similar. Grecic & Collins (I) indicated the importance of personal epistemology in coaching profession. Therefore it is important to investigate personal epistemology on experienced coaches to explicate whether experiences in the field effective on personal epistemology among sport coaches. David Grecic & Dave Collins (2013) The Epistemological Chain: Practical Applications in Sports, *Quest*, 65:2, 151-168 Schommer, M. A. (1990). Effects of beliefs about the nature of knowledge on comprehension. *Journal of Educational Psychology*, 82 (3), 498-504. Hofer, B.K. (2000). Dimensionality and Disciplinary Differences in Personal Epistemology. *Contemporary Educational Psychology*, 25, 378-405.

#### MAKE IT OR BREAK IT: CONFLICT IN COACH-ATHLETE RELATIONSHIPS

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**Introduction** The coach-athlete relationship plays a central role in sport performance (Jowett & Shanmugam, in press). However, as in every relationship, conflict is inevitable and needs to be managed effectively. Despite its practical relevance in everyday coaching, research has failed to contribute a systematic scientific basis from which to examine conflict processes, determinants and consequences of interpersonal conflict. Recently, empirical efforts to study conflict have been noted around conflicts within sport teams (Partridge et al., 2015); organizations (Kerwin et al., 2011) or fan groups (Schumacher Dimech et al., 2016). The current study aims to provide a comprehensive account of interpersonal conflict within coach-athlete dyads through elite coaches' perspectives. **Methods** A total of eleven coaches from team ( $n=8$ ) and individual ( $n=3$ ) sports participated in the study. Coaches' performance level ranged from national ( $n=5$ ) to international ( $n=6$ ). The interview guide consisted of 26 open-ended questions that were classified in four categories: 1) Introduction/ Coaching Experience (5); 2) Interpersonal Conflict/ Concept (2); 3) Conflict Experience (9); and 4) Determining Factors/ Outcomes (10). The semi-structured interviews lasted from 48 minutes to over 2 hours and 14 minutes. All interviews were transcribed verbatim and a cross-case content analyses was conducted (Krippendorff, 1989). Ethical approval for carrying out the study was obtained from the researchers' institution. **Results** In total, three higher-order themes were derived from the data, covering the following areas: 1) Determining Factors and Conflict Circumstances; 2) Interpersonal Conflict as a Process; and 3) Conflict Consequences. **Discussion** This study provides an in-depth insight into the experiences of conflict within the context of the coach-athlete relationship. The results shed light in the ways coaches perceive interpersonal conflict as well as the influences of conflict in their emotions, thought processes and behaviors. Moreover, the results suggest that conflict can be both a facilitative and a debilitating process. Finally, the results provide initial practical suggestions concerning strategies that may minimize the negative effects of interpersonal conflict. The current study paves the way for more research in a significant yet underdeveloped psychosocial area. **References** Jowett S, Shanmugam V (in press). *Routledge International Handbook of Sport Psychology*. Routledge. Kerwin S, Doherty A, Harman A (2011). *Small Gr Res*, 42(5), 562-594. Krippendorff K (1989). *International encyclopedia of communication*, Vol. 1, 403-407. New York, NY: Oxford University Press Partridge JA, Knapp BA (2015). *J Appl Sport Psychol*, 28(1), 113-127. Schumacher Dimech A, Brechbühl A, Seiler R (2016). *Sport Soc*, 1-20. Contact S.Wachsmuth@lboro.ac.uk

## PERCEIVED HINDRANCES EXPERIENCED BY SPORT COACHES IN SOUTH AFRICA

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**Introduction** Despite the fact that there is a high turnover of sport coaches in South Africa, very little is known about the impediments encountered by sport coaches in the country. Thus, the present study attempts to fill the void in the literature as such information could help sport organisations to design strategies that could help to retain sport coaches in the country. Therefore, the present study was carried out to ascertain perceived hindrances experienced by sport coaches in South Africa. **Methods** A total of 224 South African sport coaches (122 males and 102 females) participated in this study. The participants represented a variety of sports: soccer (n = 87), athletics (n = 45), netball (n = 44), cricket (n = 19), rugby (n = 12), swimming (n = 10), boxing (n = 4); three coaches did not indicate their sports. Forty-five per cent of the coaches were in the 18–25 years age group, 30% in the 26–35 years age group, 20% in the 36–45 years age group, 4% in the 46–65 years age group and 1% older than 65 years of age. The Perceived Hindrance Scale (PHS) developed by Kamphoff and Gill (2008) was used to collect data. The questionnaire comprised 34 items measured on a 9-point Likert scale ranging from 1 (not at all a hindrance) to 9 (completely a hindrance). Participants were asked to rate the most important hindrances in their coaching profession. A Cronbach alpha coefficient of 0.947 was obtained for the entire questionnaire. **Results** The major hindrances experienced by sport coaches were “Lack of support systems for women players” (M = 5.39, SD = 2.93); “Lack of support for women coaches from superiors” (M = 5.35, SD = 2.89); “Low salary” (M = 5.23, SD = 3.16); “Lack of opportunities for promotion” (M = 5.13, SD = 3.02); “Difficulties with parents/spectators” (M = 5.10, SD = 2.70) and “Lack of job security” (M = 4.98, SD = 3.07). **Discussion** Based on the results of this study, the following recommendations are proffered. First, mentoring programmes which could provide encouragement and support for female coaches should be enacted. Second, female coaches, who are role models, should be invited to discuss challenges facing female athletes and coaches, respectively, and how they can be addressed. Third, coach–parent meetings should be organised regularly by teams as this will minimise conflicts between coaches and parents, thus maximising children’s participation in sports. Finally, a sport association for coaches should be formed. This will ensure equitable salaries and guarantee that the needs of the sport coaches are well catered for. **References** Kamphoff C, Gill D (2008). Collegiate athletes’ perceptions of the coaching profession. *Inter J Sport Sci Coac*, 3(1), 55-72. Contact Email address: kubayina@tut.ac.za

## PERCEPTIONS, AWARENESS AND KNOWLEDGE OF THE FEMALE ATHLETE TRIAD AMONGST COACHES – ARE WE MEETING THE EXPECTATIONS FOR ATHLETE SAFETY?

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**Introduction** Female Athlete Triad (FATr) is a condition with the potential of long-term adverse effects on health and sports performance in female athletes. Coaches’ awareness and knowledge can play a critical role for primary prevention, early detection and management of the triad. The primary objective of this study was to investigate the awareness, knowledge and perceptions of Singaporean coaches on FATr. **Methods** The study was a cross-sectional survey with 106 participant coaches (81 males; 25 females) from the Singapore National Registry of Coaches. A 31 item questionnaire was developed to determine the perceptions, awareness and knowledge on FATr. The coaches’ responses were obtained in the presence of the research team. Data analyzed included demographic and coaching practice information, awareness and knowledge levels, gender differences in knowledge and differences in awareness and knowledge between participants with different levels of coaching qualification. **Results** A 100% response rate was achieved. The knowledge levels were found to be low with 85% coaches not having heard of the FATr, 89% coaches not able to identify at least one component of the triad and only 2 coaches being able to correctly identify the three components of FATr. A significant proportion of coaches had misperceptions related to low body fat, leanness, menstrual irregularity and bone health in female athletes. There was no significant difference in knowledge based on gender, level of coaching qualification and years of coaching experience. **Discussion** Coaches have low levels of awareness and knowledge on FATr. The misperceptions and knowledge gaps need to be addressed through multifaceted coach education programs developing the awareness and knowledge on FATr, skills for early recognition of red flags, athlete referral to health professionals and attitudes and skills for regular communication with the athletes on nutrition, menstrual history and bone health. **References** Nattiv A, Loucks AB, Manore MM, Sanborn SF, Sundgot-Borgen J, Warren MP. (2007). *Med Sci Sports Exerc*, 39 (10), 1867-1882. Brown KN, Wen-green HJ, Beals KA. (2014). *J Pediatr Adolesc Gynecol*. 27(5), 278-282 Pantano KJ. (2006). *N Am J Sports Phys Ther*, 1(14), 195-207. Contact: swarup.mukherjee@nie.edu.sg

## Oral presentations

### OP-PM53 Nutrition & Dietetics

## DIETARY COUNSELING INTERVENTION FOR FEMALE HEAVYWEIGHT JUDO ATHLETES DECREASED CARDIOMETABOLIC RISK

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**Introduction** There is a concern that some heavyweight (HW) Judo athletes have high cardiometabolic risk (CMR) due to excess body fat mass (FM) along with their large body mass (BM). Our previous study showed that female HW Judo athletes had high FM and some of them developed insulin resistance (IR) (Murata, et al., 2013). Visceral fat (VF) and IR have been shown as main contributors of CMR (Despres, et al., 2008) and our previous study showed that a dietary counseling intervention (DCI) for male HW Judo athletes decreased CMR by decreasing VF (Murata, et al, 2015). Therefore, the purpose of this study was to examine whether DCI for female HW Judo athletes can effectively decrease CMR without reducing their physical performance. **Methods** Fourteen female Judo athletes who belonged to 78kg and over 78kg classes participated in this study. They were divided into 2 groups such as DCI group (n=7; age: 20.1±1.3 years, BM: 80.3(78.7–107.3)kg) and control (CONT) group (n=7; 20.1±0.6 years, 82.8(78.0–92.0) kg). DCI group completed a 10-week DCI using e-mail and personal interview by the certified Sports Dietitian which instructed them to have a well-balanced diet with proper caloric intake. VF

and body composition were assessed by magnetic resonance imaging and dual energy X-ray absorptiometry, respectively. Physical fitness was also examined by hand grip strength (HGS) and the 20-m shuttle run (SR) test. Results After DCI, reductions of %BF (from  $29.3 \pm 5.8\%$  to  $27.8 \pm 6.1\%$ ) and FM in DCI group were significantly larger than CONT group ( $p < 0.05$ ), whereas increases of total fat-free mass (FFM), HGS and the number of SR in DCI group were significantly larger than CONT group. HOMA-IR in DCI group was also significantly decreased compared to CONT group ( $p < 0.01$ ). Discussion It was found that the 10-week DCI for female HW Judo athletes significantly lowered %BF, FM and HOMA-IR with increasing FFM, muscle strength as well as cardiorespiratory fitness. Interestingly DCI group did not significantly decrease VF. Previous study showed that overweight men decreased larger VF than overweight women in calorie restriction with exercise (Redman, et al., 2007). Therefore, although DCI effectively reduces CMR for female HW Judo athletes, it may have less effect on reducing VF for female HW Judo athletes. Conclusion DCI for female HW Judo athletes reduced CMR without reducing their physical performance. References Despres JP, Lemieux I, Bergeron J, et al. (2008). *Arterioscler Thromb Vasc Biol*, 28:1039-49. Murata H, Oshima S, Torii S, et al. (2015). ECS annual congress abstract, 320. Murata H, Takata K, Natsui H, et al. (2013). *Jpn J Clin Sports Med*, 24:623-31. Redman LM, Heilbronn LK, Martin CK, et al. (2007). *J Clin Endocrinol Metab*, 92, 865-72. Contact hiromura@toki.waseda.jp

## PREVALENCE OF OMNIVORES, VEGETARIANS AND VEGANS IN RUNNING EVENTS: THE NURMI STUDY

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**Introduction** Considering the growing background numbers of vegetarians and vegans (Craig et al., 2009; Stahler, 2011), the number of vegetarian and vegan runners is likely to rise, too. Therefore, the aim of the Nutrition and Running High Mileage (NURMI) Study was to investigate the prevalence of omnivores, vegetarians, and vegans in running events in the first step. **Methods** The NURMI Study was conducted following a cross-sectional design. The present study determined epidemiological aspects of runners. Data collection (1/10/2014 to 31/12/2015) was accomplished using a standardized questionnaire. Analysis was performed using SPSS software package. All data derived from the statistical methods were presented as mean  $\pm$  standard deviation. **Results** Data collected built a basic sample size of 3163 runners (1779 women: 56.2%; 1384 men: 43.8%) predominantly from German-speaking countries (Austria, Germany, Switzerland: 2788) with lower numbers from the rest of Europe (375). The prevalence of omnivores, vegetarians and vegans in running events was 1434 (45.3%), 665 (21.0%) and 1065 (33.7%), respectively. An association between sex and diet was observed ( $p < 0.001$ ): the prevalence for female and male runners was 673 (37.8%) vs. 761 (55.0%) in omnivores, 431 (24.2%) vs. 234 (16.9%) in vegetarians, and 675 (37.9%) vs. 389 (28.1%) in vegans. Omnivorous runners were found to be older and heavier (age:  $39.2 \pm 11.1$  y; body weight:  $69.0 \pm 10.9$  kg; body mass index (BMI):  $22.7 \pm 2.5$  kg.m<sup>-2</sup>;  $p < 0.001$ ) compared to vegetarians and vegans (age:  $36.2 \pm 11.0$  vs.  $35.2 \pm 10.2$  y; body weight (BW):  $65.0 \pm 10.5$  vs.  $65.3 \pm 10.4$  kg; BMI:  $21.8 \pm 2.4$  vs.  $21.9 \pm 2.5$  kg.m<sup>-2</sup>;  $p < 0.001$ ). A sex-diet interaction was found on BW ( $p = 0.022$ ,  $n_2 = 0.002$ ) and BMI ( $p < 0.001$ ,  $n_2 = 0.007$ ). **Discussion** The main findings of the present study were (1) almost equal numbers of female omnivorous and vegan runners, whereas the major count of male runners were omnivores; and (2) omnivorous runners were older and heavier than non-omnivores in this study. However, beneficial and detrimental effects of vegetarian and vegan diets on the health status are well known (Cullum-Dugan et al., 2015). Since scientific data about endurance athletes following a vegetarian and particularly vegan diet is limited (Wirnitzer & Kornel, 2014; Leischik & Spelsberg, 2014), the NURMI Study is the first to assess this issue considering a bigger sample size. Therefore, these results provide a major contribution by adding knowledge to overcome the lack of data on the prevalence and demographics of vegetarians and vegans in running events (Scheerder et al., 2015), and might be helpful as reference data for future studies. This further may help to augment the body of science on the limited data of vegan athletes in general (Fuhrmann & Ferreri, 2010). **References** Craig WJ, Mangels AR (2009). *J Am Diet Assoc* 109(7):1266-1282 Cullum-Dugan D, Pawlak R (2015). *J Am Diet Assoc* 115(5):801-810 Fuhrmann J, Ferreri DM (2010). *Curr Sports Med Rep* 9(4): 233-241

## DIETARY HABITS AND SUPPLEMENT USE OF ELITE ADOLESCENT CYCLISTS

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**Introduction** Diet is key to health and athletic performance. Dietary intake of British Cycling Olympic Development Programme (ODP) athletes was assessed and compared in 1st and 2nd year cyclists. Supplement use of these athletes was also determined. **Methods** Forty adolescent cyclists, 25 male and 15 female (mean age 16.2 years) completed a Dietary Habits Questionnaire (DHQ) that included a Food Frequency Questionnaire (FFQ) and questions to assess monthly supplement use. Dietary analysis was conducted with a sample of 21 FFQ, using Microdiet™ software. Supplement use was calculated for all 40 participants. Energy and macronutrient intake was compared to UK dietary reference values (DRVs). **Results** ODP cyclists achieved DRVs for energy, carbohydrate and saturated fat (SF), but both males and females consumed more protein than recommended, exceeding DRV by 137.1g and 111.6g respectively ( $Z = -3.180$ ,  $p = 0.001$ ,  $n = 13$ ;  $Z = -2.521$ ,  $p = 0.012$ ,  $n = 8$ ). Dietary intake of 1st and 2nd year cyclists did not differ. Supplement use did not differ between 1st and 2nd year cyclists ( $\chi^2 = 0.231$ ,  $df = 1$ ,  $p = 0.631$ ) but were used at least once a week by 95% of ODP athletes. Average intake per rider per month was 78.2 items, although there were large range values of total monthly use per rider (0-272). Use was more prevalent in male athletes than females (96 vs. 49 items per month) ( $\chi^2 = 15.234$ ,  $df = 1$ ,  $p < 0.001$ ) and compared to other squads, the sprint athletes (TS) used significantly more (122 vs. 75 (Endurance), 24 (BMX), 77 (MTB)), ( $\chi^2 = 64.60$ ,  $df = 3$ ,  $p < 0.001$ ). The most popular supplements amongst the 40 athletes were protein/recovery drinks, multivitamins, fish oil/omega 3, vitamin C and carbohydrate (CHO) bars. **Discussion** Dietary intake appeared to be adequate, but further research is needed using DRVs specific to young athletes. Small improvements in dietary composition appeared in 2nd year athletes although these were not significant. 2nd year athletes consumed more of their total energy from CHO (+1.76%) and protein (+0.82%) and less from fat (-2.45%), suggesting nutrition education may have had a small impact. The high prevalence of supplement use found among these young athletes is consistent with previous findings from young UK athletes from other sports (Petróczi et al., 2008). However, these results are concerning as young athletes are advised against using supplements by the IOC (2011) due to the associated risks. Further research is needed in order to develop an athlete-specific, validated FFQ and also to determine reasons for supplement use. **References** IOC consensus statement on sports nutrition 2010. (2011). *Journal of Sports Sciences*, 29, S3-S4 Petróczi, A, Naughton, DP, Pearce, G, Bailey, R, Bloodworth, A, McNamee, MJ. (2008). Nutritional supplement use by elite young UK athletes: fallacies of advice regarding efficacy. *JISSN*, 5(22), 1-24. Contact 1219939@chester.ac.uk

## DIETARY CALCIUM AND VITAMIN D ADEQUACY IN UNIVERSITY-LEVEL ATHLETES: INITIAL FINDINGS FROM THE D-BICEP STUDY

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**Introduction:** Vitamin D (VitD) and calcium (Ca) are essential for the maintenance of musculoskeletal health. Athletes residing in countries at higher latitudes, and specifically those who train or compete indoors, are at risk of VitD inadequacy (Close, 2013). This is because VitD is primarily synthesized following cutaneous exposure to ultraviolet B (UVB) irradiation, with dietary VitD as a secondary source. **Method:** We recruited 58 healthy participants (21 women & 37 men) who compete in a range of sports from the University of Surrey. Subjects were investigated to determine dietary intake, anthropometrics, bone health and blood parameters. All subjects completed a total body composition analysis using bioelectrical impedance (TANITA) and a bone density scan of the radius using peripheral quantitative computed tomography (pQCT). Participants also completed a 5-d food diary and under-reporting of dietary intake was determined by calculating energy intake to basal metabolic rate ratio (Goldberg, 1991). Dietary and statistical analysis were carried out using DietPlan6 (2013) and SPSS21(2013), respectively. **Results:** Average age of participants was  $20 \pm 1$  y. Men had higher BMI and FFM compared to women;  $24.8 \pm 3.1$ ,  $22.6 \pm 3.2$  kg/m<sup>2</sup>;  $67.5 \pm 8.8$ ,  $49.2 \pm 5.6$  kg, respectively ( $p < 0.05$ ). Radial bone mass at 4% site averaged:  $1.54 \pm 0.29$ ,  $1.14 \pm 0.20$  mg ( $p < 0.001$ ); Radial Mass at 66%:  $1.21 \pm 0.53$ ,  $1.20 \pm 0.40$  mg, respectively for men and women. There was a trend for energy intake (EI) to be higher in men compared to women:  $2352 \pm 754$ ,  $1942 \pm 544$  kcal/d ( $p = 0.076$ ) respectively. Ca intake was higher in men:  $1046 \pm 370$  mg,  $866 \pm 517$  mg. VitD intake however, did not differ between genders  $2.7 \pm 1.8$ ,  $2.8 \pm 2.9$  µg. Positive correlations were observed between 4% radial site and Ca intake;  $r = .356$  ( $p < .05$ ), specifically within females;  $r = .562$  ( $p < .05$ ). Under-reporting of dietary intakes (EI: BMR ratios:  $0.79 \pm 0.22$ ) were present in 100% of the cohort (range: 0.42-1.28). **Conclusions:** Dietary Ca exceeded the RNI (700mg/d; DOH, 1991) within this cohort. However, both groups did not achieve a sufficient VitD intake of 15µg, as recommended by the Institute of Medicine (2010), on average achieving a restrictive intake of 2.75µg/d. Under-reporting could be a contributing factor to these lower intakes; hence further investigation is therefore warranted in this active sub-population. From these results it can be suggested that UK dwelling non-supplemented university athletes are at risk of VitD insufficiency. Further analysis of this dataset is underway, with specific focus on summer and winter VitD status and physical performance.

## ASSOCIATIONS BETWEEN BREAKFAST FREQUENCY AND OBJECTIVELY-MEASURED PHYSICAL ACTIVITY AND SEDENTARY TIME IN CHILDREN FROM 12 COUNTRIES

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**Introduction** There is limited support for an association between breakfast frequency and physical activity (PA) or sedentary time in samples of children from high-income countries with limited socioeconomic diversity. Using data from the International Study of Childhood Obesity, Lifestyle and the Environment (ISCOLE), associations between breakfast frequency and objectively-measured physical activity and sedentary time were examined in 9–11-year-old children from 12 countries representing a wide range of geographic and socio-cultural variability. **Methods** Multilevel statistical models with participants (level 1) nested within schools (level 2) and country (level 3) were used to examine associations between breakfast frequency and accelerometry-derived PA and sedentary time in 6163 children from 12 ISCOLE study sites. Model 1 adjusted for age, sex and parental education; Model 2 also adjusted for body mass index (BMI) z-score. **Results** Models 1 and 2 showed rare breakfast consumption to be associated with more sedentary time than occasional (Model 2:  $P = 0.045$ ; 95% confidence intervals (CI): 0.22 to 18.61) and frequent (Model 2:  $P = 0.041$ ; 95% CI: 0.35 to 16.37) consumption; Model 2 also showed less light PA for rare compared to occasional consumption ( $P = 0.049$ ; 95% CI: -14.35 to -0.02). Using Model 1, moderate-to-vigorous PA was higher for frequent compared with rare consumption ( $P = 0.035$ ; 95% CI: -5.35 to -0.19), and the higher moderate-to-vigorous PA for frequent vs. occasional consumption neared significance ( $P = 0.055$ ; 95% CI: -3.34 to 0.03). Similarly, moderate PA was higher for frequent compared with occasional consumption ( $P = 0.049$ ; 95% CI: -2.11 to -0.00) and vigorous PA for frequent compared with rare consumption ( $P = 0.050$ ; 95% CI: -2.47 to -0.00). No associations for moderate-to-vigorous, moderate or vigorous PA were found when adjusting for BMI z-score (Model 2). No interactions with study site were found. **Discussion** In a multinational sample of children, more frequent breakfast consumption was associated with less sedentary time, independent of age, sex, parental education and BMI z-score. Additionally, occasional breakfast consumption was associated more time in light PA than rare consumption. Although we found some evidence of more moderate-to-vigorous PA with more frequent breakfast consumption, these associations became non-significant when controlling for BMI z-score. Experimental research is required to determine the possible causal role of frequent breakfast consumption in reducing sedentary time and increasing PA in globally representative samples of children.

## Oral presentations

### OP-PM41 Exercise & Health

#### THE IMPACT OF EXERCISE AND FAT TYPE ON HYPERTRIGLYCERIDEMIA IN HEALTHY MALES

FOGARTY, M.C.1, BRAY, J.W.1, O'DOHERTY, A.1, EVANS, W.1, SCOTT, C.1

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**INTRODUCTION** A substantial body of literature postulates that high levels of postprandial blood triglycerides (TG) can promote and environment for the facilitation of atherosclerosis and cardiovascular disease mediated by oxidative stress (OS). Contemporary research has raised interest in food sources of medium-chain triglycerides (MCTs) and their prevalence for a reduced TG response post consumption. Although a bout of moderate exercise prior to a high fat meal has been shown to support the removal of TG postprandial less is known about the impact of exercise in the hours following fat consumption, and the role of the type of fat ingested. Therefore the aim of the present investigation was to determine the influence of fat source, acute exercise, and OS on postprandial hypertriglyceridemia (PHTG). **METHODS** Nine healthy male participants ( $26.0 \pm 4.6$  y) completed in a randomised crossover design: (1) high-fat meal alone (HF) (2) high-fat meal with one hour of moderate exercise (60% VO<sub>2</sub>max) two hours postprandial (HF+EX) (3) high-fat meal of virgin coconut oil



(VCO) with one hour of moderate exercise (60% VO<sub>2</sub>max) two hours postprandial (HF\_EXVOC). The high fat meals consisted of 0.6g of fat (76% energy intake), 0.2g of carbohydrates (15% energy intake) and 0.1g of protein (9% energy intake) per kg of body mass. TG was measured in venous blood at baseline, 2 and 4 hour postprandial. Other supporting biochemical markers were also collected and will be presented in full at the conference (LDL, HDL, TC & LOOH). Following failure of normal distribution data was analysed using area under the curve (AUC) for a non-parametric comparison of the three conditions. Pairwise comparisons were performed with a Bonferroni correction for multiple comparisons. Data is presented as median [IQR] and median difference (MD). RESULTS AUC for TG was statistically significantly different between the three conditions ( $X^2(2) = 14.889$ ,  $P = 0.001$ ). TG was statistically significantly lower for HF\_EXVCO (2.4 [1.6]) compared to HF\_EX (3.2 [1.7]) (MD = -0.8 mM.L,  $P = 0.029$ ) and HF\_only (3.6 [1.07]) (MD = -1.2 mM.L,  $P = 0.0001$ ). However, there was no statistically significant difference between HF\_EX vs. HF\_only (MD = -0.4 mM.L,  $P = 0.716$ ). CONCLUSION These results propose that a single session of moderate aerobic exercise can decrease TG levels succeeding a high-fat meal. Furthermore, VCO TG response is lowered earlier with exercise potentially due to a more direct oxidation mechanism at the liver. The data correlating the PHTG with lipid markers of oxidative stress is currently undergoing analysis and will add an additional level of analysis to these novel findings.

#### COMPARISON BETWEEN DESCENDING VERSUS ASCENDING STAIR WALKING INTERVENTION FOR INSULIN SENSITIVITY, LIPID PROFILES AND FUNCTIONAL PHYSICAL FITNESS OF ELDERLY OVERWEIGHT WOMEN

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**Introduction** Repeating maximal eccentric exercise of the knee extensors once a week for 8 weeks has been shown to improve blood lipid profile and insulin sensitivity of young women (1). Our previous study (ECSS2013) showed greater improvement of fitness and health after progressive eccentric than concentric exercise training of the knee extensors performed once a week for 12 weeks by elderly men. One of the simplest eccentric exercises is descending stairs (DS). The present study investigated the hypothesis that repeating DS would improve lipid profile, insulin sensitivity and functional physical fitness (FPF) greater than ascending stairs (AS). **Methods** Overweight women ( $\geq 60$  y) were assigned to either DS or AS group ( $n=8$ /group). An elevator was used to take the participants from the 1st to 5th floor for DS, and the 5th to 1st floor for AS, and DS and AS were performed twice a week for 12 weeks by increasing the volume gradually (1st wk: 2 reps/session, 12th wk: 24 reps/session, 1 rep=110 stairs). Overnight fasting blood samples were taken 5 days before the first training session and 4 days after the last training session, and analysed for serum triacylglycerols (TG), total (TC), high-density lipoprotein (HDL) and low-density lipoprotein cholesterol (LDL), glucose, insulin, homeostasis model assessment (HOMA) and whole blood glycosylated hemoglobin (HbA1C), and 2-h oral glucose tolerance test (OGTT) was performed. Resting heart rate, systolic (SBP) and diastolic blood pressure (DBP), maximal voluntary isometric contraction strength of the knee extensors (MVC) and FPF tests for older adults (9 tests, e.g. 30-s chair stand: CS, 6-minute walk) were measured before and after the training period. **Results** The average HR during DS (90 beats/min) was lower ( $P<0.05$ ) than that of AS (111 beats/min). Resting HR (-8%) and SBP (-7%) decreased greater after DS than AS (-3%). Most blood variables changed significantly from baseline to post-training, but decreases in glucose, insulin, HOMA, HbA1C, TG, TC, LDL and OGTT (area under the curve), and increases in HDL were greater ( $P<0.05$ ) after DS than AS. Most of FPF tests improved greater ( $P<0.05$ ) for DS (e.g. CS: 39%) than AS (16%), and MVC also increased greater for DS (35%) than AS (19%). **Discussion** These results supported the hypothesis that DS would improve lipid profile, insulin sensitivity and fitness of elderly overweight women better than AS. It is important to note that DS is less metabolically demanding than AS. It is concluded that DS can be used as effective exercise intervention for less-fit individuals to improve their health and fitness. **References** 1. Paschalis et al. MSSE. 43:64-73, 2011 **Contact:** k.nosaka@ecu.edu.au

#### STRENUOUS PHYSICAL EXERCISE ACCELERATES THE LIPID PEROXIDE CLEARING TRANSPORT BY HDL

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**Purpose** Physical exercise has cardioprotective functions, which have been partly linked to high-density lipoprotein (HDL), and its functions. We studied the effects of endogenous oxidative stress, induced by acute exhaustive physical exercise, on concentration of oxidized HDL lipids. **Methods** Twenty-four male national top-level endurance runners, 12 middle-distance runners and 12 marathon runners, performed a maximal run on a treadmill until exhaustion. We analysed concentrations of oxidized HDL (oxHDL lipids) and LDL lipids (oxLDL lipids), serum antioxidant potential (TRAP), paraoxonase activity and malondialdehyde (MDA). Venous blood samples were taken before, immediately, 15 min and 90 min after exercise. **Results** During the treadmill run the concentration of oxHDL lipids was increased by 24 % ( $p < 0.01$ ). Simultaneously, the ratio of oxHDL lipids to oxLDL lipids increased by 55 % and the oxLDL lipids levels decreased by 19 % ( $p < 0.001$ ), while serum malondialdehyde and TRAP increased by 54 % ( $p < 0.001$ ) and 29 % ( $p < 0.01$ ), respectively. After the 90 minutes recovery the concentration of oxHDL lipids was decreased towards the pre-exercise level, but that of oxLDL lipids remained decreased below pre-exercise values ( $p < 0.001$ ). The change in oxLDL lipids during run correlated positively with VO<sub>2</sub>max ( $r = 0.67$ ,  $p < 0.001$ ) and negatively with the change in paraoxonase activity ( $r = -0.47$ ,  $p < 0.05$ ). **Conclusions** We conclude that acute exhaustive physical exercise increased the concentration of oxHDL lipids and decreased that of oxLDL lipids and the ratio of oxLDL lipids to oxHDL lipids, which suggests, that during physical exercise HDL has an active role in the removal of lipid peroxides.

#### THE REPEATABILITY OF THE ORAL FAT TOLERANCE TEST WITH AND WITHOUT PRIOR AEROBIC EXERCISE

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**Introduction** The Oral Fat Tolerance Test (OFTT) is considered a repeatable measure used to assess triglyceride (TAG) responses within the postprandial state (Ryan et al., 2013), with higher TAG levels being observed in cardiovascular and metabolic disorders. Acute aerobic exercise intervention before OFTT reduces the postprandial TAG response (Maraki & Sidossis, 2013) but its effect on the repeatability of this measure is unknown. We aimed to investigate the repeatability of TAG to a specifically designed OFTT with and without prior standardised aerobic exercise. **Methods** On four separate days, healthy adult male participants underwent repeat OFTT and repeat OFTT with one hour of aerobic exercise (exercise intensity: 90% oxygen consumption at anaerobic threshold) performed immediately before meal ingestion. The OFTT meal composition included 75.4g total fat (47.5g saturated fat), 21.7g carbohydrate and 13.7g protein. Venous blood was sampled at baseline and hourly for 4 hours after OFTT meal ingestion and TAG area under the curve (AUC) was calculated using the trapezoidal method. Repeatability was assessed using non-parametric Bland Altman plots with predefined limits of agreement set at  $\pm 10\%$  and  $\pm 15\%$ . **Results** Eleven males, median age 30 (IQR 17) years, body mass of 79.0 (IQR 14.6) kg, and body mass index (BMI) 24.6

(IQR 3.5) kg/m<sup>2</sup> were assessed. One participant was excluded for the OFTT condition due to breach of protocol. Bland Altman analysis of 4 hour TAG AUC revealed that 5 of 10 repeat measurements fell within  $\pm 10\%$  and 9 of 10 repeat measurements fell within  $\pm 15\%$  of the median TAG AUC for OFTT, a typical error of  $\pm 0.86$  mmol.4hour.<sup>-1</sup>. By comparison, only two of 11 repeat measurements fell within  $\pm 10\%$  and two of 11 repeat measurements fell within  $\pm 15\%$  of the median TAG AUC for OFTT with 1 hour prior aerobic exercise. Discussion The OFTT is a repeatable test in healthy men, however, moderate intensity aerobic exercise performed immediately before OFTT considerably increases the variability of TAG AUC. These findings have implications for interpretation of postprandial studies investigating the effects of exercise intervention performed immediately before OFTT. Future studies should investigate the repeatability of exercise intervention performed 8-24 hours before OFTT, a typical study design within this area of research. Maraki, M. I., & Sidossis, L. S. (2013) The latest on the effect of prior exercise on postprandial lipaemia. *Sports Med*, 43(6), 463-481. Ryan, M. F., Grada, C. O., Morris, C., et al. (2013) Within-person variation in the postprandial lipemic response of healthy adults. *Am J Clin Nutr*, 97(2), 261-267. Contact a.o-doherty@2013.hull.ac.uk

## IMPACT OF 4-WEEK EXERCISE TRAINING ON THE ACUTE CHANGE IN VASCULAR FUNCTION TO EXERCISE

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Introduction: Exercise is a potent stimulus for acute changes in vascular function. The exact nature of this response is variable, with a decrease, increase or no change reported. In the present study, we explored whether the type of exercise and/or exercise training impact the nature of the response. Therefore, we aimed to determine 1) if acute, exercise-induced changes in vascular function are different between endurance and resistance exercise, and 2) whether this response is altered after 4-week of exercise training in healthy young men. Methods: Vascular function was assessed using flow-mediated dilation (FMD) both before and immediately after a 30-min exercise bout, consisting of endurance exercise (n=16, 20.9 $\pm$ 2.2 yr, 74.0 $\pm$ 7.6 kg, 178 $\pm$ 6 cm) or resistance exercise (n=15, 21.0 $\pm$ 2.4 yr, 76.1 $\pm$ 8.2 kg, 178 $\pm$ 5 cm). To explore the impact of exercise training, subjects were assigned to perform 4-weeks of Endurance Training (ET; 3 sessions per week) or leg Resistance Training (RT; 3 sessions per week). After training, vascular function was re-assessed before and after an acute bout of exercise (matched to the first exercise bout for relative exercise intensity). Results: First, we found a significant impact of the type of exercise on the exercise-induced change in FMD. Post-hoc analysis revealed that an acute bout of endurance exercise did not alter FMD (6.3 $\pm$ 2.1% to 6.2 $\pm$ 1.9%, P>0.05), whilst resistance exercise increased FMD (7.2 $\pm$ 2.3% to 9.3 $\pm$ 3.0%, P=0.02). Secondly, exercise training significantly altered the nature of the change in FMD to acute exercise (P=0.022). Post-hoc analysis showed that 4-week endurance training caused a decrease in FMD after exercise (7.9 $\pm$ 2.6% to 5.3 $\pm$ 2.1%; P=0.001), whilst 4-week resistance training abolished the acute, exercise-induced change in FMD (7.6 $\pm$ 3.1% to 8.0 $\pm$ 3.0%; P>0.05). Conclusion: Our data suggest that the mode of exercise alters the acute change in FMD following a single bout of exercise, with no change in FMD after endurance exercise and an increase in FMD after resistance exercise. Furthermore, 4-weeks exercise training altered the nature of the post-exercise change in FMD in both types of training, as training decreased FMD after endurance exercise and abolished the initial increase in FMD after resistance exercise. These data therefore strongly suggest that the mode of exercise as well as 4-week exercise training alters the nature of the change in FMD after an exercise bout in healthy young men.

## 12-WEEK RECREATIONAL SOCCER TRAINING IMPROVED HEALTH PROFILE OF TYPE 2 DIABETES PATIENTS MORE THAN RUNNING AND DIET ALONE – A BRAZILIAN STUDY

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Introduction Among Latin America countries, Brazil has the highest number of people with Type 2 Diabetes (T2D) estimated in 12.1% in São Paulo state (Borges et al., 2014). Lifestyle modification has been demonstrated to prevent outcomes, particularly coronary heart disease, and induce remission of early T2D. Therefore, we aimed to investigate the impact of recreational soccer combined with a caloric restricted diet on health profile of untrained Brazilian T2D patients vs. running training. Methods Sixty (n=60) untrained Brazilian T2D patients aged 47-74 years were randomized into a soccer+diet group (SDG; n=19), a running+diet group (RDG; n=19) and a diet group (DG; n=22). Training sessions were held for 40 min, 3 times per week for 12 weeks. Dual-energy X-ray, treadmill testing, and fasting blood samplings were performed before and post 12 weeks. Results Maximal oxygen uptake increased only in the training groups (P<0.05) while a decrease (P<0.05) was observed in DG after 12 weeks. Systolic blood pressure reduced (P<0.05) only in the SDG from 128.2 $\pm$ 3.2 to 124.2 $\pm$ 2.2 mmHg after 12 weeks, with no changes in diastolic blood pressure for any of the groups. HbA1c decreased (P<0.05) by  $\sim 10\%$  in all groups after 12 weeks. In all groups, bone mineral density increased (P<0.05) by  $\sim 0.02$  g/cm<sup>2</sup>, fat mass decreased (P<0.05) by  $\sim 3$  kg, and lean body mass was not altered  $\sim 64$  kg (P>0.05). For SDG and RDG, respectively, baseline triglycerides, total cholesterol and VLDL-cholesterol were reduced by 24.8% (37.3 $\pm$ 1.9 mg/dL), 12.5% (22.2 $\pm$ 0.2 mg/dL) and 24.3% (7.3 $\pm$ 1.8 mg/dL); 27.9% (50.6 $\pm$ 4.4 mg/dL), 10.4% (21.4 $\pm$ 0.5 mg/dL) and 28.0% (10.2 $\pm$ 0.8 mg/dL). LDL-cholesterol was lowered (P<0.05) only in the SDG by 15.4% (16.4 $\pm$ 1.3 mg/dL), while HDL-cholesterol was unaltered (P>0.05) in all groups after 12 weeks. Regarding between-group differences, SDG improved more (p<0.05) in baseline fasting lipids than RDG and DG during the 12-week intervention period. Discussion Soccer training lowered systolic blood pressure, which may reflect a better muscle capillarization and vascular structural adaptations (Krustrup et al., 2009). In addition, lower LDL-cholesterol levels suggests greater increased fat oxidation rate post-training (Pachalis et al., 2011) due to the multiple intense actions during soccer training stimulating musculoskeletal and cardiovascular adaptations better than running training. Recreational soccer training plus diet resulted in large benefits on health profile of T2D, and appear to better prevent cardiovascular issues than running plus diet and diet alone. References Krustrup et al (2009) *Br J Sports Med*, 6, 81-98 Pachalis et al (2011) *Med Sci Sports Exerc*, 43, 64-73 Borges et al (2014) *Diabetol Metab Syndr*, 6, 122.

## Oral presentations

### OP-SH21 Organizational Aspects & Success

#### ORGANIZATIONAL FACTORS INFLUENCING THE INTERNATIONAL SPORTING SUCCESS IN HIGH-PERFORMANCE JUDO

MAZZEI, L., BÖHME, M.T., DE BOSSCHER, V.

*School of Physical Education and Sport of University of São Paulo*

**Introduction** Researchers and managers have a great interest in analysing the existing sports policies in different countries in the search of explanations for the international sporting success achieved by some countries and not by others. Recently, the studies in this issue have further advanced studying certain aspects of elite sport policies and key success factors of specific sports (Brouwers, Sotiriadou, & De Bosscher, 2015). In this study, the objective was to identify the organizational factors that influence the international sporting success in high-performance Judo. **Methods** A Sequential Exploratory Design (Creswell & Plano Clark, 2011) according was used, which involves an initial phase that collects and analyses qualitative data, followed by a second intermediate phase related to the development of a questionnaire and a third phase involves quantitative analysis. 33 international high-performance Judo stakeholders were interviewed in an initial phase. A questionnaire developed and validated by Content Validation of six experts was the second phase. And finally, in a third quantitative phase was performed an Exploratory Factor Analysis (EFA) on data obtained in a sample of 406 Brazilian judokas, divided into athletes, coaches, performance directors and experts. **Results** In the qualitative phase, 11 categories and 44 subcategories were identified, which were considered the dimensions and the organizational factors influencing the international sporting success in high performance Judo respectively. From these results, in the second phase a questionnaire was developed, validated and allowed the quantitative phase. In the quantitative phase, all the organizational factors were in the EFA results. The first six Factors had the highest coherence with the qualitative results, contributing with 50.97% of the total variance. **Discussion** The results found in the qualitative phase are similar to other studies that had the purpose of investigating elite sport policies and factors for the international sporting success. However, specific Judo characteristics and environment influence the development of Judo. Furthermore, the qualitative and quantitative phase allowed the development of the 'Judo Organizational Factors Influencing the International Sporting Success' model. Future research can deepen the understanding of the relationship among organizational factors or carrying out procedures involving other sports. Future research can deepen the understanding of the relationship among organizational factors or carrying out procedures involving other sports. **References** Brouwers, J., Sotiriadou, P., & De Bosscher, V. (2015). Sport-specific policies and factors that influence international success: The case of tennis. *Sport Management Review*, 18(3), 343–358. Creswell, J. W., & Plano Clark, V. L. (2011). *Designing and conducting mixed methods research* (2nd ed.). Los Angeles: SAGE Publications.

#### PERFORMANCE MANAGEMENT: A SYSTEMATIC REVIEW OF PROCESSES IN ELITE SPORT AND OTHER HIGH PERFORMANCE DOMAINS

MOLAN, C.1, KELLY, S.1, ARNOLD, R.2, MATTHEWS, J.1

*1: University College Dublin (Ireland), 2: University of Bath (UK)*

**Introduction** The desire to achieve success within elite sport has seen various sports look beyond the application of sport sciences and coaching to management-led processes. Performance management has been identified as a process that impacts how athletes, coaches and support staff contribute to elite sport success. Due to the limited research in this area within elite sport and the potential transferability of processes from other settings, there is considerable merit in examining how performance is managed across alternative high performance domains, where individuals or teams must also work under pressure to deliver high standards of performance, e.g. military, surgical medicine and performing arts. The aim of this study was to conduct a systematic review of performance management within elite sport and other high performance domains. **Methods** Electronic database keyword searches and reference tracing were conducted to identify published, English language, peer reviewed articles with original empirical evidence. Further eligibility criteria related to the type of performance management process and performance domain were applied. Title, abstract, and full text screening was undertaken by two reviewers, and inter-rater reliability statistics were calculated. Following data extraction, thematic synthesis enabled the organisation of key performance management factors into 'descriptive themes'; and the development of higher level 'analytical themes'. **Results** A total of 17 studies from a possible 12,196 were included in the review. Five analytical themes (and 15 descriptive themes) representing factors associated with effective performance management in high performance domains emerged: collaboration, execute and review performance, leadership, manage the performance environment, and recruitment and retention of staff. Research design and sample characteristics for each study were also reported. **Discussion** This review details prominent features of performance management that are required to perform consistently at high levels in intensely pressurised environments. These identified factors range across person, operational and system levels and also highlight how factors from alternative high performance domains could be harnessed to enhance the performance management process within elite sport organisations or high performance units. Further research is needed to develop our understanding of both the theoretical components and the operationalisation of performance management within elite sport. Contact: conor.molan@ucdconnect.ie

#### RELATIONSHIP BETWEEN RISK TAKING WITH EMOTIONAL INTELLIGENCE IN SPORT ENTERPRISES

AYAZI, M.

*Faculty member, Department of Physical Education, Roudehen branch, Islamic Azad University, Tehran, Iran*

**Introduction** Cherniss (2000) have defined "Emotional intelligence" is the basis for personal qualities such as realistic self-confidence, personal integrity, knowledge of personal strengths and weaknesses, resilience in times of change or adversity, self-motivation, perseverance. As opportunities represent possible gain, pursuit of that gain must be tempered by the potential of loss through miscalculated efforts. Risk taking is not only the willingness to take a chance on an opportunity; it is the ability of the organization to use calculated actions to mitigate the risk inherent in opportunity pursuit (Mullins, 2005). **Methods** The research is regarded as an application one and the methods of data collection is descriptive and correlation, the population on this study included managers of sport enterprise in Iran. Sample size is based on formula for calculating the morgan and kerji table sample size 75 females and men completed the questionnaire risk taking (becherer, 2008) and emotional intelligence (bar-on, 2000). the data was analyzed based on multiple regression with the

significance level set at 0.05. Results Linear Regression analysis was performed in order to study the first research hypothesis. Risk taking and Emotional intelligence were the independent variables while sport enterprise was the dependent one. The analysis indicated that only risk taking was correlated ( $R=0.47$ ) and could significantly predict ( $F=37.15$ ,  $p<0.001$ ), though moderately, a proportion of variance (44.2%) of the dependent variable. Discussion Emotional intelligence leads to marketing effectiveness in sport enterprise. Emotional intelligence and risk taking were affected to sport enterprise. Emotional intelligence domains deemed to be effectively risk taking in this exploratory study, there is evidence to suggest that it is contributing to overall marketing effectiveness of sport enterprise. In general, there is a strong relationship between the emotional intelligence domain of a sport enterprise and risk taking effectiveness. Therefore It is hardly deniable, that a substantial dose of cognitive intelligence is needed by a manager, but it is evident from the foregoing discourse that how well leaders manage and direct the feelings of sport enterprise, in order to attain the desired goals, largely depends on the managers level of emotional intelligence and risk taking. References Bar-On, R. (2000), "Emotional and social intelligence: insights from the emotional quotient inventory", Jossey-Bass, San Francisco, CA, pp. 363-88. Becherer, et al., (2008). An exploratory investigation of entrepreneurial marketing in SMES: The influence of the owner/operator. Journal of Business and Entrepreneurship, Vol. 20, No. 2, Mulins, et al. (2005). Missing the boat or sinking the boat: A study of new venture decision making. Journal of Business Venturing, 20, 47-69.

## 11:30 - 12:45

### Plenary sessions

#### PS-PL03 Crossing borders through technology

##### COMPUTER VISION IN SPORTS

MOESLUND, T.

*Aalborg University*

Sports is said to be the social glue of society. It allows people to interact irrespective of their social status or age. With the rise of the mass media, a significant quantity of resources has been channeled into sports in order to improve understanding, performance and presentation. Manual creation of data describing details in sports events is tiresome and in many cases simply unrealistic. Technology is therefore becoming more and more crucial as the demand for improved understanding, performance and presentation increases. Moreover, since the nature of most sports means that monitoring by the use of sensors or other devices fixed to players or equipment is generally not possible, a rich set of opportunities exist for the application of camera-based computer vision techniques to help the competitors, trainers and audience. This talk will first present a brief overview over where computer vision is currently being used in sports as well as possible future applications of computer vision in sports. Hereafter a more in depth presentation of different computer vision researches in sports will be presented. These will focus on using thermal cameras (in order to ensure privacy) to automatically provide answers to questions like: How many people are currently using a particular sports facility? What are they playing? The level of oxygen consumption?

##### INNOVATIVE TECHNOLOGY IN SPORT: ETHICAL PERSPECTIVES

LOLAND, S.

*The Norwegian School of Sport Sciences*

Technological innovations of many kinds change sport. Firstly, a systematic review is given of various kinds of innovative sport technology. A categorization is proposed ranging from development of traditional sport equipment to innovations in information technology and biotechnology. Secondly, actual and possible implications for sport of these innovations are discussed from an ethical point of view. On the one hand, innovative technology can increase experiential values such as joy and mastery, reduce health risk, and enhance performance. On the other hand, new technology can change the nature of sport in problematic ways, increase health risk, and challenge athletes' status as responsible moral agents. Particular attention will be given to challenges posed by innovative biotechnologies.

## 13:00 - 14:00

### Conventional Print Poster

#### PO-CPP-03 Biomechanics & Motor Learning

##### COMPARING FACTORS DETERMINING THE ENJOYMENT OF PHYSICAL ACTIVITY IN 10-12 YEAR-OLD CHILDREN IN JAPAN AND SOUTH KOREA

IKEDA, T.1, HAN, N.2, CHOI, T.2, AOYAGI, O.3

*1 Fukuoka Prefectural University, 2 Jeju National University, 3 Fukuoka University*

Introduction Recently, Asian children have recorded poor results in relation to physical activity (PA) (Muller et al., 2013). Despite Japan and South Korea both being located in East Asia and having similar political and economic systems, it is still instructive to compare them in terms of issues relating to children's education and health. The purpose of this study was therefore to investigate and compare factors contributing to the enjoyment of PA in 10-12 year-old children in Japan and South Korea. Methods The research participants were 1,689 Japanese and Korean children aged from 10 to 12 years. Of these participants, 1,638 (96.98%) completed a questionnaire based on the "Scale on the Joy of Exercise" devised by Tokunaga & Hashimoto (1980). Factor analysis was applied in order to investigate the factors



determining PA enjoyment. Results Three factors pertaining to the enjoyment of PA were extracted: activity- and motor-characteristics (F1), self-improvement and human relations (F2), and watching and cheering (F3). The ANOVA for F1 showed a significant difference in relation to gender alone ( $F(1, 1637) = 17.282, p < .001, B > G$ ). Similarly for F2, the effect of nationality was found to be significant ( $F(1, 1637) = 17.627, p < .001, J > K$ ). By contrast, for F3, a significant interaction effect was detected ( $F(1, 1637) = 8.618, p < .01$ ). The multiple comparison test combining nationality and gender therefore indicated a significant "nationality effect" in both of boys and girls ( $t(824) = 2.890, p < .0125, JB > KB / t(810) = 7.639, p < .0125, JG > KG$ ). Discussion A tendency to enjoy PA was a common feature in boys in this age range irrespective of their nationality. On the other hand, cultural differences between Japan and South Korea were found with the exceptions of gender for (i) self-improvement and relationships with friends, and (ii) the watching or cheering of other activities. These results imply that it may be useful to provide PA while focusing on the amount of exercise and characteristics of the activities in order to improve the level of enjoyment among boys in both countries. For Japanese girls, it may be constructive to give them the chance to make friends through physical exercise or watching the activities of others. However, for Korean girls, as they did not exhibit enjoyment in relation to any factor, special consideration is required. These findings therefore revealed the nature and extent of some of the similarities and differences between Japanese and South Korean children in relation to PA. References Gao, Z. et al. (2014). *Psychol Health Med* 19(5), 605-613. Garcia, B. E. et al. (2010). *Res Q Exerc Sport* 81(1), 7-16. Muller A.M. et al. (2013). *Asia Pac J Public Health*. 25(3), 227-38. Remmers, T. et al. (2015). *J Phys Act Health* 12(8), 1066-1073. Tokunaga, M. & Hashimoto, K. (1980). *Journal of health science* 2, 75-90. Seabra, A. C. et al. (2013). *Eur J Public Health* 23(5), 794-798. Contact: i-ikeda@fukuoka-pu.ac.jp

### THE DIFFERENCE BETWEEN THE MOVEMENT AND SELF-RECOGNITION OF CHILDREN IN THE STANDING LONG JUMP

YASUE, M., TATSUYA, A., TOMOHIRO, F., TAKESHI, U.

*Hiroshima University*

Introduction It is necessary for effective motor learning to recognize the ideal and actual movements correctly. However, few studies had revealed the degree of recognition for fundamental movements in children. The aim of this study was to investigate the level of the children for self-recognition in the standing long jump. In addition, we examined the relevance of the degree of self-recognition and the actual movement. Furthermore, we divided the self-recognition into two categories that were the recognition of the ideal movements and the recognition of their actual movements in this study. Methods As subjects, four elementary school boys and seven elementary school girls (fourth grade to sixth grade) were participated in this study. Subjects watched a video of the model for the standing long jump with its explanation, then performed as far as possible. Their movements were monitored and analyzed using three-dimensional motion analysis system (VENUS-3D, Tokyo). After the standing long jump, subjects evaluated their movements by using of visual analog scale. It was focused on the shoulder, knee, and landing angle in the standing long jump, and compared among the ideal, actual, and self-recognition of their movements. Results The results were summarized as follows; 1) children were able to correctly recognize the ideal movement in relation to the only landing angle. 2) Children were not able to correctly recognize the knee flexion angle at the takeoff phase and angle of shoulder joints at the air phase. 3) Children tended to have small images the ideal movement and perceive their own movements larger than actual. 4) There was no significant differences between images to the ideal movement and self-recognition of their movements. In other words, children could feel own movement in the same way as model. 5) There was no significant correlation between the degree of self-recognition and performance in present study. Discussion In conclusion, it might be difficult for children to recognize movements accurately regardless of their performance level. Therefore, there was a need for teaching to enhance not only the recognition of ideal movements, but also the recognition of own movements. Contact m156945@hiroshima-u.ac.jp

### MIRROR-INDUCED VISUAL FEEDBACK IMPROVES INTER-MANUAL TRANSFER OF A SPORT SPECIFIC SKILL: COMPARISON BETWEEN DIFFERENT SKILL LEVELS

STEINBERG, F., PIXA, N.H., DOPPELMAYR, M.

*Johannes Gutenberg-University Mainz*

Introduction Mirror training therapy is a promising tool to facilitate the recovery process of motor skills after diseases such as stroke or hemiparesis. Recent studies have shown that the inter-manual transfer of fine motor skills is increased through mirror visual feedback compared to direct feedback conditions. This beneficial performance increase is thought to be effective not only in patients but also in healthy participants (review in Deconinck et al., 2014). This study tries to evaluate whether these augmented performance improvements by mirror-induced visual feedback could be used for learning a sport specific skill and whether effects are modulated by skill level. Methods 39 healthy and experienced Basketball and Handball players (18-38 yrs., 21 female) and 41 healthy novices with no Handball or Basketball experience (18-38 yrs., 21 female) participated in this study. They were equally assigned to a control group receiving direct feedback of the moving (right) hand and to a group who received mirror visual feedback. They were requested to perform a stationary basketball dribble task on a test setup typically used in the mirror training therapy, which was adapted to let participants dribble a basketball either with feedback through a mirror or direct feedback (adopted from Hamzei et al., 2012). The number of successful dribbling in a pre-test (left and right hand) was compared with the dribbling in a posttest (right and left hand) after completing four training days only with the right hand. Results ANOVAs with repeated measures revealed that experienced as well as novices improved dribbling performance of both hands from pre- to posttest measurements (all  $p < 0.001$ ;  $\eta^2 > 0.689$ ). Only for the experienced group a significant interaction showed that the left hand improvements of the mirror group was more pronounced than for the control group ( $F(1,37) = 16.21$ ;  $p < 0.001$ ;  $\eta^2 = 0.305$ ). Discussion Inter-manual motor learning transfer from right to left hand can be improved by mirror visual feedback in a sport specific task. However, this effect cannot be generalized to motor learning per se since it appears to be modulated by individuals' skill level. References Deconinck, F. J., Smorenburg, A. R., Benham, A., Ledebt, A., Feltham, M. G., & Savelsbergh, G. J. (2014). Reflections on Mirror Therapy A Systematic Review of the Effect of Mirror Visual Feedback on the Brain. *Neurorehab Neural Re*, 29(4), 349-361. Hamzei F, Läppchen CH, Glauche V, Mader I, Rijntjes M, & Weiller C. (2012). Functional plasticity induced by mirror training: the mirror as the element connecting both hands to one hemisphere. *Neurorehab Neural Re*, 26(5), 484-496. Contact Fabian.steinberg@uni-mainz.de

### THE INFLUENCE OF THROWING DEVELOPMENT ON LEARNING VOLLEYBALL OVERHAND SERVE

CHANG, C.Y., LIU, Y.T.

*National Chengchi University, National Taiwan Normal University*

Introduction The primary techniques of volleyball serve were "tossing the ball" and "swinging the arm to hit the ball". The skill of overhand throwing is similar to the movement of "swinging the arm to hit the ball". It is possible that the development of throwing acts as an

influential factor in performing the volleyball overhand serve. The purpose of this study was to explore the relation between the volleyball overhand serve and the throwing development for the elite and novice volleyball players. Methods Ten female advanced-level college volleyball players and ten female college students without any volleyball overhand service experience participated in the study. The experts were tested with 10 trials of the overhand serves and 10 trials of distance throws. The novices had additional 10 trials of throwing test followed by practicing volleyball overhand serve for 270 trials over 3 weeks prior to the final tests of 10 trials of distance throw and 10 trials of the overhand serves. All the test performances were filmed with a high-speed camera (300fps). The task outcomes, ball velocity, and movement forms of the throws and serves were compared between groups; throwing variables from the 2 tests of the novice group were also compared. In addition, the Pearson product correlation was used to examine the relations among all the variables within the group. Results The performances of throwing and serving for the experts were significantly better than novices, and the throwing distance also improved after practicing the overhand serves for the novices. The throwing distance, ball velocity of throws, and throwing forms of experts and novices showed significant positive correlations with one another. The service performances also had significant positive correlation with the throwing movement forms for novices. There was no correlation, however, for experts. Discussion The performance of the volleyball overhand serve had tight relation with the development of distance throw ability. This tight link was demonstrated not only by the superior performances of both tasks from the advanced volleyball players but also the improvement of the distance throw from the novices after extended practice of the volleyball overhand serves. The mutual influences between the throwing and overhand serves continue before the stable patterns of both skills have occurred after prolonged practices. The overarm throws ability that is developed in childhood (Robertson, 1977) is important not only for the specific throwing performance found in baseball and softball but also for the performances of similar sport skills such as volleyball overhead serves. PE teachers and volleyball coaches may consider using the distance throw as an auxiliary exercise for volleyball beginners when learning overhand serve. Reference Robertson MA. (1977). *J Human Mov Studies*, 3, 49-59.

## REPRESENTATIONAL MOMENTUM IN ADOLESCENT DANCERS

CHEN, Y.H.1,2, BELLERI, R.1, CESARI, P.1

1. *University of Verona, Italy*; 2. *National Chengchi University*

Representational momentum (RM) refers to the tendency that observers remember the stopping point of an event as being further forward in the direction of movement than it is in reality (Freyd & Finke, 1984). Previous studies reported that experts show a stronger RM effect than novices when viewing their domain-specific actions (Blättler et al., 2010; 2011). In this study, we investigated whether the RM effect could be also observed in adolescent ballet dancers when viewing a highly dynamic dance jump (i.e., grand jeté jump) that was divided into the ascending, flying and descending phases for showing different levels of movement momentum. Female adolescent dancers (n = 22; mean age = 14.9 years; with 9.8 years of classical ballet training) and age-matched non-dancers as controls (n = 19; mean age = 14.4 years) were recruited. In each trial, participants were first presented with three frozen-action photos of a dancer model performing a grand jeté jump. Then, they had to decide whether a fourth photo that showed the jump with different shift sizes (either moving forward or backward or no movement) was the same as the third photo or not. The overall pattern of results showed that memory for the stopping point of the jump was biased in the direction of movement, particularly for the descending and flying phases. The tendency found in the descending phase could be considered as a RM effect because the movement momentum in this phase was great due to gravity. Whereas the tendency found in the flying phase might be due to task difficulty because in this phase the dancer model was moving mainly forward in the air and the movement momentum was hardly to be detected. Moreover, adolescent dancers showed a marginally stronger RM effect than controls in the descending phase, suggesting that expertise can enhance the internal representation of the observed action with greater movement momentum implied.

## WHY DOES MUSCLE RELAXATION DIFFICULT DURING SPORTS?

KATO, K., KANOSUE, K.

*Waseda University*

Introduction Muscle relaxation is an important aspect to make a fine control of the body in sports as well as daily life. It has been suggested that volitional muscle relaxation from contraction is accomplished by an active process in the brain, and not just the end of contraction (Toma et al., 1999). Recently, we have observed that muscle relaxation in one limb induced decrease in EMG level of contraction in the ipsilateral another limb (Kato et al., 2014; 2015). However, the mechanism of remote effect during muscle relaxation has not been well understood. The objective of this study was to clarify how the relaxation of one muscle influences on corticospinal excitability (Exp.1) and short interval intracortical inhibition (SICI) (Exp.2) in other remote muscles by using single- and paired- pulse transcranial magnetic stimulation (TMS). Then, we further investigated the inhibitory mechanism by adjusting test pulse of paired-pulse TMS (Exp.3). Method Subjects were asked to volitionally relax the right foot with either dorsiflexion (tibialis anterior; TA relaxation) or plantarflexion (soleus; SOL relaxation) in response to an auditory stimulus. Single- (Exp.1) and paired- (Exp.2) pulse TMS was delivered to the hand area of the left primary motor cortex at different time intervals before and after the onset of TA or SOL relaxation. Motor evoked potentials (MEPs) were recorded from the right extensor carpi radialis (ECR) and flexor carpi radialis (FCR). Based on the results of Exp. 2, in Exp. 3 inhibitory mechanisms were carefully investigated by adjusting the MEP amplitude of the test-pulse. Result In Exp.1, MEP amplitudes of ECR and FCR caused by single-pulse TMS temporarily decreased after TA and SOL relaxation onset, respectively, as compared with those of the resting control. Furthermore, short-interval intracortical inhibition (SICI) of ECR evaluated with paired-pulse TMS temporarily increased after TA relaxation onset in Exp.2 and 3. Discussion Our findings indicate that muscle relaxation of the dorsiflexor induced reduction of corticospinal excitability of the ipsilateral hand muscles. This is most likely caused by an increase in intracortical inhibition. During multilimb movement in sports, simultaneous usage of each muscle with appropriate degree of contraction or relaxation is needed for good performance. Although coaches often just say "Relax more for only this muscle" to the player, we all know it's difficult to do. The present results suggest that when we try to relax in one limb, the desired muscle contraction in other limb is, unfortunately, also suppressed. References Toma K et al., Activities of the primary and supplementary motor areas increase in preparation and execution of voluntary muscle relaxation: An event-related fMRI study. *J Neurosci*. 19:3527-3534. 1999 Kato K et al., Interaction between simultaneous contraction and relaxation in different limbs. (2014) *Exp Brain Res*. 232:181-189. Kato K et al., Effects of muscle relaxation on sustained contraction of ipsilateral remote muscle. (2015) *Physiol Rep*. 3. pii: e12620.

## Conventional Print Poster

## PO-CPP-07 Health &amp; Fitness 4

**A MIXED-METHODS EXAMINATION OF PHYSICAL ACTIVITY, SEDENTARY TIME, AND THEIR ASSOCIATION WITH FRAILTY AMONGST ETHNICALLY DIVERSE MIGRANT WOMEN 60+ YEARS**

CASTANEDA-GAMEROS, D.1, REDWOOD, S.2, THOMPSON, J.L.1

1: *University of Birmingham. Sport, Exercise and Rehabilitation Sciences*

**Introduction:** Physical activity (PA) and sedentary time (ST) are recognised as key modifiable behaviours to improve older adults' health by preventing diseases, reducing disability and improving well-being. However, their association with frailty is less clear. In addition, little is known about factors influencing PA and ST in older women from diverse ethnic, socio-economic, and migration backgrounds. Therefore, the aims of the study were to: 1) examine associations between frailty and objectively measured ST and PA in ethnically diverse migrant women 60+ years living in the UK; and 2) explore key factors influencing PA and ST behaviours in this group. **Methods:** Sixty first generation migrant women (Mean age $\pm$ SD= 70.8 $\pm$ 8.1) wore a GT3X accelerometer for 7 days to measure PA and ST. Frailty was defined using a modified version of the frailty phenotype. Group differences were assessed using independent t-tests. Associations between PA, ST and frailty were examined via logistic regression. Semi-structured interviews were conducted in a subsample (n=36) and analysed using an inductive thematic approach. **Results:** On average, participants spent 69% of their waking time engaged in ST. Only 15% met the weekly recommendations for moderate-to-vigorous PA (MVPA). Frail participants had significantly higher ST (565.1 $\pm$ 92.4 min/d vs. 528.2 $\pm$ 85.6 min/d,  $p=0.04$ ) and lower MVPA (4.5 $\pm$ 4.9 min/d vs. 19.6 $\pm$ 18.9 min/d,  $p=0.03$ ) than non-frail participants; time spent in low PA was similar in frail vs non-frail participants (236.47 $\pm$ 68.7 min/d vs. 189.3 $\pm$ 94.6 min/d,  $p=0.11$ ). Logistic regressions indicated that higher ST (OR: 1.02, 95% CI: 0.98-1.03) and lower MVPA (OR: 0.82, 95% CI: 0.68-0.98) were independently associated with frailty. Qualitative analyses indicated that maintaining independence and social support were the two key factors in promoting the uptake and maintenance of PA. Pain and risk of injury were the two most commonly reported barriers to achieving PA recommendations. **Conclusions:** Both frail and non-frail participants were highly sedentary with very few meeting MVPA recommendations. The associations between ST, MVPA and frailty suggest that increasing PA and decreasing ST may promote healthy ageing by decreasing the risk for frailty. Future PA strategies developed for this population should emphasise the importance of social support and maintaining independence in increasing the engagement of older ethnically diverse migrant women in PA. Recommendations should also provide detailed information on specific activities that are both safe and of sufficient intensity to optimise health and physical function.

**AGE RELATED DIFFERENCES IN MUSCLE ACTIVATION AND EXPLOSIVE FORCE PRODUCTION IN OPEN AND CLOSED KINETIC CHAIN EXERCISES**

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**Introduction:** Decline in explosive strength and its functional significance in old age has been well acknowledged (Häkkinen and Häkkinen, 1991; Klass et al., 2008). The purpose of the study was to observe activation of the agonist - vastus lateralis (VL) - muscle and rate of force development in open (OKC) and closed (CKC) kinetic chain exercises in young (YP) and old (OP) participants. **Methods:** Twenty YP (24  $\pm$  3 yr) and 15 OP (69  $\pm$  4 yr) subjects did explosive isometric unilateral knee extension - OKC and leg extension on leg press machine - CKC. EMG signal of VL in the first 100 ms after torque/force rise was expressed as relative EMG (normalized to maximal voluntary contraction, rEMG). Torque/force impulse in first 100 ms was analysed and expressed relative to maximal impulse (IMMAX). One-way ANOVA was used to test the differences between OP and YP, furthermore a two-way repeated measures ANOVA with one within (chain) and one between subjects factor (age group) was done. **Results:** Old participants had compared to YP significantly lower rEMG in OKC (68% vs. 89%,  $p<0.01$ ), but not in CKC (78% vs. 86%,  $p=0.353$ ). A two way ANOVA revealed significant effect of age group  $\times$  chain interaction on rEMG of VL muscle ( $p<0.05$ ). Age related differences regarding open and closed chain were confirmed also in mechanical parameters; there was significant effect of age group  $\times$  chain interaction on IMMAX ( $p<0.01$ ), differences between OP and YP were significant only in OKC (~ 41 % lower in OP,  $p<0.01$ ), meanwhile there were no differences in CKC (~ 9% lower in OP). **Discussion:** Differences in VL activation and torque/force impulse between YP and OP were greater in the knee extension task than in the leg extension task. We concluded that age related loss of explosive strength was more affected in OKC compared to CKC, which was probably due to greater usage in daily activities. **References:** Häkkinen K, Häkkinen A (1991). Eur J Appl Physiol Occup Physiol, 62(6), 410-414. Klass M, Baudry S, Duchateau J (2008). J Appl Physiol, 104(3), 739-746.

**HEALTH BENEFITS OF CYCLE ERGOMETER TRAINING FOR OLDER ADULTS OVER 70: A REVIEW**

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**Introduction:** As the number of older adults continues to increase worldwide, more attention is being paid to geriatric health care needs, and successful ageing is becoming an important topic in the medical literature. A preventive approach to the care of older adults is thus a priority in our aging societies. The purpose of this study was to update evidence for the health benefits of cycle ergometer training (CET) for older adults over 70. **Methods:** We searched online through eight electronic databases (PubMed Central, Medline, Scopus, Web of Science, SportDiscus, Embase, CINAHL Plus, and Cochrane library) up to September 2015 for original studies using the following keywords "exercise training, endurance training, or aerobic training and cycle ergometer, cycling or bicycle and health, health benefits and older adults, elderly, very old/elderly, aged, aging, oldest, old and over 70". Only studies that assess the health benefits of CET among older adults over 70 were included. **Results:** Among the 4080 studies examined, twenty-five studies met the inclusion criteria. These studies reported that CET has a positive impact on cardiovascular function through an improvement in cardiorespiratory fitness, blood pressure values and endurance parameters. Specifically, it helps control metabolic outcomes through an improvement in body composition, metabolic and endocrine disorders. CET also improves functional reserve capacity mainly by increasing muscle strength, with conflicting results concerning the physical performance. Finally, one study suggests that CET may improve also the cognitive performance in older adults over 70. **Discussion:** The main findings of this current review highlighted the effectiveness of CET as a major component of endur-

ance training program among older patients. The possible reasons of these positive findings can be explained by the suitable form of CET for promoting overall physical health among older adults over 70, and particularly because it is relatively easy and safe and causes no related injuries compared to walking on a treadmill. According to the current review, clinicians can now formulate actions to enable older adults over 70 to profit from the health benefits of CET. This will reinforce the current public health efforts to improve the health of this frail older population, and to help them to continue pursuing their daily activities independently. Contact [wahid.bouaziz.88@gmail.com](mailto:wahid.bouaziz.88@gmail.com)

### EFFECTS OF SQUARE-STEPPING EXERCISE WITH MUSIC ON COGNITIVE FUNCTION IN HEALTHY OLDER ADULTS

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Introduction: Older adults generally have reduced functional fitness, including muscle strength, endurance and balance than young adults. Moreover, they have less cognitive function. Therefore, it is very important to improve not only physical fitness but also cognitive function for vitality aging in older adults. Some studies suggest that square-stepping exercise (SSE) could be an effective means to improve cognitive function (Abe et al., 2015). Furthermore, exercise with music program has been associated with enhanced cognitive function (Emery et al., 2003). The purpose of this study was to investigate the intervention effects of SSE with music on cognitive function in healthy older adults. Methods: Participants were twenty-four healthy older adults. Twelve participants performed SSE with music program for 90 min, 1 day a week, for 12 weeks (M-SSE group;  $72.5 \pm 6.3$  years). We adopted familiar music for Japanese older adults in M-SSE group. On the other hand, the remaining participants performed normal SSE program without music for 90 min, 1 day a week, for 12 weeks (N-SSE group;  $71.6 \pm 3.9$  years). SSE was performed using a thin-felt mat that was partitioned into 40 squares (Shigematsu et al., 2006). Cognitive function (Five-Cog. Test; Yatomi et al., 2005) was measured 2 times (first day session and 3 months after the initial session) in all the participants. Results: M-SSE group showed significant improvement in performance on the position judgment task (pre:  $52.1 \pm 14.6$ , post:  $56.8 \pm 16.4$ ,  $P < 0.01$ ) and animal name imagination task (pre:  $49.9 \pm 1.0$ , post:  $55.3 \pm 10.4$ ,  $P < 0.05$ ). On the other hand, N-SSE group showed significant improvement in performance on the word memory task (pre:  $59.8 \pm 8.2$ , post:  $68.5 \pm 10.2$ ,  $P < 0.01$ ), Clock drawing task (pre:  $46.8 \pm 9.0$ , post:  $52.1 \pm 4.4$ ,  $P < 0.05$ ), and animal name imagination task (pre:  $53.8 \pm 10.8$ , post:  $61.1 \pm 10.2$ ,  $P < 0.01$ ). Discussion: This study suggests that SSE with music has more beneficial effects on attentional capacity and verbal fluency than normal SSE. It could be a reason that the participants have to be conscious of both stepping to the rhythm and stepping into the correct position during SSE with music. However, it has smaller effects than normal SSE on episodic memory and visual-spatial ability. References: Abe et al. (2015) Jpn J Gerontol. 52, 162-169. Emery et al. (2003) Heart Lung. 32, 368-373. Shigematsu R, Okura T. (2006) Aging Clin Exp Res. 18, 242-248. Yatomi N. (2005) Jpn J Gerontol. 27, 74-80. Contact: [shimura@oiu.jp](mailto:shimura@oiu.jp)

### THE EFFECTS OF RESISTANCE, AEROBIC AND COMBINED TRAINING AND DETRAINING ON BLOOD APOLIPOPROTEINS, LIPOPROTEIN <A> AND HS C-REACTIVE PROTEIN PROFILE IN CORONARY ARTERY DISEASED PATIENTS

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Introduction Every year an increasing number of individuals are diagnosed suffering from coronary artery disease while this disease is the number one cause of death worldwide. For combating the risk factors of coronary artery disease many investigations recommended as important factors the exercise training and the avoidance of sedentary life style (Tully et al., 2005; Booth et al., 2012). Methods 60 males with coronary artery heart disease were randomly assigned into the resistance exercise group (n=11), the aerobic exercise group (n=18), the combine exercise group (n=16) and the control group (n=15). The three exercise groups carried out 8 months of resistance, aerobic or combine training consisting of 3 exercise sessions per week. Before the beginning of the study, after 4 and 8 months of training and after 1, 2 and 3 months of detraining blood apolipoproteins, lipoprotein (a) and hs C-reactive protein profile were determined. Results At the end of the training period, aerobic and combined training induced increases by 7.4% and 6.8% in apolipoprotein-A1 and decreases by -5.8% and -6.4% apolipoprotein-B, respectively. Resistance training did not cause any alterations in apolipoproteins. For hs C-reactive protein, a significant interaction between group  $\times$  time and a main effect of time was found. More specifically, after the training period, resistance, aerobic and combined exercise decreased hs C-reactive protein by -13.4%, -15.7% and -17.9%, respectively. During the detraining period, apolipoproteins, lipoprotein (a) and hs C-reactive protein were gradually returned to baseline values. Discussion The purpose of the present investigation was to compare the effects of three types of chronic exercise on blood apolipoproteins, lipoprotein (a) and hs C-reactive protein in aged patients suffering from cardiac artery disease. It was found that 8 months of aerobic or combined exercise caused significant elevations in apo-A1 and decreased apo-B levels whereas no changes were observed after resistance exercise. Lp(a) was not altered after exercise at any group. The biological role of apo-A1 is to protect the wall arteries while of apo-B is to promote arteriosclerosis, thus exercise modes that induced increases in apo-A1 and decreases in apo-B are considered to be very important for individuals suffering from heart diseases. hs-CRP levels were decreased after the three types of exercise. This observation is of importance since hs-CRP is a sensitive inflammatory marker that has been associated with CAD (Ridker et al 2003). References Tully MA., Cupples ME., Chan WS., McGlade K., Young IS. (2005). Preventive medicine 41 (2):622-628. Booth FW., Roberts CK., Laye MJ. (2012). Comp. Physiol. 2, 1143-1211. Ridker PM, Buring JE, Cook NR, Rifai N (2003). Circulation 107:391-397 Acknowledgements This work has been granted by the Cyprus Research Promotion Foundation under the framework 'Research Infrastructure', action 'New Infrastructure', Project EPYNE/0506/17.

### DEVELOPMENT OF STEP WALKING EXERCISE PROGRAM USING NATURAL USER INTERFACE AND THE MICROSOFT KINECT TO PREVENT DEMENTIA: A PRELIMINARY STUDY

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Introduction Walking is a complex process involving motor skills, cognition, and perception, as well as a method to evaluate the onset of functional capacity decline (Makizako et al., 2015). Walking speed is known to be a reliable predictor of cognitive function and dementia, and difficulty walking while performing dual tasks is associated with cognitive impairment (Doi et al., 2014). Methods An exercise game aimed at dementia prevention in the elderly population will be developed, including the walking step exercise program contents, a mat



for lower limb movement detection, and a 3D camera. A natural user interface will inform users' movement using sound, vibration, and lights from the mat. The Microsoft KINECT TM will be used to develop a computer game exercise with several components: Active Walking (P1), Balance Walking (P2), Dual Task Walking (P3), and Visual Perception Walking (P4). Each program has three levels with five steps each. P1 is designed to promote caloric consumption via aerobic exercise. Lower limb muscular strength, balance, and posture control are emphasized for P2, while upper limb movements and walking combined for P3. Visual information for complex walking patterns is provided for P4. Results Feasibility and level of difficulty of walking exercise were screened and evaluated by professional instructors. They stated that this "Integrated interactive Exergame system" can be utilized to promote exercise and to address health problems in the elderly. Discussion Safety, motivation level, exercise frequency, and volume level necessary to prevent a decline in cognitive function need to be evaluated in a future intervention study. Also, this step walking exergame will enhance physical activity in the aging population. References Makizako H, Shimada H, Doi T, Tsutsumimoto K, Lee S, Hotta R, Nakakubo S, Harada K, Lee S, Bae S, Harada K, Suzuki T. (2015). *Int J Environ Res Public Health*, 12(3), 3002-3013. Doi T, Shimada H, Makizako H, Tsutsumimoto K, Uemura K, Anan Y, Suzuki T. (2014). *BMC Neurol*, 14(67), doi: 10.1186/1471-2377-14-67. Contact suhjang@smu.ac.kr

## PHYSICAL FITNESS AND SELF PERCEPTION OF AGED POPULATION WITH DIFFERENT LIFE STYLE

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**Introduction** Older adults should do at least 150 minutes of moderate-intensity aerobic physical activity (WHO,2011) Short-time training programs without any strength component can have moderate impact on functional capacity and self-perception of quality of life (Araújo & Araújo,2002). This study aims to clarify the relationship between the amount of weekly physical activity and physical fitness in older adults. **Methods** The sample consisted of 27 elderly voluntary patients (age  $70.4 \pm 3.7$  years old), height  $155 \pm 59$  cm, weight  $68.9 \pm 9.7$  kg, BMI  $28.5 \pm 3.0$  92.6% women, 7.4% men. They were divided into 2 groups according to their weekly physical activity attendance: Group A trained one day a week and Group B two times a week. Physical fitness was assessed by Handgrip, 30-Second Chair, 6 Minute Walk, 8 Foot Up-and-Go, Back Scratch, Chair Sit-and- Reach tests; and two dimensions of the SF-36 questionnaire (Physical Functioning and Role Physical) were also assessed. Data has been analyzed using ANOVA One-Way to determine the differences between groups in the study variables. The statistical significance was set at  $p < 0.05$ . The study was done according to the Declaration of Helsinki. Results No significant differences were found between groups in physical fitness tests, but 8 Foot UP-and-Go test where Group B showed better scores than group A ( $F(1,26)=6.2$ ;  $p=.020$ ) The outcomes regarding to self-perception of health condition did not show any significant difference in the analyzed dimensions. **Discussion** The increase in training attendance seem not to have improved neither the physical fitness nor the self-perception of health. Findings report positive influence only on the agility test. The absence of significant differences between groups in the remaining variables may be influenced by the number of subjects; the type of exercises that were mainly focused on the cardio respiratory capacity, and not including muscle strength and flexibility. Further studies, including muscle strength intervention, and more robust samples are needed in order to maximize the impact of regular physical activity in elderly populations. References Araújo, D. S. M. S.; Araújo, C. G. S.(2002) Autopercepção corporal de variáveis da aptidão física relacionada à saúde *Rev Bras Med Esporte* \_ Vol. 8, Nº 2 – Mar/Abr,p.37-49. Silva et al (2008).Balance, Coordination and Agility of Older Individuals Submitted to Physical Resisted Exercises *Practice Rev Bras Med Esporte*. Vol. 14, No 2. WHO(2011)Global Recommendations on Physical Activity for Health. Contact: carolinaana2013ms@gmail.com

## ACTIGRAPHY-BASED SLEEP BEHAVIOR AND HIGH INTENSITY INTERVAL TRAINING : THE CHRONOTYPE EFFECT

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**INTRODUCTION** Physical activity can improve sleep quality through numerous mechanisms by creating a state of general well-being. It is difficult to understand exactly how exercise impacts on sleep and vice versa: different volumes, intensities and types of physical activity could have some positive or negative effects on sleep and sleep loss or restriction could influence both physical and cognitive performances (Souissi et al., 2008). It is largely demonstrated that M-types go to bed and wake up earlier than E-types and that E-types use to sleep less during the working days but more during the weekends (Vitale et al., 2015). The aim of this study was to evaluate the effects of sleep behavior following the 4x4 min of high-intensity interval training (HIIT) proposed by Helgerud (Helgerud et al., 2001), performed by subjects at 08:00 pm, also taking into account the influence of the chronotype variable. **METHODS** 15 male subjects (mean age:  $20 \pm 2$ ), soccer players, enrolled in the School of Exercise Science, University of Milan, at baseline filled in the Horne-Ostberg Morningness-Eveningness Questionnaire (MEQ) for the assessment of chronotype (Horne & Ostberg, 1976). An actigraph monitoring was performed for one week to detect nocturnal sleep PRE-HIIT, and POST-HIIT taking into account the following actigraphy-based sleep parameters: Actual Sleep % (AS), Sleep Efficiency % (SE), Immobile Time % (IT) and Movement Fragmentation Index % (MFI). We compared sleep behavior from PRE to POST conditions between chronotypes. **RESULTS** 9 soccer players resulted E-types while 6 resulted M-types. E-types and M-types did not present any significant differences for sleep behavior from PRE to POST condition, nevertheless M-types showed a trend to worsen their sleep in the POST condition with a decrease in SE and an increase in MFI. **DISCUSSION** Our results suggest that HIIT performed at 08:00 pm did not affect the sleep behavior in E-types while M-types, who are more active in the first part of the day, showed a strong trend to worsen their sleep quality therefore it seems that they are disadvantaged when performing a training task in the evening. **REFERENCES** •Helgerud J et al., Aerobic endurance training improves soccer performance, *Med Sci Sports Exerc*.2001 Nov; 33(11):1925-31 •Horne JA & Ostberg O, A self-assessment questionnaire to determine morningness-eveningness in human circadian rhythms, *International Journal of Chronobiology* 1976; 4(2):97-110 •Souissi N et al., Effect of time of day and partial sleep deprivation on short-term, high-power output, *Chronobiol. Int*.2008; 25(6):1062-76 •Vitale JA, et al., Chronotype influences activity circadian rhythm and sleep: differences in sleep quality between weekdays and weekend, *Chronobiol. Int*.2015 Apr; 32(3):405-15 **CONTACT** Letizia.Galasso@unimi.it

## VOLTA DA UNICAMP: A ROAD RACE DROVE BY EDUCATIONAL ACTIVITIES

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**Introduction** Road races have become the most popular sporting event in Brazil and all around the world, and this fast growing can be considered an important social phenomenon. The road race 'Volta da Unicamp' is an annual event in which the participant can choose between running 5 or 10 km or walking 5 km. The aim of this project was to integrate the concept of road race to the visions of the univer-

sity, integrating different areas of knowledge, contributing to the student's process of teaching and learning, producing knowledge and promoting healthy and - oriented physical activity Methods During the road race were done informative lectures; monitored training, route recognition and orientation about road races strategy. Training and health profile diagnosis of the participants were performed through optional survey at moment of the registration. Analysis of hydration was done before and after the race for a sample of participants; general health evaluation and guidance of the athletes; sensory analysis of isotonic drink before and after the race; measurement of the event impact in the environment through the emission of CO<sub>2</sub> and compensation by planting trees; and gathering, recycling all the garbage produced at the event. Results The road race was theme of papers in three scientific conferences and it was used as a laboratory to data acquisition to 4 PhD theses, to 3 final papers to undergraduate students and to 3 scientific initiation projects. Beyond the immediate results of evaluations, in order to guidance and remedy the most frequent questions from participants were made free lectures about: sports nutrition, training, health and hydration, special populations, biochemical markers, performance and technology etc. It was still created a permanent official website to the event with specific information writing by professionals. Discussion The 'Volta da Unicamp' promotes and encourages physical activity, produces and disseminates knowledge, contributes to sports professionals by creating a basis of study and formation to students and, above all, offers to athletes and general public information's that may help them to know them own body, creates a new modality to the health and performance perspective and promotes social and civic action. References SALGADO, JVV.; LOLLO, PC B.; AMAYA-FARFAN, J.; CHACON-MIKAHIL, M.P.T.. Dietary supplement usage and motivation in Brazilian road runners. Journal of the International Society of Sports Nutrition, v. 41, p. 47, 2014. doi:10.1186/s12970-014-0041-z.

## Conventional Print Poster

### PO-CPP-11 Molecular Biology & Biochemistry

#### EXPRESSION OF ANGIOGENESIS- AND INFLAMMATION-RELATED FACTORS AFTER EXERCISE-INDUCED MUSCLE DAMAGE IN HUMANS

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**Introduction:** Multiple molecular and cellular processes are rapidly activated following skeletal muscle damage to restore normal muscle structure and function. The remodelling processes may involve revascularization [1] and an inflammatory response, which can activate angiogenic pathways in the damaged tissue before its resolution and the completion of muscle repair or regeneration [2]. Nevertheless, less is known about the expression profile of angiogenesis and inflammation-related factors following eccentric exercise-induced muscle damage [3]. The aim of this study was to examine the expression responses of genes associated with angiogenesis and inflammation in human skeletal muscle after eccentric exercise. **Methods:** Ten healthy men (25±5 yr, 180±5 cm, 77±8 kg) performed 50 maximal eccentric muscle actions using the knee extensor muscles on an isokinetic dynamometer. Muscle biopsy samples were collected from the vastus lateralis before and 6h, 48h and 120h post-exercise. Real Time-PCR was used to examine changes in the mRNA expression of the inflammation and angiogenesis-related factors: VEGF, VEGFR-2, HIF-1α, Ang-2, Ang-1, Tie-2, TNF-α, IL-6, IL-8 and MMP-9. ANOVA was used for statistics. **Results:** Muscle damage resulted in increased mRNA levels of some of the factors examined but with a differential time-expression profile. Specifically, TNF-α expression increased 6h and 48h post exercise (p<0.05), while IL-8 expression increased and remained elevated throughout the experimental period (p<0.01). HIF-1α exhibited an early increase only at 6h after the completion of the exercise (p<0.05). Both VEGFR-2 and Tie-2 increased only at 48 h post-exercise (p<0.05). Ang-2 revealed an increase at 6h and 48h post exercise (p<0.05), while IL-6, VEGF, MMP-9 and Ang-1 mRNA expression did not exhibit statistically significant changes throughout the experimental period (p>0.05). **Discussion:** The post-exercise increased expression of angiogenesis and inflammation related factors may indicate the activation of these remodelling processes after muscle damaging exercise. The different time course of the transcriptional upregulation of those factors may imply their specific biological roles during the regeneration and adaptation processes following muscle damage. More studies are needed to further characterize the inflammatory and vascular remodelling responses of skeletal muscle to eccentric exercise in humans. **References** 1.Jarvinen et al. Am. J. Sports Med. 2005;33:745-764 2.Philippou et al. Adv Clin Chem. 2012;58:49-87 3.Chen et al. J Appl Physiol. 2003;95:2485-2494 Contact tfilipou@med.uoa.gr

#### ENDURANCE EXERCISE TRAINING REGULATES MITOCHONDRIAL BIOGENESIS IN SKELETAL MUSCLE OF DIABETIC MICE

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**Introduction** It is well established that mitochondrial biogenesis is an important factor for metabolic function. However, decreased mitochondrial biogenesis has been reported in skeletal muscle of diabetes (Ritov et al., 2005). Regular endurance exercise has significant benefits on overall health, including the prevention of obesity, cardiovascular disease, and diabetes (Gaziano et al., 2007). Therefore this study examined the role of endurance exercise training on mitochondrial biogenesis in type 2 diabetic mice. **Methods** Twelve db/db mice were divided into exercise training group (n=6) and control group (n=6). Mice in exercise training group ran on a rodent treadmill for 1 hour at 12m/min for 12 weeks (5d/w). Soleus (type I) and extensor digitorum longus (type II) muscles were obtained to compare the change of mitochondrial biogenesis response. AMPK, PGC-1α, NRF-1, mtTFA protein expressions were analyzed by western blotting. **Results** PGC-1α(116%), NRF-1(127%) and mtTFA(39%) protein expression in type I muscle were significantly higher than those in type II muscle (p<.01). Exercise training significantly increased the expression of phospho/total AMPK(51%, p<.001), PGC-1α(65%, p=.008), mtTFA(39%, p=.027) in type I muscle. However, only mtTFA(27%, p=.048) was significantly increased by exercise training in type II muscle. **Discussion** This study demonstrated that 12 week endurance training significantly increases mitochondrial biogenesis markers in diabetic mice. The higher expression of PGC-1α and down-regulated proteins (NRF-1, mtTFA) in type I than type II muscle of diabetic mice seems to be due to different mitochondrial content according to muscle fiber types. Furthermore, the exercise training contributed to increase phospho/total AMPK, PGC-1α expression only in type I muscle, whereas mtTFA protein was increased in both type I and type II muscles by the training. Taken together, these results suggest that long-term endurance training positively effects on mitochondrial biogenesis in skeletal muscles of diabetic mice and the effects would be differently associated with muscle fiber types. **References** Gaziano TA, Galea G, Reddy KS. (2007). Lancet, 370(9603), 1939-46. Ritov VB, Menshikova EV, He J, Ferrell RE, Goodpaster BH, Kelley DE. (2005). Diabetes, 54(1), 8-14. Contact hjkim@knsu.ac.kr

**MONITORING OF A FOOTBALL TEAM DURING A COMPETITION SEASON BY MEASURING SERUM MYOSIN ISOFORMS**

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**Introduction** We developed an ELISA methodology sandwich type to improve the medical diagnosis of the professional sports men muscle damage. The new technic was applied to obtain basal values of a reference population and to monitor a team players during a football season. Methods 49 reference volunteer and 27 male professional football players from the Sporting of Gijón Club participated in this study. In the case of players, blood was obtained at the pre-season and at different time-points along the season. In ELISA test monoclonal anti myosin fast and slow antibodies tapissed a polystyrene plate. The calibration curve was performed with purified pork myosin. To close the sandwich ELISA, the polyclonal rabbit antibody was added. Plates were incubated with an anti-anti rabbit antibody linked to peroxidase and TMB substrate for the luminescent reaction of the peroxidase. The absorbance was read at 450 nM wavelength. Results The calibration curve shows a very good linearity. The intra-assay coefficient of variation was assayed using three different samples low, medium and high values. CV is below 11% for Fast myosin and below 6% for Slow myosin. Linearity for Fast myosin was 80% and for the Slow myosin 90%. Comparing the results of the football team with reference population we observe that our players move below the normal average respect to Fast myosin and above the normal average respect to Slow myosin. In the competitive pre-season there is not increase in serum but at the beginning of season both types of fiber are damaged but not in the same magnitude, as the ratio indicated, due to the tactic and training conducted by the team. Discussion The new ELISA assay has greater speed, sensitivity and reproducibility that the Western Blot and shorten the result time from 48 to 4 hours, allows for processing 26 samples at the same time and it is more economic. Values for Fast myosin in the reference population shows no differences between sex and age. Significant differences were found of Slow myosin from older group (45-66) compared to younger (20-44). It may be caused by their lifestyle, which must be more sedentary at maturity, or loss of muscle into mature persons. Moreover, tracking myosin isoforms during a season of racing in a soccer team offers new insight into the state of the fast and slow fibers relating it to the possible significance of sarcomere damage that can occur during different phases of training and competition. References Ekstrand J, Hagglund M, Walden M. Br J Sports Med.(2011). 45, 553-558. Guerrero M, Guiu-Comadevall M., Cadeiau JA., Parra J., Balus R., Estruch A., Rodas G., Bedini JL., Cussó R. Br J Sports Med. (2008). 42, 581-584. Meister S, Faude O, Ammann T, Schnitker R, Meyer T.(2013). Scand J Med Sci Sports. 23. 156-163. Contact. lmcusso@ub.edu]

**PROTEOMIC PROFILE OF CALCANEAL TENDON IN AGING AND RESISTANCE TRAINING**

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**INTRODUCTION** The calcaneal tendon (CT) is the most commonly injured tendon in the human body (Maffulli 1999). Moreover, with advancing age, the amount of damage increases further (Chen, Yao et al. 2006). In this context, resistance training (RT) could be used to minimize such damages (Kjaer 2004). The aim of the present study was to obtain the identification, detailed protein cataloging and biochemical characterization based on the effects of the aging process and the RT in CT of rats. **METHODS** Twenty-four Rattus norvegicus albinos, ages 4 and 24 months, were used and further divided into four groups: young sedentary (YS), young trained (YT), old sedentary (OS) and old trained (OT). RT climbing protocol was performed on alternating days, three times per week for 12 weeks. Subsequently, the CTs were removed and analyzed by liquid chromatography tandem-mass spectrometry (LC-MS/MS). **RESULTS** The analysis by LC-MS/MS showed 142 distinct proteins, however, only 29 proteins met the inclusion criteria and were analyzed. Aging causes a reduction in the abundance of seven proteins related to extracellular matrix (ECM) organization and other biological regulations. However, RT promoted the positive regulation of seven proteins in YT and two in OT group, results in an adjustment of the ECM organization and the maintenance of healthy tendons. **DISCUSSION** This study contributes to a better understanding of beneficial effects of RT on the proteomic profile of the calcaneal tendon during aging. Our results demonstrated a down regulation of important proteins for tendon functionality and homeostasis during aging, as collagen alpha-2(I), collagen alpha-1(I), cartilage oligomeric matrix protein and serotransferrin, which might explain the clinically large number of lesions along with the decline of the biomechanical properties during senility. Moreover, changes in proteins related to ECM organization, biological regulation, stability of the ciliary architecture and metabolic/development/cellular processes functions, demonstrated the importance of RT as a strategy to reduce the deleterious effects inherent to biological aging. **REFERENCES** Chen, H., X. F. Yao, S. Emura and S. Shoumura (2006). 'Morphological changes of skeletal muscle, tendon and periosteum in the senescence-accelerated mouse (SAMP6): a murine model for senile osteoporosis.' Tissue Cell 38(5): 325-335. Kjaer, M. (2004). 'Role of extracellular matrix in adaptation of tendon and skeletal muscle to mechanical loading.' Physiol Rev 84(2): 649-698. Maffulli, N. (1999). 'Rupture of the Achilles tendon.' J Bone Joint Surg Am 81(7): 1019-1036. CONTACT fabricio.barin@gmail.com

**PREVENTIVE EFFECTS OF PHYSICAL TRAINING ON OXIDATIVE STRESS PARAMETERS AND NEUROTROFIC AND INFLAMMATORY MEDIATORS DURING SARCOPENIA PROCESS IN ELDERLEY MEN**

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**INTRODUCTION** Regular exercise can decrease the deleterious effects of the aging and limit the development and progression of chronic disease in elderly people. The aim of this study was to investigate the effects of different physical training programs on oxidative stress parameters, inflammatory and neurotrophic mediators in serum of elderly men. **METHODS** Fifty-five volunteers healthy men (60 to 80 years) were divided into four groups: control (Ctr, n=14), aerobic training in dry land (ATd, n=12); combined training in dry land (CTd, n=12); and combined training in water (CTw, n=17). The training protocols were performed for a total period of 8-wk, three times per week, 60 minutes per workout. Ten milliliter of blood were drawn 72 hours before (baseline) and 48 hours after the last training session. The serum was aliquoted and stored at -70 °C until biochemical assays of BDNF, IGF-1, MDA, carbonyl groups, total thiols, catalase, GPx, TRxR, GSH, IL-1 $\beta$ , IL-6, IL-8 and IL-10. **RESULTS** An elevated level of BDNF was observed in ATd group while IGF-1 level was increased in CTd group. All training models were reduced oxidative damage in lipid and increased the activities of both TRxR and GPx as well as GSH level. However, the CTw group seems to be more effective in the antioxidant system. In addition, IL-6 and IL-8 levels were decreased significantly, but IL-6 was more susceptible to different types of physical training. **DISCUSSION** Changes in levels of neurotrophic and growth factors (Kalinkovich and Livshits, 2015), oxidative stress parameters and inflammatory mediators (Meng and Yu, 2010) have been observed during aging, and it can be linked with sarcopenia. In this sense, the physical exercise has been appointed as one of the

possible strategies to regulate the cellular redox state in the elderly subjects (de Gonzalo-Calvo et al., 2013). However, the type, intensity, frequency and duration of exercise are not yet fully established and seem to be decisive for this protective effect. Our results showed that the mechanisms of systemic adaptation induced by different models of training in dry land and water were distinct, where each type of exercise activates differently neurotrophic and growth factors as well as the regulation of cellular oxidative stress and inflammatory parameters. Taken together, the results show that the effects of training in elderly men are varied and exercise type-dependent manner. REFERENCE Kalinkovich A, Livshits G. Ageing Res Rev. 2015;22:58-71. Meng S-J, Yu L-J. Int. J. Mol. Sci. 2010; 11:1509-1526. de Gonzalo-Calvo D et al. Age (Dordr). 2013;35:407-17.

### EFFECT OF AEROBIC EXERCISE TRAINING ON NADPH OXIDASE ACTIVITY IN MUSCLE MICROVASCULAR ENDOTHELIAL FUNCTION IN AGED MEN

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**Introduction** Elevated oxidative stress is a prominent feature of vascular diseases, for which obese individuals are at increased risk (Thomas et al., 2003). NADPH oxidase has been shown to be a significant source of oxidative stress derived from vascular tissue (Griendling et al., 2000), and may be particularly relevant to the obese population. The present study was performed to investigate the exercise training effect on NADPH oxidase activity on microvascular endothelial function of skeletal muscle in control and obese aged men. **Methods** Five control and six obese aged men (>65 yrs) were participated in the study. All subjects performed an aerobic exercise training for 12 weeks (70% HRmax). Microdialysis experiments were conducted in the vastus lateralis muscle of all subjects. Samples were analyzed for H<sub>2</sub>O<sub>2</sub> and nutritive blood flow. **Results** Significant difference in NADPH oxidase activity existed between lean and obese individuals, whereas no significant difference found in dialysate H<sub>2</sub>O<sub>2</sub> concentration between groups before and after aerobic training ( $P > .05$ ). However, it was higher in old obese men than old control by SOD containing APO perfusion ( $P = .036$ ). Nutritive blood flow perfused by ACh containing APO was significantly higher (decrease in o/i ratio) than only ACh perfusion in old obese group ( $P < .05$ ). **Discussion** These findings confirmed that ROS mainly produced by NADPH oxidase as well as microvascular endothelial function would be improved by inhibiting NADPH oxidase in obese aged men. Additionally, ROS and nutritive blood flow did not altered in the aged men following aerobic exercise training. **References** Griendling KK, Sorescu D, Ushio-Fukai M. (2000). Circ Res, 86, 494-501. Thomas SR, Chen K, Keaney Jr JF. (2003). Antioxid Redox Signal, 5, 181-194. Maiorana A, O'Driscoll G, Taylor R, Green D. (2003). Sports Med, 33, 1013-1035. Contact cckim@knsu.ac.kr

### GENOME-WIDE ASSOCIATION STUDY OF ELITE RUSSIAN ENDURANCE ATHLETES

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It is well recognized that humans vary in their ability to achieve success in endurance sports and their predisposition is based on genetic factors. The aim of the study was to identify single nucleotide polymorphisms (SNPs) associated with elite endurance performance (maximal oxygen consumption rate, VO<sub>2</sub>max) in Russian endurance athletes using a genome-wide association study (GWAS) approach. VO<sub>2</sub>max was measured in 71 elite endurance Russian athletes (41 males and 30 females). HumanOmni1-Quad BeadChips (Illumina Inc, USA) were used for genotyping of 1,140,419 SNPs. We found that 568 SNPs were associated with VO<sub>2</sub>max in the combined cohort of endurance athletes (with  $P < 0.001$  adjusted for sex). Of those, two SNPs, namely SLC16A10 rs9400467 ( $P = 0.0002653$ ) and SLC38A1 rs10785611 ( $P = 0.00013$ ) are located in or near the genes expressions of which in the human skeletal muscle were previously reported to be linked with VO<sub>2</sub>max (Su et al. 2015). These genes are involved in the regulation of energy metabolism in skeletal muscles (SLC16A10) and glutamine uptake (SLC38A1). Interestingly, the rs9400467 polymorphism is also associated ( $P = 6.5 \times 10^{-14}$ ) with tyrosine levels of human blood samples (Shin et al. 2014) and tyrosine ingestion improves aerobic performance. Our results suggest that at least SLC16A10 rs9400467 and SLC38A1 rs10785611 polymorphisms may predict human physical performance. **References:** Shin SY. et al. An atlas of genetic influences on human blood metabolites. Nat Genet. 2014; 46(6):543-50. Su J. et al. A novel atlas of gene expression in human skeletal muscle reveals molecular changes associated with aging. Skelet Muscle. 2015; 5:35.

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### PO-CPP-15 Nutrition 2

#### HYDRATION STATUS AND WATER INTAKE OF CYPRIOT ADOLESCENT STUDENT-ATHLETES LIVING IN A WARM ENVIRONMENT

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**Introduction** Dehydration can decrease exercise capacity, self-rating of alertness and ability to concentrate (Shirreffs et al., 2004), which can affect school work. As chronic dehydration was observed in young athletes living in a cool environment (Phillips et al., 2014), the aim of this study was to assess the hydration status and water intake of Cypriot adolescent student-athletes living in a warm environment, during school hours. **Methods** 141 student-athletes (15–17y; boys n=102) participated in this study. All data were collected on arrival at school (7.30am) and at 1.30pm (temperature  $\geq 28^\circ\text{C}$ ). Hydration was assessed via urine specific gravity (SG): Euhydration  $\text{SG} \leq 1.020$ , slight dehydration  $\text{SG} 1.021\text{--}1.029$ , serious dehydration  $\text{SG} \geq 1.030$ . Participants completed a subjective feelings questionnaire on thirst, fatigue, concentration and alertness (Shirreffs et al., 2004), and recorded all food and fluid intake (from waking until leaving school) for water intake estimation (DietPlan6 software). **Results** On arrival at school, 13 students were euhydrated (group 1), 67 students were slightly dehydrated (group 2), and 50 students were seriously dehydrated (group 3). Hydration status of the participants did not change over time. Group 3 had less water intake before coming to school ( $209 \pm 108$  ml) than the other groups (group 1:  $234 \pm 114$  ml; group 2:  $274 \pm 149$  ml;  $P = 0.000$ ). Total day water intake was similar between groups (group 1:  $670 \pm 388$  ml; group 2:  $875 \pm 489$  ml; group 3:  $751 \pm 477$  ml;  $P = 0.126$ ). Group 3 felt less alert than the other students ( $P = 0.029$ ) in the morning. Alertness decreased further for group 3 by the



end of the school day ( $P = 0.009$ ). Thirst was similar between groups. Increased SG correlated with fatigue ( $P = 0.006$ ), which in turn correlated with decreased concentration ( $P = 0.000$ ) and alertness ( $P = 0.000$ ). Discussion 90% of the participants were dehydrated for the entire school day. Seriously dehydrated students did not feel thirstier and had similar water intake with their better hydrated peers. Dehydration was related with increased sense of fatigue and indirectly with decreased concentration and alertness. As student athletes are expected to perform well both academically and in competitive sport, dehydration during school hours should be prevented and managed. References Phillips SM, Sykes D, Gibson N. (2014). Hydration status and fluid balance of elite European youth soccer players during consecutive training sessions. *J Sport Sci Med*, 13, 817–822. Shirreffs SM, Merson SJ, Fraser SM, Archer DT. (2004). The effect of fluid restriction on hydration status and subjective feelings in man. *Brit J Nutr*, 91, 951–958.

### EFFECTS OF COLOSTRUM SERUM ADMINISTRATION ON SEROTONIN SYNTHESIS IN THE BRAIN DURING EXHAUSTIVE EXERCISE IN RATS

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**INTRODUCTION** It is well known that over-expression of serotonin (5-hydroxytryptamine, 5-HT) in the brain induced by exhaustive exercise disturbs exercise performance. Tryptophan hydroxylase (TPH) is the rate-limiting enzyme for serotonin biosynthesis. This study was conducted to determine the effects of colostrum serum on serotonin synthesis in the brain during exhaustive exercise in rats. **METHODS** In this study, animals were randomly divided into five groups: control group, exercise group, 50 mg/kg colostrum treatment and exercise group, 100 mg/kg colostrum treatment and exercise group and 200 mg/kg colostrum treatment and exercise group ( $n = 10$  in each group). The rats in the exercise groups performed treadmill running once a day for 7 days. On the 7th day of the experiment the time to exhaustion during treadmill running was determined for the exercise groups. **RESULTS** In the present results, 5-HT-positive cell, TPH-positive cell, 5-HTT, 5-HTTA expression in the dorsal raphe nucleus were significantly increased by exhaustive treadmill running. Treatment with colostrum led to a significant increase in the time to exhaustion in response to exhaustive running on a treadmill with the significant decrease in 5-HT synthesis, TPH expression, 5-HTT, 5-HTTA expression in the DRN of rats. **DISCUSSION** The present study demonstrated that colostrum serum increased endurance exercise performance through inhibition on serotonin production in the brain.

### INTAKE OF MACRO-AND MICRONUTRIENTS AMONG HUNGARIAN SOCCER PLAYERS

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**INTRODUCTION** In sport nutrition one of the general concepts is that the varied natural diet spontaneously consumed may cover the needs. However the nutritional requirement of different sport types, the actual changes in body composition, the nutritional defects especially in micronutrients may require to use of specified nutrition. In competitive sport, hydration and supplements have also a distinguished role for maximal performance. **OBJECTIVE** The aim was to examine professional Hungarian soccer players' macro- and micronutrients intake, eating habits, body composition in general and according to the different training cycles (training-, rest- and match days). Based on that personal dietary advises were also aimed to formulate. **INVESTIGATION AND METHODS** Twenty seven elite athletes aged between 18-30 years were included from a single soccer team. The participation was anonym and voluntary. Dietary analysis software (NutriComp®) recorded the athletes' three-day dietary diary in relation to their exercise cycles (training, rest and competition days). We performed body composition measurement with InBody device 230®. The data analysis was performed using SPSS software package including paired t-test. **RESULTS** On the training day the average energy intake was 38.5 kcal/kg/day, at rest day 36.2 kcal/kg/day, and at match day it amounted to 40.3 kcal/kg/day. The evaluation of averaged three-day dietary diary revealed that energy intake remained significantly ( $p < 0.05$ ) below the desired value (adjusted to the present quantified sporting activities it was 50 kcal/kg/day). The vitamin D, iron, calcium intake was below the recommended RDA values defined for the adult population (calcium 741 mg/day, iron 13.7 mg/day, vitamin D 3.5 mg/day). On average, soccer players consumed variable kinds of supplements daily which did not include vitamin D or calcium products. On training day one-fifth of the soccer player energy intake came from protein, and the rest came from fat and carbohydrates in about the same ratio (42% carbohydrates, 37% fat, 20% protein intake, 1% other). There was no significant difference in carbohydrates consumption between training and match days. High fat diet was typical among the Hungarian professional soccer players in each training cycle period. On match day the most attention was paid to increase protein intake on expense of fat intake. **SUMMARY** Appropriate energy intake is only possible with a well-balanced macronutrient consumption meeting the enhanced energy requirement. In our survey a negative energy balance characterized each training cycle. Defective food habits and incorrect diet throughout the training cycle may degrade performance. The micronutrient dis-balance especially attracts attention and call for the importance of individual and targeted intervention regarding nutrition supplements. In addition, defining lifestyle factors disturbing or supporting nutrition would be also helpful for explanation.

### A PALEOLITHIC HIKING INTERVENTION IMPROVES ACUTE BUT NOT CHRONIC CLINICAL MARKERS OF HEALTH IN ATHLETIC MALE ADULTS

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Department of Sports Medicine and Sports Nutrition, Faculty of Sport Science, Ruhr-Universität Bochum, Germany **Introduction** Imitation of Paleolithic lifestyle (PL) is associated with health-improving effects due to its relation to the human genome [1,2]. However, previous studies mainly describe the benefit of a Paleolithic diet (PD) or movement pattern (PM) for overweight or diabetic people with a higher cardiovascular risk. Aim of the study was to investigate the health-improving potential of a PL intervention for healthy athletic male adults. **Methods** A group of 12 healthy athletic young adults (age=22±2 y; BMI=23.4±2.0 kg/m<sup>2</sup>; VO<sub>2</sub>max=57.9±4.1 mL/min/kg) were exposed to the rural area of Lapland reproducing PM and PD for 10 days (d1-d10: daily hiking distance: 13.0±2.5 km, 1 day rest). Testing occurred before, during and after (d-6, d6, d+1) the intervention followed by a follow-up 3 months after the end of the intervention (d+91). Serum glucose (GLU), total cholesterol (CHO), high density lipoprotein cholesterol (HDL) and triglyceride (TG) were analysed. Also body mass (BM), fat mass (FM) and systolic blood pressure (SBP) were measured. **Results** We found a significant acute decrease of BM, FM, SBP, CHO, GLU and TG ( $p < 0.05$ ) (BM: d-6=76.0±2.1, d6=74.0±1.9, d+1=73.1±1.9 kg; FM: d-6=12.5±0.4, d+1=11.1±0.4 %; SBP: d-6=124±11, d+1=113±8 mmHg; CHO: d-6=3.8±0.2, d6=3.4±0.2, d+1=3.6±0.2 mmol/L; GLU: d-6=5.1±0.1, d6=2.8±0.7, d+1=4.7±0.1 mmol/L; TG: d-6=0.8±0.1, d6=0.6±0.0, d+1=0.6±0.0 mmol/L, respectively). HDL increased on d+1 but remained unchanged during and after the intervention com-

pared to d-6 ( $p>.05$ ) ( $d-6=1.3\pm0.1$ ,  $d6=1.2\pm0.1$ ,  $d+1=1.5\pm0.1$ ,  $d+91=1.4\pm0.1$  mmol/L, respectively). BM increased and GLU decreased on d+91 compared to d-6 ( $p<.05$ ) ( $d+91$ : BM=  $77.8\pm2.1$  kg; GLU= $3.7\pm0.2$ ; mmol/L, respectively). FM, SBP, CHO and TG remained unchanged 3 months after the end of the intervention ( $p>.05$ ) ( $d+91$ : FM= $12.7\pm0.5$  %; SBP= $123\pm10$  mmHg; CHO= $3.7\pm0.2$  mmol/L; TG= $0.8\pm0.1$  mmol/L, respectively). Conclusion In conclusion, a 10-day PL intervention has an acute small beneficial effect on health related parameters like FM, SBP, GLU, TG in healthy physically active male adults. The intervention did not result in any effects on mean value of HDL. Furthermore the intervention does not enhance clinical markers of health 3 months after the end of the intervention. However, increase of BM 3 months after the intervention is not associated with increased FM. Compared to results of past studies we speculate about a reinforcing mechanism by the combination of PM and PD without evidence about the primary predictor [1]. Further research is needed in a randomized controlled setting. References [1] Frassetto et al. (2009). *Eur J Clin Nutr*, 63, 947-55. [2] O'Keefe et al. (2004). *Mayo Clin Proc*, 79, 101-8. [2] Manheimer et al. (2015). *Am J Clin Nutr*, 102, 922-32.

## MEAL FREQUENCY DOES NOT AFFECT BODY COMPOSITION CHANGE DURING WEIGHT GAIN PERIOD IN ATHLETES

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Introduction Positive energy balance is important factor for weight gain in athletes. However, when the volume of one meal is large, the body increase their burden of digestion and absorption. Although it is recommended to increase the meal frequency in the position stand (La Bounty et al., 2011), the study has not been done on positive energy balance. The effect of meal frequency on body composition change during weight gain period for athletes is unknown. Therefore, the aim of this study is to examine the effect of meal frequency on body composition change during weight gain period. Methods Eight rowers ( $20.5\pm1.1$  years, body height:  $169.8\pm2.9$  cm, body weight:  $68.3\pm4.84$  kg) were participated in this study. The study was a randomized crossover design with two 8-wk dietary intervention. During the intervention, subjects overall consumed the same amount of energy and nutrients per day which makes athletes in positive energy balance with either regular meal frequency (3 meals/d; RFr) or high meal frequency (6 meals/d; HFr). A 5-wk washout period was placed between the trials. Body composition was measured by DXA and fasting blood samples were collected at pre- and post-intervention of each trial. The feeling of fullness was assessed by 100-mm visual analogue scales (VAS) before eating every meals. Results Training volumes of all the subjects during both intervention periods were similar. In the RFr trial, body weight (BW), skeletal muscle (SM) and adipose tissue (AT) increased by  $2.92\pm1.91$  kg,  $1.04\pm0.62$  kg and  $1.65\pm1.30$  kg, respectively. In the HFr trial, BW, SM and AT increased by  $3.14\pm1.42$  kg,  $1.28\pm0.39$  and  $1.69\pm1.15$  kg, respectively. There were no significant differences in the increases of each measurements between trials. Subjective feeling of fullness vary in individuals. Insulin, HOMA-IR, cortisol, testosterone levels were not significantly different between trials. Discussion It was found that meal frequency does not affect body composition change during weight gain period, because the amount of energy and nutrients intake was absolutely identical. We hypothesized that body weight and fat mass are gained by RFr meal, as a reason for that, large amount of energy intake per meal induce increasing quantities of insulin secretion. However, there was no difference in insulin concentration in this study. Consequently, when the additional energy is equal, meal frequency may not effect on change in body composition in athletes. This is the first study to investigate the effect of meal frequency when athletes are under positive energy balance for weight gain. References La Bounty, P. M., Campbell, B. L., et al. (2011). *J Int Soc Sports Nutr*, 8:4 Contact mtaguchi@waseda.jp

## THE INFLUENCE OF BUCHINGER'S FASTING ON ISOMETRIC RESISTANCE PERFORMANCE OF SPORTS STUDENTS

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Buchinger fasting (BF) is associated with beneficial cardiovascular, metabolic, and psychological adaptations. Early fasting is characterized by a high rate of gluconeogenesis with the use of amino acids. Prolonged protein catabolism possibly causes a loss of muscle mass, making BF for athletes unfavourable. The aim of this study was to analyse if the increased protein degradation affects the resistance performance, hence if fasting should be avoided by athletes. 18 sports students (female:  $n=8$ , male:  $n=10$ , age:  $24.5\pm1.6$  y, height:  $175.7\pm6.7$  cm, body mass:  $74.9\pm9.8$  kg) underwent a BF with one relief day, five fasting days, and three build-up days. Subjects were tested before (Pre), while (W, on 5th fasting day), and after (Post, on 3rd build-up day) BF. While BF they did moderate physical activity as recommended by Buchinger without systematically training. Body composition was measured by bioelectrical impedance analysis (BIA) and Body Fat Caliper (BFC). Isometric manual strength was tested with a manual force measuring device and the isometric strength of leg extension with a force gauge on a force chair. Both were tested regarding to maximal strength and strength endurance. For the statistical analysis the best out of three maximal contractions was considered for maximal strength, the mean over ten maximal contractions of 6 sec with 15 sec break for strength endurance. Body weight was reduced (Pre:  $74.9\pm9.8$  kg; Post:  $71.4\pm10.7$  kg,  $p=0.000$ ) as well as the body fat mass (BIA, Pre:  $13.0\pm3.3$  kg; Post:  $11.5\pm2.4$  kg,  $p=0.007$ ). The muscle mass showed no difference between before and after BF (BFC, Pre:  $27.3\pm8.0$ ; Post:  $26.1\pm6.4$  kg). BF had no influence on the maximal manual strength (Pre:  $50.0\pm9.9$  kg; W:  $47.4\pm10.8$  kg; Post:  $47.0\pm10.0$  kg), and the maximal strength of leg extension (Pre:  $58.4\pm13.9$  kg; W:  $56.9\pm14.6$  kg; Post:  $58.1\pm13.7$  kg). The strength endurance of manual strength (Pre:  $38.9\pm7.6$  kg; W:  $37.7\pm8.6$  kg; Post:  $38.1\pm7.2$  kg), and leg extension strength (Pre:  $51.9\pm12.4$  kg; W:  $52.7\pm13.2$  kg; Post:  $53.6\pm13.0$  kg) remained also unaffected. Short-term fasting had no effect on the isometric maximal strength and strength endurance of sports students. The loss of body mass along with no reduction in muscle mass is not relevant for isometric strength performance. According to that, athletes could fast at pre-season preparations without expecting a loss of isometric strength. For further studies in this area a survey of long-term effects (e.g. retesting after two and four weeks) of fasting on resistance performance would be recommendable. In case of positive effects periodical fasting might be beneficial for athletes.

## PARABEN ANALYSIS ON SPORT AND ENERGY DRINKS BY LC-MS-IT-TOF

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Introduction Parabens have been employed for about a century as preservatives in foodstuff, cosmetics and pharmaceuticals, beverage and personal care products. In general, after they enter human body, PBs are partially hydrolyzed by esterases to p-hydroxy-benzoic acid or hydroxylated to produce glycine/glucuronide/sulfate conjugates. These conjugates possess increased water solubility relative to the free species, which facilitates their excretion. In vitro studies indicate that PBs induce the growth of MCF-7 human breast cancer cells

and influence the expression of estrogen dependent genes. In this respect and although parabens were generally considered harmless to human beings for a long time, several concerns have been raised over the past twenty years about parabens safety with emphasis given on their endocrine disrupting potential (Myridakis et al., 2015; Papadopoulos et al., 2016; Patel et al., 2016). Sport and energy drinks are often used in the various areas of competitions by sportsman. Although there is description about ingredient of these drinks there is no data about preservative compounds such as parabens. Thus in this study some commercially available drinks are analysed whether they include parabens or not. Methods The sport drinks were analysed in a Shimadzu LC-MS IT-TOF system (Shimadzu, Tokyo, Japan) instrument. Mobile phase was used as solvent A, acetonitrile (95%); solvent B, water (5%) at a flow rate of 0.15 ml/min and a sample injection volume of 2 µl. Relative mass of the observed peaks in chromatograms were checked in the MS spectrums and the mass values that were in agreement with the calculated Mass of any paraben were determined. Results Eight different samples were analysed in the present study. In some of them some parabens were detected. However, none of the determined parabens were out of suggested limits. Discussion LC-MS IT-TOF is very sensitive and rarely used system in analyses of the compound in very large interest area. In the present study, by using this system a new method, which can be used for detection of parabens was developed and applied for sport and energy drinks. Some interesting data were obtained. References Myridakis A, Chalkiadaki G, Fotou M, Kogevinas M, Chatzi I, Stephanou E.G. (2015). Environmental science & technology. Papadopoulos C, Frontistis Z, Antonopoulou M, Venieri D, Konstantinou I, Mantzavinos D. (2016). Ultrasonics Sonochemistry, 31, 62-70. Patel U, Dharaiya N, Bahadur P. (2016). Journal of Molecular Liquids, 216, 156-163. Contact uacar@anadolu.edu.tr

## Conventional Print Poster

### PO-CPP-19 Physiology 3

#### CHANGES IN NEURAL ACTIVITY DUE TO POSTURE POSITION

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**Introduction** Posture position is one of the factors that effects human's mental activity (Rice et. al., 2013). In recent studies, neuronal synchronization was investigated during resting state using the elite sportsmen, amateur sportsmen and healthy control subjects (Del Percio et. al., 2011). This study aimed to analyze the electrophysiological differences that are observed between different positions during tasks that are involving working memory activities among the elite sportsmen and healthy controls with electroencephalogram. **Methods** Subjects (n=3) were asked to rest while sitting, standing up and lying positions (on a hang up bed in a supine position). 16 channel EEG electrodes have been placed on frontal, parietal, occipital, central and temporal areas. Backwards subtraction from a three digit number by seven was used as a paradigm to increase the mental workload. Applying this paradigm requires increased working memory. For each condition, EEG data has been recorded for 3 minutes. After this preprocessing step, EEG data has been epoched using 1 sec windows and the Fourier spectrum has been obtained for each corresponding window. Finally frequency outputs were averaged over epochs. **Results** Inline with previous studies, it was observed that the parietal and occipital alpha band powers were decreased when the subjects open their eyes. During the eyes closed mental activity period, alpha band power was found to be lower than the eyes closed resting and higher than the eyes open resting period. When the subjects were in the standing upright position, similar results were obtained as in the sitting position tasks. **Discussion** According to previous studies, it was reported that in elite sportsmen, parietal and occipital alpha and delta band powers were found to increase more than the alpha and delta values of the control subjects (Babiloni et. al., 2010). Moreover, in elite athletes cortical activity was found to be greater than the controls while they were standing up on a force/balance platform (Del Percio et. al., 2009). Our results are also in agreement with the literature. Our research was limited with the number of subjects that participated in the experiments. Nevertheless, number of the subject are going to be increased. **References** Babiloni C, Marzano N, Lacoboni M, Infarinato F, Aschieri P, Buffo P, Cibelli G, Soricelli A, Eusebi F. (2010). Brain Res Bul, 81,149-156. Del Percio C, Babiloni C, Marzano N, Lacoboni M, Infarinato F, Vecchio F, Lizio R, Aschieri P, Fiore A, Toran G, Gallaminij M, Baratto M, Eusebi F. (2009). Brain Res Bul, 193-200 Del Percio C, Infarinato F, Marzano N, Lacoboni M, Aschieri P, Lizio R, Soricelli A, Limatola C, Rossini M, Babiloni C. (2011). International Journal of Psychophysiology. Rice JK, Rorden C, Little JS, Parra LC. (2013). Neurolmage. Contact: canelifozcan@hotmail.com This research is supported by Marmara University Scientific Research Fund under the project number SAG-C-YLP-100615-0251.

#### EFFECTS OF PHYSICAL TRAINING ON ERYTHROCYTE TRACE ELEMENTS .

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**INTRODUCTION** One of the least studied physiological aspects of sports nutrition are the trace elements and their actions in athletes. Physical activity can change the concentration of minerals available in blood (plasma and serum), as well in urine. Therefore, the objectives of this work are to determine trace mineral concentrations in erythrocyte of subjects with different levels of physical training compared with a sedentary control group. **METHOD** So we've had a total of 76 subjects living in Cáceres (Spain) and separated into three groups: 22 belonging to the group of highly trained, 24 moderately trained group and 30 to the sedentary group that did not practice physical activity. We take, to all of them, blood samples at nine hours of fasting and after erythrocyte was separated with centrifugation. The samples, after being appropriately treated, were analyzed by ICP-MS. **RESULTS** The results of our study show, in erythrocytes, lower concentrations of Cu, Fe and Zn ( $p<0,001$ ) in athletes compared to moderate training group and control group. An inverse correlation between degree of training and erythrocyte concentration of Cu, Fe, Se and Zn was found ( $p<0.001$ ). **DISCUSSION** These low values of Fe are probably related to deficiencies in iron intake as indicated by some studies (Latunde-Dada, 2012). The decrease in Cu erythrocyte, sometimes referred in athletes, appears to be related to a change in the intake of Cu but could reflect a redistribution in tissues by physical activity (Vitoux y cols., 1999). The study of Carvalho et al. (2012), with results similar of our study and conducted in swimmers, indicate a possible nutritional deficiency of this mineral. Therefore we can conclude that physical training produces changes in erythrocyte concentrations of trace elements Cu, Fe, Se and Zn. **REFERENCES** Giolo De Carvalho F, Rosa FT, Marques Miguel Suen V, Freitas EC, Padovan GJ, Marchini JS (2012). Evidence of zinc deficiency in competitive swimmers. Nutrition. 28 (11-12):1127-31. Latunde-Dada, G. O. (2013). Iron metabolism in athletes - achieving a gold standard. European Journal of Haematology, 90 (1), 10-15. Vitoux, D., Arnaud, J., & Chappuis, P.

(1999). Are copper, zinc and selenium in erythrocytes valuable biological indexes of nutrition and pathology? *Journal of Trace Elements in Medicine and Biology*, 13(3), 113-128. CONTACT Prof. Dr. Marcos Maynar Mariño.mmaynarmarino@gmail.com not insert authors here

### SKIN-GAS ACETONE CONCENTRATIONS ON SURFACE OF ACTIVE MUSCLES FOLLOWING SUBMAXIMAL EXERCISE

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**Introduction** Ketone bodies (3-hydroxybutyrate, acetoacetate and acetone) are generated in the liver, mainly from the oxidation of fatty acids, and exported to other tissues for use as energy source (Mitchell et al. 1995). Acetone is mainly produced by decarboxylation of acetoacetate. Therefore, it is known that exercise increases acetone levels in plasma (Balasse et al. 1989), expired air and skin-gas (Yamai et al. 2009). Although a few studies (Mori et al. 2008, Yamai et al. 2009) have reported increased human skin-gas acetone concentrations according to exercise intensity, no one has confirmed changes in skin-gas acetone directly from the surface of active muscles during submaximal exercise. Therefore, the purpose of this study was to measure skin-gas acetone concentrations directly from surface of active muscles following submaximal exercise. **Methods** Eleven healthy male students performed constant-load (60%HRmax) cycle exercise for 30 min. The skin-gas samples were obtained from left hand and left quadriceps muscle by covering with a polyethylene bag in which pure nitrogen gas (150mL) was introduced for 30 sec, and collected in a sampling bag at rest, 5, 10, 15, 20, 30 min during exercise, and 5, 10, 20 min recovery of the exercise. Acetone concentration was analyzed by gas chromatography. **Results** Skin-gas acetone concentrations significantly increased during the exercise compared to the resting values ( $p < 0.01$ ), then immediately returned to resting values both in hand and quadriceps muscle samples. Significantly higher resting skin-gas concentrations are observed in hand compared to quadriceps muscle samples, however, higher increasing rates were found in quadriceps muscle samples (5-6 times) than in hand (2 times) compared to resting values. **Discussion** We succeeded to measure skin-gas acetone concentrations directly from surface of active muscles following the exercise. Increased skin-gas acetone concentrations both in hand and active quadriceps muscles after the exercise have suggested that 60%HRmax cycle exercise in this study induced the production of ketone bodies in the liver, from the oxidation of fatty acids (Mitchell et al. 1995), and some of increased ketone bodies eliminated as skin-gas acetone. Differences in increasing rates between hand and quadriceps muscles may due to the differences in blood flow rates in each tissues (Rowell et al. 1986). **References** Mitchell GA et al. (1995) *Clin Invest Med* 18: 193-216. Balasse EO and Féry F. (1989) *Diabetes Metab Rev* 5: 247-70. Yamai et al. (2009) *Redox Report* 14: 1-5. Mori. (2008) *Redox Report* 13: 139-42 Rowell et al. (1986) *Am J Physiol* 251: H1038-44. Contact Hiroshi Itoh [itoh.hiroshi@nitech.ac.jp]

### EFFECT OF UNDERWATER ACTIVITY ON SKELETAL MUSCLE METABOLISM AND NUTRITIVE BLOOD FLOW IN SCUBA DRIVERS

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**Introduction** This study was performed to investigate the mechanism for microvascular response (vasoconstriction) by  $\alpha$ -adrenaline after a single bout of diving of SCUBA divers who have been undergone long-term intermittent cold exposure. To purpose of the study, nutritive blood flow, metabolism and reactive oxygen species ( $H_2O_2$ ) were analyzed by locally perfusing the  $\alpha$ -adrenergic blockade (phenolamine) in vastus lateralis of quadricep muscles. **Methods** Seven divers (age 35-45 years) who have been diving over 50 times per year were participated in this study. An acute bout of diving was performed at 20m below the East sea (13-14°C) for 30 min after wearing dry suit and SCUBA gear. Dialysate samples were obtained through three microdialysis probes inserted into right vastus lateralis muscle at pre and post diving and recovery (60 min). **Results** The skin temperature of vastus lateralis was significantly decreased after 20 minutes compared with those before diving ( $p = 0.35$ ), and it was increased during elevation to surface between 25-30 minutes ( $p = 0.15$ ). There was no interaction in the nutritive blood flow ( $p > .05$ ) between treatment (phenolamine perfused probe vs. control probe) and period (pre and post diving, recovery 40 minutes). No interactions were observed between treatment and period ( $p > .05$ ) in glucose, pyruvate, lactate, and glycerol of vastus lateralis muscle.  $H_2O_2$  was not changed in pre diving, post diving and the recovery for 40 minutes ( $p > .05$ ), however it was increased at 60 minutes of recovery compared with 40 minutes of recovery ( $p = .034$ ). **Discussion** Taken together, these results suggest that  $\alpha$ -adrenergic activity by low water temperature do not affect the microvasculature in skeletal muscle of scuba divers have been undergone long-term intermittent cold exposure. The concentration of the metabolites such as glucose, glycerol, lactate, pyruvate might be related to energy metabolism by diving activities in cold water, but not by  $\alpha$ -adrenergic activity. **References** Burkett N, Heijine-Fisher U. (1998). *Internet Sport J*, 78-85. Contact ra89269@hanmail.net

### MYOGLOBIN REGULATES MITOCHONDRIAL RESPIRATION THROUGH ITS INTERACTION WITH COMPLEX IV

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**Purpose** Mitochondria play a principal role for metabolism, and their respiratory capacity regulate energy expenditure. A key enzyme regulating the respiratory capacity is cytochrome c oxidase complex IV. Any deficiency in complex IV would reduce  $VO_2$  and are linked to several diseases, such as mitochondrial myopathy. In muscle, mitochondrial respiration tends to be very sensitive to complex IV activity. Recently, we showed that the muscle-specific protein myoglobin (Mb) interacts with complex IV. Here, we demonstrate that the interaction facilitates the mitochondrial respiratory capacity in skeletal muscles. **Methods** The experiments in the present study were composed of two parts: one utilized Mb overexpressing myotubes, and the other used genetic modification to overexpress or suppress Mb expression. Myotubes were used to investigate the significance of the Mb up-regulation during differentiating period. Myoblasts enabled us to analyze the transient effect of Mb gene modification without effects of endogenous myoglobin. Mitochondrial oxygen consumption using Oxygraph-2k were measured to evaluate phenotype in mitochondrial respiration by Mb gene modification. Immunoprecipitation and immunoblotting in cell fractionations were performed to test the localization of the Mb protein and to investigate its interaction with given proteins in the mitochondria. **Results** Although mitochondrial DNA copy numbers were not altered in Mb-overexpressing myotomes,  $O_2$  consumption was greater in these myotubes than in mock cells. This improved respiratory capacity could arise from the activation of enzymatic activity of respiratory complexes. The experiments show that mitochondrial respiration was up-regulated in myoblasts transiently overexpressing Mb. Only complex IV activity was activated in Mb-overexpressing myoblasts. Complex IV activity was decreased in the myoblasts that Mb expression was suppressed by Mb-siRNA transfection. **Conclusion** We conclude that Mb specifically regulates the



activity of complex IV in skeletal muscles, and that Mb modulates directly skeletal muscle mitochondrial respiration and oxidative capacity.

### **CIRCULATING IRISIN LEVEL AS A PREDICTIVE BIOMARKER FOR SARCOPENIA**

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**Introduction** Myokines are in high on the list of candidate biomarkers of sarcopenia due to its muscle-specificity and endocrine effects. Irisin is one of the recently identified myokines, however, its role of pathological sarcopenia still remains unclear. The objective of the present study is to investigate the validity and accuracy of circulating irisin level as a potential biomarker for sarcopenia. **Methods** We evaluated anthropometrics, body composition, sarcopenia-related parameters and measured serum irisin level in 715 community-dwelling Koreans. Sarcopenia was determined based on a clinical diagnosis of muscle atrophy and weakness. Receiver operating characteristic (ROC) was performed in order to validate the performance of circulating irisin as a biomarker to discriminate between normal and sarcopenia. **Results** Mean circulating irisin levels were significantly decreased in sarcopenia groups regardless of gender (all  $p < 0.05$ ) and a negative correlation between serum irisin concentration and incident sarcopenia was revealed by nominal logistic regression ( $p < 0.001$ ). In logistic regression models, the association persisted after adjustment for characteristic of individuals ( $p < 0.01$ ). Serum irisin concentrations of  $<1.0 \mu\text{g/ml}$  for men and  $<1.2 \mu\text{g/ml}$  for women had the optimal predictive values for sarcopenia, with the area under the ROC curves of 0.873 and 0.685, respectively. In fully adjusted model, the discriminatory potentials improved to 0.942 ( $p < 0.01$ ) for men and 0.804 ( $p < 0.01$ ) for women, respectively. **Conclusion** Decreased circulating irisin level sensitively reflects muscle weakness concomitant with muscle atrophy. Therefore, irisin could be a potential biomarker to predict sarcopenia and provide new avenues for monitoring age-related muscle changes. **Contact** In Deok Kong, MD, PhD: kong@yonsei.ac.kr

### **EFFECTS OF VOLUNTARY EXERCISE AND CALORIC RESTRICTION ON HEPATIC FAT ACCUMULATION IN WBN/KOB-LEPRFA RATS.**

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**Introduction:** Physical exercise and caloric restriction are commonly recommended for prevention and amelioration of obesity and life-style-related diseases, including diabetes and fatty liver. The WBN/Kob-Leprfa (fa/fa) rat is a model of chronic pancreatitis and non-insulin-dependent diabetes with obesity, that has been developed by introducing the mutant leptin receptor fatty gene (Leprfa) derived from the Zucker fatty rat into the original WBN/Kob (lean) rat genome. The aim of the present study was to investigate the effects of voluntary exercise and/or caloric restriction on the hepatic fat accumulation and its relationship to insulin resistance in genetically obese WBN/Kob-Leprfa rats. **Methods :** Male WBN/Kob-Leprfa (fa/fa) rats at 6 weeks of age were randomly assigned to obese (OB;  $n=10$ ), obese-caloric restriction (CR;  $n=8$ ), or voluntary exercise plus caloric restriction (CR+EX;  $n=9$ ) groups. WBN/Kob (+/fa) lean rats served as a control (C;  $n=6$ ) group. The C and OB rats had free access to food. The CR and CR+EX rats had food intake restricted to 69% and 70% of the OB group level, respectively. The CR+EX rats were exercised voluntarily on the wheel ergometer with a load of 30% on their body weight every day. Mean running distance was  $1711 \pm 458 \text{ m/day}$ . After 6 weeks, all rats were prepared for the experiment. The liver was excised and weighed. Hepatic tissues were prepared for transmission electron microscopy. **Results :** The body weights, food intake and epididymal fat weights of the OB rats were significantly greater than the C, CR and CR+EX rats. Electron micrographs of the hepatocytes in both the OB and CR rats revealed lipid droplets accumulation. Voluntary exercise combined with caloric restriction attenuated weight gain, reduced visceral fat weights, increased the soleus muscle weight and significantly reduced the value of HOMA-IR, the serum glucose, triglycerides and free-fatty acids concentrations compared with the OB rats. Furthermore, CR+EX rats showed marked reduction of lipid droplets in the hepatocytes. However, caloric restriction alone elevated the HOMA-IR as OB rats and tended to increase serum free-fatty acid levels compared with the OB rats. **Discussion :** These findings suggest that voluntary exercise combined with caloric restriction improved obesity and insulin resistance in this model of chronic pancreatitis and non-insulin-dependent diabetes with obesity, whereas caloric restriction alone could not. The improvements in insulin resistance by voluntary exercise, may contribute to the amelioration of hepatic fat accumulation as well as lipid metabolism in WBN/Kob-Leprfa (fa/fa) rats. **Contact :** shiroya@wayo.ac.jp

### **EVALUATION OF EXERCISE BENEFITS: TYPE 2 DIABETES DEVELOPMENT IN FRUCTOSE FED RATS**

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**Introduction** Type 2 diabetes (DT2) is a major risk factor of atherosclerosis. As hypertension or dyslipidemia, DT2 can occur in patients with metabolic syndrome and may result in endothelial dysfunction. Physical activity is one of the preventive treatments of endothelial dysfunction. The aims of this study were thus to develop a new animal model of induced DT2 and to investigate the impact of exercise on the DT2 development. **Methods** Male Wistar rats were randomly divided in 4 groups, sedentary (Sed;  $n=8$ ), exercise (Ex;  $n=8$ ), sedentary fructose (SedFF;  $n=8$ ) and exercise fructose (ExFF;  $n=10$ ) with a fructose enriched drink (20% w/v) for 12 weeks. Exercise rats (Ex, ExFF) were trained on a treadmill at moderate intensity (60-70% maximal aerobic speed) for 6 weeks (0° incline, 1h/day, 5 days/week). Rats were weighed, their drink and food consumption were measured weekly. Fasting glycaemia and systolic pressure were monitored. Glucose tolerance was evaluated using an oral glucose tolerance test; insulinemia was measured concomitantly. Endothelial function was studied on isolated aorta rings. Antioxidant enzymes activities (Catalase (CAT), Super oxide dismutase (SOD) and Glutathion Peroxidase (GPx)) were measured on a spectrophotometer in both left ventricle and gastrocnemius muscle. **Results** After 6 weeks of fructose, supplemented rats had a higher energy intake ( $p < 0.001$ ) but were not overweight. These rats also presented an increased fasting glycaemia ( $p < 0.001$ ) and a reduced glucose ( $p < 0.01$ ) and insulin ( $p < 0.05$ ) tolerance. Systolic blood pressure ( $137 \pm 3$  vs.  $111 \pm 2 \text{ mmHg}$ ,  $p < 0.001$ ) and heart weight were also increased ( $p < 0.05$ ). After 12 weeks of fructose supplementation, SedFF rats had an increased weight ( $p < 0.001$ ) and presented insulin resistance (Homeostatic model assessment of insulin resistance (HOMA-IR): SedFF  $2.51 \pm 0.5$ , cut-off value for insulin resistance: 1.85). In FF rats, exercise helped to reduce weight ( $p < 0.001$ ), fasting glycaemia ( $p < 0.01$ ), heart weight ( $p < 0.01$ ) and insulin resistance (HOMA-IR  $p < 0.001$ ). Fructose diet progressively induced an increased in antioxidant enzymes in both studied muscle. On the other hand, exercise reduced antioxidant enzymes activities level independently of the diabetic status. This reduction is supposed to be beneficial. Surprisingly, even though fructose supplementation had no effect on aorta endothelial function, an improvement of this function was observed with moderate exercise in both diabetic and control rats ( $p < 0.01$ ). **Conclusion** In this new model of Wistar rats with induced DT2, moderate

exercise improved some DT2 markers like fasting glycaemia and insulin resistance and as beneficial impact on antioxidant enzyme activities levels. However exercise improves endothelial function independently of diabetic status. Contact Julie.dupas@univ-brest.fr

### EFFECT OF BEETROOT JUICE SUPPLEMENTATION ON MITOCHONDRIAL FITNESS IN HEALTHY ELDERLY MEN.

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**INTRODUCTION** Several studies report relevant benefits of dietary NO<sub>3</sub><sup>-</sup> in athletes. They may also be potentially positive for aging people with exercise intolerance. Aging is associated with functionally impaired mitochondria and increased oxidative stress, but the benefits of dietary NO<sub>3</sub><sup>-</sup> in the elderly remain largely unknown [1]. Mitochondrial activity in human blood cells (PBMCs) has been described in various disease states, linked to physical fitness [2], and considered a potential systemic mitochondrial marker. Hence, we decided to investigate the influence of beetroot juice supplementation on mitochondrial respiration in PBMCs of healthy elderly people. **METHODS** 5 males (68.8±5 yy; 77.3±10 kg; 172.2±6.3 cm; V̇O<sub>2</sub>peak 39.2±4.2 mL/kg/min) participated in a randomized, double blind, cross-over study. Baseline measurements (V̇O<sub>2</sub>peak, blood sampling) were carried out before the treatment and after 6 days of concentrated beetroot juice supplementation (or placebo). Mitochondrial respiration was assessed in freshly purified human PBMCs with a OROBOROS O-2k. ROUTINE respiration (R), Complex I-linked LEAK, OXPHOS capacity (CI), CI&II-linked OXPHOS and ETS capacity were determined in a single SUIT protocol. **RESULTS** Concentration of leukocytes did not change before and after the treatment. Tukey's multiple comparison test showed that NO<sub>3</sub><sup>-</sup> supplementation significantly increases (p<0.05) flux control ratios associated to basal metabolism (ROUTINE) and CI oxidative activity (5 and 6% respectively). Data relative to O<sub>2</sub> specific flux supported by CI&II and the ETS state were significantly increased from 43±15 to 58±21 (p<0.05), while RCR was significantly reduced (p<0.05). A significant relationship between age, V̇O<sub>2</sub>peak and respiratory ratios associated to complex I and ETS was found at baseline. **DISCUSSION** The preliminary results obtained in 5 subjects (on-going study) suggest that PBMCs are suitable cells to investigate the mitochondrial adaptations to nitrate supplementation in healthy, elderly subjects. There is a growing interest in the use of NO<sub>3</sub><sup>-</sup> supplementation also for therapeutic aims (COPD, hypertension, heart failure and insulin resistance). Recent studies investigated the effects of dietary NO<sub>3</sub><sup>-</sup> on skeletal muscle, leading to variable and controversial results affected also by O<sub>2</sub> availability [1,3]. The evidence that beetroot juice affects the pattern of mitochondrial bioenergetics in PBMCs opens the possibility to easily monitor adaptations in longitudinal studies and to further understand the mechanistic details of NO<sub>3</sub><sup>-</sup> response. 1 Affourtit C et al., *Frontiers in Phys.* doi: 10.3389/fphys.2015.00211 2 Tyrrell DJ et al., (2015) *Exp Gerontol.* doi: 10.1016/j.exger.2015.07.015. 3 Whitfield J et al., (2016) *J Physiol.* Jan 15;594(2):421-35.

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### PO-CPP-23 Rehabilitation & Physiotherapy 2

#### EVALUATING THE EFFECTIVENESS OF A PILATES BASED EXERCISE PROGRAMME FOR THE REDUCTION OF PERCEIVED FUNCTIONAL DISABILITY AND PAIN ASSOCIATED WITH NON-SPECIFIC CHRONIC LOW BACK PAIN.

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Non-specific low back pain (LBP) has become a major health problem and is, by definition, a symptom of unknown cause. Approximately one-third of the adult population is affected by LBP and the related costs have now reached epidemic proportions. Health care resources in the current economic climate are limited and more cost effective methods for the treatment and management of non-specific LBP need to be established. Pilates based exercise is becoming increasingly incorporated in to spinal rehabilitation, yet there is limited evidence on the efficacy of the technique. The aim of this study was to evaluate the effectiveness of a 6-week Pilates based exercise programme for the reduction of perceived functional disability and pain associated with non-specific chronic low back pain. Subjects (n=13) with chronic non-specific LBP (>12-weeks) were recruited to a wait-list controlled trial. All subjects were assigned to a 6-week control period (WLC) and a subsequent one hour Pilates based exercise intervention (PI), twice per week, for 6-weeks. Outcome measures for perceived functional disability and pain were assessed pre/post control and intervention periods with the Oswestry functional disability questionnaire (ODQ) and visual analogue scale (VAS) respectively. Results from a related samples Wilcoxon signed rank test revealed a significant (p<0.01) improvement in ODQ scores after the 6-week Pilates intervention. A paired samples t-test revealed no significant difference in VAS scores (t=1.21; df=11; p>0.05) post intervention for the PI group. The findings of this research concluded that a 6-week Pilates based exercise programme was effective in reducing perceived functional disability but not pain associated with non-specific chronic LBP. These results should be viewed cautiously due to the study design, limited sample size and short duration of the intervention. Future research should consider a randomised wait-list controlled trial of greater duration and sample size to ascertain the long term effectiveness of Pilates based exercise for chronic non-specific LBP.

#### SENSORIMOTOR TRAINING VS. REACTIVE BALANCE TRAINING: SPECIFIC STIMULI INDUCE SPECIFIC NEUROMUSCULAR AND FUNCTIONAL ADAPTATIONS

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**Introduction** Balance training is widely applied in different settings of rehabilitative medicine (Silva et al. 2015) and as a training method for fall and injury prevention (Pan & Bai 2014). Typically, two types of balance modality can be classified according to their biomechanical constraints, and thus result in different strategies of compensating for dislocated masses: sensorimotor training (SMT) referring to a static ledger pivoting around the ankle joint vs. reactive balance training (RBT) challenging equilibrium via externally applied perturbations of the support surface. Possible differences in task-specific functional outcomes between the two modalities have not been profoundly studied. The objective of the study was to investigate the specificity of neuromuscular adaptations in response to SMT and RBT within a test-intervention paradigm. **Methods** Thirty-eight subjects were assigned to either SMT or RBT. Before and after four weeks of intervention training, postural sway and electromyographic activities of shank and thigh muscles were recorded and co-contraction indices (CCI) were

calculated. We argue that specificity of training interventions could be transferred into corresponding test settings containing properties similar to those of SMT and of RBT, respectively. Results i) Postural sway was reduced in both intervention groups in all test paradigms; magnitude of changes and effect sizes differed dependent on the paradigm: when training and paradigm coincided most, effects were augmented ( $P < 0.05$ ). ii) These specificities were accompanied by segmental modulations in the amount of CCI, with a greater reduction within the CCI of thigh muscles after RBT compared to the shank muscles after SMT ( $P < 0.05$ ). Discussion The results clearly indicate the relationship between test and intervention specificity in balance performance. When intervention and test paradigm coincided, effects were augmented; thereby neuromuscular segmental distinctions occurred to a larger extent in the proximal body segment in the RBT-group and in the distal segment in the SMT-group. Based on the current findings, RBT could serve as a further expansion to include the proximal segment into training. Considering fall or injury mechanisms, it is supposed that when the available torque at the ankle joint is not sufficient, regaining stability requires resorting to more proximal strategies (Bobrova et al. 2009). Hence, the strategy to precisely control the upper body segment oscillations contributes to determine the risk of falling (Bobrova et al. 2009). References Silva P et al. (2015). J bodywork and movement therapies, 19(3): 453–457. Pan X & Bai J (2014). Int J Nurs Sci, 1(4): 441–445. Bobrova et al. (2009). Biophysics, 54(5): 648–651. Contact kathrin.freyler@sport.uni-freiburg.de

## EFFECTS OF AEROBIC WARM-UP ON FLEXIBILITY AND ISOMETRIC STRENGTH AFTER STATIC STRETCHING

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Introductions Many previous studies have proposed that static stretching before competitive sports should be avoided (Behm et al., 2011) because performance decreases immediately after static stretching. Warm-up programs before sports practice comprises aerobic warm-up following static stretching. However, the effects of aerobic warm-up after static stretching are unclear. If aerobic warm-up recovers the decrease in performance after static stretching, it may be possible to use static stretching beneficially, because it prevents muscle-tendon related injuries (Amako et al., 2003). Purpose The aim of this study was to elucidate the effects of aerobic warm-up after static stretching on flexibility and isometric strength in the ankle joint. Methods Fourteen healthy male subjects (age:  $23.9 \pm 2.2$  years) performed in two separate randomized groups: (1) control group and (2) warm-up group. Subjects enrolled in the control group performed 10-min rest after 5-min static stretching. Subjects enrolled in the warm-up group performed 10-min aerobic warm-up using a cycling ergometer (60 W, 60 bpm) after the static stretching. Muscle tendon unit (MTU) stiffness from 15 to 25 degrees of ankle dorsiflexion, ankle dorsiflexion range of motion (ROM), passive torque at ROM maximum, and peak torque during isometric contraction of ankle plantar flexion were measured using an isokinetic dynamometer. Results In the control group, ROM ( $26.8 \pm 7.5$ – $28.9 \pm 7.6$  degrees,  $p < 0.05$ ), MTU stiffness ( $0.69 \pm 0.19$ – $0.54 \pm 0.12$  Nm/degree,  $p < 0.05$ ), and peak torque during isometric contraction ( $111.6 \pm 32.7$ – $90.6 \pm 33.3$  Nm,  $p < 0.05$ ) were significantly different; however, passive torque at ROM maximum did not change significantly ( $25.6 \pm 7.3$ – $27.6 \pm 7.5$  Nm,  $p = 0.52$ ). In the warm-up group, ROM ( $25.0 \pm 5.9$ – $29.3 \pm 6.5$  degrees,  $p < 0.05$ ), passive torque at ROM maximum ( $24.4 \pm 7.4$ – $28.7 \pm 7.4$  Nm,  $p < 0.05$ ), and MTU stiffness ( $0.68 \pm 0.18$ – $0.53 \pm 0.18$  Nm/degree,  $p < 0.05$ ) were significantly different; however, peak torque during isometric contraction ( $112.8 \pm 33.6$ – $118.5 \pm 36.6$  Nm,  $p = 0.18$ ) did not change significantly. Conclusions The results indicated that aerobic warm-up recovers the negative effects of static stretching in relation to decrease of isometric strength. References Behm DG, Chaouachi A. A review of the acute effects of static and dynamic stretching on performance. Eur J Appl Physiol. 2011 Nov;111(11):2633–51. Amako M, Oda T, Masuoka K, Yokoi H, Campisi P. Effect of static stretching on prevention of injuries for military recruits. Mil Med. 2003 Jun;168(6):442–6.

## INTRA-RATER RELIABILITIES OF ANKLE DORSIFLEXION STRENGTH EVALUATION USING THE ORIGINAL COSTUMED DEVICE IN WEIGHT BEARING POSITION

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Introduction Since malalignment of the lower limb results in the risk of the lower limbs injuries, it is important to evaluate the posture during basic physiological activities, such as squat and jump landing. Deficits of ROM or dorsiflexion strength in ankle joint are risk factors of knee and ankle injuries. Therefore, it is essential to evaluate the joint movement on sagittal plane because all lower extremity joints are needed to have flexibility in weight bearing position for absorbing the landing force during dynamic performances. Limitation of ankle dorsiflexion ROM and deficit of ankle dorsiflexion strength interfere with dynamic performance. Some researchers measure ankle dorsiflexion strength using a handheld dynamometer (HHD). However, most researches had assessed the ankle dorsiflexion strength with the subjects in a supine position. We consider that it is more valid to measure it in weight bearing position than in non-weight bearing position. Furthermore, HHD is easy to use, and is portable, but it is not certain if HHD has reliability for measuring isometric ankle dorsiflexion strength. The purpose of this study was to confirm the intra-rater reliabilities of dorsiflexion strength assessment using HHD in the subjects with weight bearing position. Methods 18 subjects with no injury of lower extremity participated in this study. Although HHD is useful to assess strength of the muscles, if not for stabilizing firmly, it could not actually measure the strength. Therefore, we used the costumed device holding HHD to measure ankle dorsiflexion strength. The subjects were seated on a chair in 90 degrees of the knees flexion and placed their foot under the device to which HHD was fixed. The examiner adjusted the device to keep the subjects with 0 degree dorsiflexion of ankle joint. HHD was placed above the dorsal side of the metatarsal bone. The subjects were asked to press HHD as much as possible strongly by dorsiflexion. The subjects exerted maximal dorsiflexion force for 5s and their maximal isometric force were recorded. The test procedure was repeated 3 times on each side. All tests were performed by one examiner (physiotherapist). Intra-class correlation coefficient (ICC) was used to confirm the inter-rater reliabilities. Results Mean dorsiflexion strength was  $20.4 \pm 5.1$  kgf (right side  $20.7 \pm 5.7$  kgf / left side  $20.1 \pm 4.4$  kgf). Intra-rater reliabilities of dorsiflexion strength testing were excellent (ICC=0.82, 95%CI 0.72 to 0.90). Evaluation of the ankle dorsiflexion strength with HHD has excellent intra-rater reliability. Discussion The measurement of isometric ankle dorsiflexion strength using HHD seems to be a reliable method. While a therapist measure ankle dorsiflexion strength using HHD, it is difficult to stabilize HHD. However, using our measurement technique, it could be measured easily and excellent reliability with weight bearing position. References Moraux, A. (2013). BMC musculoskeletal disorders, 14, 104. van der Heijden, RA. (2015). International journal of sports medicine, 36, 1201. Contact masahiro@hokusho-u.ac.jp

## PHYSICAL ACTIVITY LEVEL IN INPATIENTS WITH CHRONIC MUSCULOSKELETAL PAIN DURING MULTIDISCIPLINARY REHABILITATION

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**Introduction** Severe orthopedic trauma often leads to chronic disabilities and pain that induce reduced daily physical activity and deconditioning. To enhance recovery, intense multidisciplinary rehabilitation is advised. In addition to specific interventions aimed at treating pain and disabilities, an important therapeutic goal of multidisciplinary rehabilitation is to increase the physical activity level (PAL). To assess the efficacy of physical activity promotion, the main objective of the present study was to measure PAL of inpatients in rehabilitation stay as compared to PAL at home. Furthermore, we sought to determine whether change in PAL was mediated by a modification of walking behavior. **Methods** The study included 124 patients with chronic musculoskeletal pain after an orthopedic trauma. They stayed in the CRR for 4 to 6 weeks. Each weekend, the patients went back to home for 2 days (days off). During the second week of the stay, from Thursday to the next Wednesday, the participants wore an accelerometer. As a proxy for PAL, we computed the proportion of waking time spent in moderate intensity activities (e.g. walking), expressed as percentage. In addition, each walking bouts were specifically detected in the acceleration signals, and the proportion of long duration walks (>1 min.) as compared to total walking time was assessed. We separately analyzed the week days (at the clinic) and the weekend days (at home). Moreover, in a subset of 32 subjects, we analyzed PAL at home during one week before the hospitalization. **Results** In the subset of 32 patients, we observed no significant PAL differences between the weekend during the stay and the week before hospitalization: the proportion of time spent in moderate intensity activities was similar (8.7% vs. 8.9%). On the other hand, in the full set (N=124), a substantial difference existed between the weekend (days off at home) and the week (at the clinic): 8.6% vs. 12.3%, i.e. +43% increase). We observed a parallel change in walking behavior between the days off and the week: the proportion of long duration walks increased from 25% to 46% (+86%). **Discussion** We found that it is very possible to take advantage of the days off spent home during the hospitalization to assess the habitual PAL. We determined that the rehabilitation cares induced a substantial increase in PAL (+43%). In addition, the patients undertook more long walks, the proportion of which almost doubled during the rehabilitation week. We conclude that multidisciplinary rehabilitation is effective to increase the patients' participation in walking activities, which enhance PAL. Contact [Philippe.Terrier@crr-suva.ch](mailto:Philippe.Terrier@crr-suva.ch)

## LOW INTENSITY ISOMETRIC HANDGRIP EXERCISE HAS NO TRANSIENT EFFECT ON BLOOD PRESSURE IN CORONARY ARTERY DISEASE PATIENTS

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**Objective:** Hypertension is highly prevalent among patients with coronary artery disease (CAD). Exercise-based cardiac rehabilitation is known to reduce blood pressure (BP). However, less is known about the transient effect of a single bout of exercise. Isometric handgrip exercise has been proposed as a non-pharmacological tool to lower BP, but its potential has not yet been evaluated in CAD patients. Therefore we aimed to investigate the acute effect of low intensity isometric handgrip exercise on BP measured shortly after exercise in the office and during the subsequent 24 hrs during daily life activities in CAD patients. **Methods:** Twenty one male CAD patients (median age 68; range 55-70) participating in a phase III cardiac rehabilitation program were included. All patients completed two experimental sessions in random order: one control session and one low intensity isometric handgrip session. BP was measured by means of a 24h ambulatory BP monitor pre-intervention, for one hour in the office and subsequently for 24 hrs during their daily practice. Physical activity was assessed by means of a SenseWear device. **Results:** Baseline BP averaged  $136.1 \pm 11.1/78.3 \pm 6.8$  mmHg and was similar at both test occasions ( $p > 0.05$ ). Following the experimental sessions, we observed a time-effect for office BP and HR ( $p < 0.001$ ) which was not different on both days ( $p$ -interaction  $> 0.05$  for all). During normal daily activities, no significant differences between both test days was found in 24h, daytime and nighttime BP and HR ( $p > 0.05$  for all). No adverse events occurred. **Conclusions:** Low intensity isometric handgrip exercise is safe in stable CAD patients but does not induce a transient reduction in BP during daily life activities. Further research investigating the longer-term effects of isometric handgrip training is still warranted.

## THE BENEFITS OF PRESCRIBING LOW INTENSITY RESISTANCE EXERCISE DURING HEMODIALYSIS ON PHYSICAL FITNESS AND SERUM LIPID PROFILE IN END STAGE RENAL DISEASE PATIENTS

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**Objective** The purpose of this study was to determine the effects of prescribing low intensity resistance exercise during hemodialysis (HD) on physical fitness and serum lipid profile in end stage renal disease patients. **Subjects** Seventeen Japanese patients participated in this study (male; 12, female; 5, age;  $70.9 \pm 10.7$  years old, dialysis history;  $6.1 \pm 5.3$  years). All the participants were diagnosed as stage 5 chronic kidney disease and received HD three times per week at NTT Medical Center Tokyo. **Methods** Ethical approval was provided after the subjects performed written informed consents. Physical therapists prescribed the patients our original tube exercise program for upper major muscle (3 types; pectoralis major, back muscles and hand grip), lower major muscle (6 types; quadriceps femoris, hamstrings, gluteus maximus, gluteus medius, adductor muscles, triceps surae) and trunk (abdominis) by using the Thera band®. The participants were asked to perform 3 sets of 10 repetitions while they were treated with a HD session of 30 min through 24-week intervention period. Exercise intensity was set at 11-13 in Borg's scale. Muscle strength (quadriceps femoris (QF), pectoralis major (PM) and 30-second sit to stand test), 6 minutes walk test, 10 meters walk test and Time up and go test were evaluated at baseline, 4 week, 8 week, 12 week and 24 week of this trial. Serum total cholesterol (T-cho) and triglyceride (TG) level were measured every 4 weeks from 8 weeks before the start of intervention to 24 weeks. The study periods were divided into 3 segments: the first third, pre-intervention (PRE); the second third of the study period (ST); and the last third (LT). Averages of serum T-cho and TG level of each segment were compared. **Results** No musculoskeletal and/or cardiovascular complications, which were induced by the exercise program, were recognized. Significantly improved muscle strength was observed; as follows QF ( $73.7 \pm 25.2$  Nm to  $83.2 \pm 27.2$  Nm,  $p < 0.05$ ) and PM ( $26.7 \pm 11.3$  Nm to  $31.6 \pm 11.3$  Nm,  $p < 0.05$ ) after 24 week. The baseline 30-second sit to stand test of  $16.5 \pm 5.0$  significantly increased up to  $19.7 \pm 6.1$  ( $p < 0.05$ ) after 12 week and  $20.6 \pm 6.6$  times ( $p < 0.05$ ) after 24 week. With respect to serum lipid profile, reduction of TG was observed in PRE vs. LT ( $111.5 \pm 46.6$  mg/dl to  $95.2 \pm 33.7$  mg/dl,  $p = 0.06$ ), while T-cho did not changed. **Conclusion** The low intensity resistance exercise during hemodialysis for patients with end stage renal disease could improve muscle strength (QF, GP and 30-seconds sit to stand test) in safe, and it might slightly impact on serum triglycerides level.



## Conventional Print Poster

## PO-CPP-27 Training &amp; Testing 4

**HYDRATION STATUS, NEUROMUSCULAR RESPONSES, AND COMPETITIVE STATE ANXIETY IN PROFESSIONAL TENNIS PLAYER DURING OFFICIAL COMPETITION**

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**Introduction:** Tennis is a racquet sport with thousands of followers around the world. During non-official competition, physiological and psychological variables have been studied. Data from the hydration status (Hornery et al., 2007) indicates that tennis players compete hypohydrated but does not sustain important dehydration during a match. Likewise, neuromuscular fatigue has not been evidenced after a tennis match (Ojala & Hakkinen, 2013). In addition, before a match, competitive state anxiety (CSA) showed changes in somatic and cognitive anxiety (Filaire et al., 2009). On the other hand, during official competition (ATP/WT, Challenger and Futures), professional players are awarded with prize money/points for the ATP ranking, which could be associated with higher physiological demands and increased competitive anxiety. The aim of this study is to describe hydration status, neuromuscular responses, and CSA in professional tennis player during an official competition. **Methods:** During the qualifying draw from a \$10000 ITF Future tournament, 9 professional male tennis players (3 with ATP ranking between 1400-1800 and 6 between 50-180 in the national ranking) were assessed using, a battery of physiological and psychological measurements. Before the match, hydration status was assessed by urinary specific gravity (USG), and fluid balance was assessed by pre and post-match body weight changes. Before, and after match, neuromuscular fatigue was assessed by counter movement jump (CMJ) and competitive state anxiety was measured using a validated questionnaire (CSAI-2R). **Results:** USG before the match was  $1.026 \pm 0.002$ . After the match participants lost  $1.2 \pm 0.2\%$  of their body weight. CMJ decreased a  $4.85 \pm 1.4\%$  after match not reaching statistical significance ( $p=0.203$ ). Before match, CSA scores for somatic and cognitive anxiety indicated medium to lower values. **Discussion:** As it was described in non-official matches, professional tennis players began official matches in a hypohydrated status. However the beverages ingestion during the match avoided significant dehydration and there were no evidence of neuromuscular fatigue. Our findings suggest that in spite of the special considerations that an official tennis match represents, CSA profile is lower in comparison to a non-official competition. **References:** Hornery DJ, Farrow D, Mujika I, Young W. (2007). Br J Sports Med. 41(8) 531-536 Filaire E, Alix, D, Ferrand C, Verger M. (2009). Psychoneuroendocrinology, 34(1), 150- 157. Ojala T, Hakkinen K. (2013). J Sports Sci Med, 12(2), 240-248. Contact: alvarolsamanes@gmail.com

**EXTERNAL LOAD ASSESSMENT DURING SMALL SIDED GAMES IN SOCCER: INFLUENCE OF PITCH SIZE AND GOAL-KEEPER PRESENCE**

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**Introduction** Several studies aimed to analyze the time motion characteristics using speed thresholds and the physiological responses (1) in soccer small sided games (SSGs). Recently the global position systems technology (GPS) allows to quantify the players acceleration (3). In this study we quantified external load during SSGs with different pitch sizes and with or without goalkeeper (GK) by using acceleration data as novel methodology. **Methods** 12 amateur soccer players took part in the study during in-season period. A total of 91 drills were monitored in 4 conditions: 2 SSGs in a 30x20 m field with (S-GK) and without GK (S) and 2 SSGs in a 40x30 m field with (L-GK) and without GK (L). Every 4-players SSGs lasted 4 x 4 minutes with 3 minutes of recovery and during these each player wore a GPS device (Viper, StatSport, UK). Differences between SSGs format were assessed for total distance covered (TD) and distance covered in six different speed zones (D): walk, jogging, medium, high and very high speed and sprinting. Also we considered the total number of accelerations (ACC) and decelerations (DEC) phases and those performed in different intensity zones. Every difference were assessed using one-way ANOVA with Bonferroni adjusted 95% confidence intervals. **Results** The results are shown as mean difference [95% CI's]. The total distance covered (TD) was higher in L-GK and L ( $470.8$  [ $462 - 478.6$ ] m and  $467.3$  [ $455.3 - 479.2$ ] m respectively) than in S-GK and S ( $372.6$  [ $364 - 381.3$ ] m and  $410.5$  [ $402.8 - 418.1$ ] respectively) ( $p < 0.001$ ). TD is also higher in S than in S-GK ( $p < 0.001$ ). The number of both ACC and DEC was higher in L-GK ( $51.8$  [ $50.6 - 53.0$ ] and  $48.1$  [ $47.0 - 49.3$ ] respectively) than other SSGs ( $p < 0.001$ ) while in L there was the lowest number of ACC and DEC ( $47.2$  [ $45.9 - 48.5$ ] and  $45.4$  [ $44.1 - 46.7$ ] respectively) ( $p < 0.001$ ). No significant differences between L and S-GK were found. Furthermore, we found several differences among SSGs format in acceleration activities distribution. **Discussion** In agreement with previous study higher TD were measured in larger pitch size, however the GK influences TD only in small pitch. The differences found in accelerations profile can help coaches to propose the correct muscular load and acceleration patterns using SSGs with different rules. **References** 1. Rampinini, E. et al (2007). Factors influencing physiological responses to small-sided soccer games. J Sp Sci, 25, 659-666 2. Hodgson C, et al. (2014). Time-motion analysis of acceleration demands of 4v4 small-sided soccer games played on different pitch sizes. Hum Mov Sci, Feb, 33, 25-32.

**A COMPARISON OF U18 SCHOOL AND ACADEMY RUGBY UNION MATCH PLAY**

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**Introduction** Understanding the physical demands of rugby union can assist coaches in the preparation of players. Match demands in senior players for domestic competitions (Cahill et al., 2013) and international games (Quarrie et al., 2013) are well established. However, despite adolescent rugby union players playing concurrently at various standards, there is no study that has attempted to compare them. Therefore, the purpose of this study was to compare the physical demands of U18 school vs. academy rugby union match play. **Methods** A full season of games from the academy (6 games) were analysed and matched by six games from the school standard. Each player wore a microtechnology unit which contained a global positioning system and tri-axial accelerometer in addition to a heart rate monitor. The players were split into forwards and backs with only players who participated in the entire game included in the subsequent analysis (Forwards; school [ $n=25$ ], academy [ $n=21$ ] and Backs; school [ $n=25$ ], academy [ $n=24$ ]). All data were analysed using magnitude based inferences. Institutional ethical approval was granted. **Results** Forwards: Total distance was almost certainly greater in academy forwards

(5461 ± 360 vs. 4881 ± 388 m). Distance walking was unclear between the two groups, but jogging, striding and sprinting was almost certainly, very likely and likely greater in academy forwards in comparison to school forwards. PlayerLoadTM slow was possibly greater for academy forwards whilst heart rate mean and maximum was likely lower for academy forwards. Backs: Total distance was very likely greater in academy backs (5597 ± 383 vs. 5260 ± 441 m). Distance walking and sprinting was unclear. Distance jogging was almost certainly greater in the academy backs and striding was possibly greater. PlayerLoadTM slow was possibly greater in academy backs whilst heart rate mean and maximum was unclear between the two groups. Discussion This study shows that academy rugby union provides forwards and backs with a greater physical demand than school players of the same position. The increase in PlayerLoadTM slow suggests an increase in static exertions for academy players. Future research should look to explore the interaction between physical and technical performances between different standards of adolescent rugby union. References Cahill, N. Lamb, K. Worsfold, P. Headey, R. & Murray, S. (2013) The movement characteristics of English Premiership rugby union players. *Journal of Sports Science*, 31 (3), pp. 229-237. Quarrie, K.L., Hopkins, W.G., Anthony, M.J., & Gill, N.D. (2013). Positional demands of international rugby union: Evaluation of player actions and movements. *Journal of Science and Medicine in Sport*, 16 (4), pp. 353-359. Contact Address correspondence to Dale Read, d.read@leedsbeckett.ac.uk authors here

## ANALYSIS OF PERFORMANCE IN DIFFERENT AGILITY TESTS IN YOUNG SOCCER PLAYERS

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Introduction: Agility, described as the ability to perform quick runs with directional changes, is an important component of soccer performance (Sheppard J.M. et al. 2006). Agility is a complex capacity (Young W.B. et al. 2002) and further information are needed to better elucidate its reproducibility and the different skills affecting performance during sprint/ agility tests. Therefore, the aim of the present study was to: i) determine the reliability of three different sprint/agility tests; ii) examine any existing relationships among the tests and iii) analyse their physical characteristics. Methods: Ten young soccer players from the same professional team (16.9±0.3 years; 178.7±4.8 cm; 68.8±5.6 kg) were involved in the study. The participants carried out two testing sessions separated by one week. Each testing day included three trials of following three tests: 1) 20-m straight sprint 2) Sprint with 90° turns and 3) Sprint with 90° turns dribbling with the ball (Sporis G. et al. 2010). Performance was measured using photoelectric cells (Optojump, Microgate, BZ, Italy), and GPS (Qstarz 15 Hr, Italy). Only the best trial was considered and the following parameters analysed: time, maximal speed (MS), mean power (MP), mean power in change of direction (CODMP). Results: A significant difference in performance time between Sprint and Agility with ball in test-retest was 3.2±0.1 vs 3.1±0.1s (p<0.01), 9.1±0.4 vs 8.9±0.5 (p<0.01), respectively. The coefficients of variation between the test-retest were: 1.8 ± 1.3, 2.8 ± 1.9% and 2.3 ± 1.0% for Sprint Agility and Agility with ball, respectively. No correlation in performance time were observed between 20-m Sprint and Agility (r=0.11 p>0.05), Sprint and Agility with ball (r=0.33 p>0.05) as well as Agility and Agility with ball (r=0.16 p>0.05). No differences (p>0.05) were noted in CODMP between Agility and Agility with ball 25.9±1.7 vs 24.2±2.0 W\*kg<sup>-1</sup> (p>0.05). Significant differences (F=966.5 p<0.001) in MP were shown between 20 m sprint vs agility (p<0.001), 20-m sprint vs agility with ball (p<0.001) and agility vs agility with ball (p<0.001). Discussion: A variation was observed in performance time between the test-retest indicating high sensitivity and the need of a familiarization period when performing sprint/ agility tests. The pronounced differences in MP together with the absence of relationships found among the three different tests suggest that different abilities upregulate performance during sprint, agility and agility with ball. References: Sheppard J.M., Young W.B. (2006). *J Sports Sci*, 24(9):919-32. Sporis G., Jukic I., Milanovic L., Vucetic V. (2010) *J Strength Cond Res*, 24(3):679-86. Warren B., Young, Mark H., Mcdowell, and Scarlett B., (2010). *J Strength Cond Res* 15(3), 315-319 Young W.B., James R., Montgomery I. (2002). *J Sports Med Phys Fitness*, 42(3):282-8

## DO TRAINING EXPOSURES PREPARE ADOLESCENT RUGBY UNION PLAYERS FOR MATCH-PLAY?

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Introduction The aim of the study was to assess the differences in external training loads and movement demands between training and match-play in adolescent rugby union (RU) players. For mean training and match demands to be similar, athletes would have to be exposed to the equivalent loading of multiple matches within their training week, which may be impractical. An alternative analysis of comparing maximum demands instead of mean demands between conditions may offer a more appropriate comparison. Methods Sixty-one adolescent RU players (mean ± SD; age 17.0 ± 0.7 years) were recruited from four teams representing school and regional academy. Players were categorized into four independent groups based on playing standard and position; school forwards (SF; n=15), school backs (SB; n=15), academy forwards (AF; n=16) and academy backs (AB; n=15). Global positioning system and tri-axial accelerometer data were obtained from 61 match files during 6 matches, and 152 training files during 15 training sessions. Maximum data from individual training sessions that elicited the highest value for each variable were used in the comparison to match-play. This approach was used to account for variance in specific training objectives for respective sessions (e.g. collision or running focus), as mean data may dilute the magnitude of exposure for specific loads within the training week. Differences between training and match-play measures were analysed using paired t-tests, Cohen's d effect sizes with 90% confidence interval. Results Within the SF group, training was significantly greater than matches for total and relative high speed running (HSR ≥61% maximum velocity (Vmax)) and HSR-min-1), total and relative very high speed running (VHSR >90% Vmax) and VHSR-min-1), and relative peak velocity (%Vmax). Contrastingly, in the SB group, training were significantly less than match play for total distance (TD), %Vmax, VHSR and VHSR-min-1. Within the AF group, match-play was significantly greater than training for relative low speed activity (LSA-min-1 <61% Vmax). Finally, within the AB group, training was significantly greater than match-play for relative PlayerLoadTM (PL-min-1) and HSR-min-1. Discussion Players from a higher representative standard (i.e. academy) were exposed to external loads and movement demands during their training week comparative to the demands of match-play. However, within schools, due to positional differences during match-play, training sessions may under-prepare backs and over-prepare forwards. Coaches should ensure that training sessions reflect the standard- and position-specific demands of match-play to adequately prepare players for competition.

## Conventional Print Poster

## PO-CPP-31 Training &amp; Testing 5

**EFFECT OF INTENSIFIED STEP AEROBICS TRAINING ON NEURAL AND MUSCULAR FUNCTION OF THE PLANTAR FLEXORS IN PATIENTS WITH OSTEOPOROSIS**

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**Introduction** Muscle strength is a major factor in balance control, gait performance and the occurrence of falls in elderly people[1]. This aspect is especially important for osteoporotic patients who have an increased risk for fall-related fractures. This study investigated the effect of intensified step aerobics training on maximum voluntary contraction strength, neural activation and muscular function of the plantar flexors in older osteoporotic patients. **Methods** Twenty-seven patients (mean age 75 yrs) were randomized into control (n = 14) and intervention groups (n = 13). The intervention group received a supervised intensified step aerobics training (twice weekly, 1 h per session) over 6 months. Neuromuscular function was investigated before, and after 3 and 6 months of training using electrical stimulation of the posterior tibial nerve. Isometric explosive and maximum voluntary contraction strength, normalized muscle activity of triceps surae and tibialis anterior, electrically evoked spinal reflex responses of the soleus muscle (H-reflex at rest, V-wave) and peak twitch torque of the plantar flexors were analyzed. The statistical approach comprised an analysis of covariance (ANCOVA) with baseline measurement and sex entered as covariates. **Results** After 3 and 6 months of training, maximum voluntary contraction strength in the intervention group was significantly higher by 7.7 Nm (9.1%; 95%CI: 3.3-12.2 Nm, P = 0.002) and 12.4 Nm (14.8%; 95%CI: 6.4-18.5 Nm, P = 0.001) compared to controls. These changes were due to neural and muscular adaptations indicated by an increased V-wave and a heightened peak twitch torque at rest. Furthermore, after 6 months of training, isometric explosive voluntary strength in the time interval 0-50 ms was significantly higher for the intervention group. **Discussion** Our data indicate that the training regimen can be recommended to improve neural and muscular function of the plantar flexors in older osteoporotic patients. High moments have to be generated by the muscles of the lower limbs to ascend and descend the step board[2]. This might have stimulated neural and muscular adaptations comparable to those induced by strength training. [1]Wolfson L, Judge J, Whipple R, King M. (1995). *J Gerontol A Biol Sci Med Sci*, 50, 64-67. [2]Andriacchi TP, Andersson GB, Fermier RW, et al. (1980). *J Bone Jt Surg*, 62-A, 749-757.

**RELATIONSHIP BETWEEN ONE-LEG STANDING ABILITY AND RATE OF FORCE DEVELOPMENT IN COMMUNITY-DWELLING ELDERLY PEOPLE**

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**Introduction** The rate of force development (RFD), which is defined as explosive muscle strength, increases with maximum voluntary contraction (MVC). However, previous studies reported that early-phase RFD in the time interval of up to 40 ms from onset of contraction, which may be primarily influenced by neuromuscular adaptations, has not been associated with MVC (Gruber, 2004; Andersen, 2006). In addition, while lower limb muscle strength is known to contribute to performance during standing in elderly people, few studies have examined the relationship between standing ability and early-phase RFD. The purpose of this study was to investigate the influences of RFD on standing ability in elderly women. **Methods** The subjects comprised 125 community-dwelling elderly women (mean age, 73.5 years). One-leg standing time (OLST) with eyes open, which was used to represent standing ability, was measured for a maximum of 180 s. Isometric strength of knee extension (MVC) at 90° flexion position was measured by using a dynamometer. RFD was defined as the slope of the force-time curve from the onset of contraction (from 2.5% of MVC). The subjects were asked to exert force as fast as they could. Early- and late-phase RFD, which were defined as time intervals of 0-30 and 0-200 ms respectively, were calculated from the mean RFD. Peak RFD was also calculated as RFDmax. Stepwise regression analysis was performed with OLST as dependent variables, and age, MVC, RFDmax, and early- and late-phase RFD as independent variables. **Results** The OLST was  $67.2 \pm 63.6$  s. The MVC was  $257.4 \pm 64.1$  N. The RFDs were as follows: maximum,  $2.19 \pm 1.02$  N/ms; early phase,  $1.38 \pm 0.99$  N/ms; and late phase,  $1.02 \pm 0.35$  N/ms. Stepwise regression analysis revealed that age (standardised coefficient = -0.356) and early RFD (standardised coefficient = 0.281) were significant and independent determinants of OLST. MVC, RFDmax, and late RFD were not identified as significant determinants of OLST. **Discussion** This study showed that only early-phase RFD was associated with OLST. Our results suggest that early-phase RFD (<30 ms) may be more important for one-leg standing ability than MVC or maximum RFD in elderly people. **References** Markus Gruber, Albert Gollhofer. Impact of sensorimotor training on the rate of force development and neural activation. *Eur J Appl Physiol*. 2004; 92: 98-105. Lars L. Andersen, Per Aagaard. Influences of maximal muscle strength and intrinsic muscle contractile properties on contractile rate of force development. *Eur J Appl Physiol*. 2006; 96: 46-52. Contact: kato.takehiro.47n@st.kyoto-u.ac.jp

**COMPARISONS OF WALKING-BASED TRAINING TECHNIQUES IN COPD**

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**Background** Low exercise capacity is a negative prognostic factor in COPD. Exercise training improves exercise capacity. Walking-based endurance training programmes are very effective in improving exercise capacity and quality of life in COPD. Exercise-induced dyspnea is a major limiting factor for endurance training in COPD. Downhill walking has been recently proposed as a brand new low metabolic-cost training program in COPD patients. **Aim:** we performed an exploratory study to evaluate and compare the respiratory patterns and the magnitude of dyspnea during different modalities of walking-based training programs in COPD. **Methods** 10 moderate-to-severe COPD patients were included in the analysis. In a random order patients were submitted for 3 consecutive days to walking-based training sessions on treadmill set-ups at different inclination (+1% or -10%) or free walking on the ground. The session lasted 6 minutes at a controlled walking speed of 80% of the mean speed recorded during baseline 6MWT. All patients were equipped with Spiropalm® which allowed measurement of the ventilatory pattern and continuous monitoring of heart rate and oxygen saturation. **Results** Compared to the other two walking-based training modalities, the walking session on treadmill set-ups at negative inclination (-10%) induced a significant

reduction of minute ventilation during the session ( $p < 0.05$ ) and at the end of the session a reduction of dyspnea ( $p < 0.05$ ). Conclusion Walking-based training session at negative inclination can represent an effective modality for exercise training in COPD. Studies evaluating long-term effects of this technique on relevant clinical outcomes in COPD patients are needed. CONTACTS luca.pomidor@unife.it

### ASSESSING BALANCE PERFORMANCE: INTRASESSION RELIABILITY OF A WOBBLE BOARD

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**Introduction** Wobble Boards (WB) are often used in different clinical settings to improve neuromuscular function and reduce injury risk (Williams and Bentman, 2014). Although their effectiveness is well known, nowadays only few devices are able to quantify WB balance performances and relatively few studies investigated their reliability (Hamer et al, 1992). Therefore, the purpose of this study was to determine the intrasession reliability of a computerized WB. **Methods** After signing an informed consent, 28 (15 females, 13 males) college (major: sport sciences) students (age:  $25.5 \pm 3.3$  years; weight:  $64.0 \pm 12.7$  kg; height:  $167.4 \pm 10.3$  cm) were involved in the study. Balance performance was assessed on a computerized WB (diameter=40cm) as the time spent in the target zone (TZ, diameter=6.3cm) displayed on a screen. Participants were asked to stand barefoot on the WB with a comfortable double leg stance, keeping their hands on their hip. The WB Balance test was administered during 2 testing sessions (Familiarization session-FS and Test session-TS), organized with a 1-week interval in between. Each session consisted of a 3-min free practice followed by three 30-s trials (1-min sitting recovery in between) of two conditions: 1) with Visual Biofeedback (VBF), showing real time performance; and 2) without Visual Biofeedback (NVBF), looking at a black wall. Consistency of the WB scores across the three trials was determined using intra-class correlation coefficients. **Results** For VBF, both FS and TS showed ICC=0.68 (FS: 95% CI: 0.50-0.82; TS: 95% CI: 0.49-0.82). For NVBF, FS showed ICC=0.41 (95% CI: 0.18-0.64), whereas the relative picture for TS was ICC=0.40 (95% CI: 0.17-0.63). **Discussion** Findings confirm that WB could be a useful, portable, and relatively affordable equipment for the evaluation of balance performances in different clinical settings, especially when a visual feedback is provided. However, the level of expertise of the studied sample limits the generalizability of the present results, thus different population needs further investigation. Reference Williams J and Bentman S, (2014). *Phys Ther Sport*, 15(3): 143-147 Hamer PW et al, (1992). *Aust J Physiother*, 38(2): 85-92 Contact andrea.fusco@unicas.it

### ANALYSIS OF TWO SPECIFIC JUMPS IN FEMALE BALLET DANCERS

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**Do not insert authors here** **Introduction** Classical ballet differs from many sports for its expressiveness and range of motion. It requires high specific skill abilities, rather than a dramatic change of physiological demands (Twicchett et al., 2009; Wyon et al., 2011). Although jumping is an integral part of the majority of ballets, for some specific jumps the dancers attempt to control technique and elegance of their executions rather than perform maximal efforts. Thus, this study aimed to investigate the dancer's ability to maintain stable jumping performances, following the ballet technique. **Methods** Two groups of female ballet dancers [Expert (EXP),  $n=12$ , age  $18 \pm 3$  yrs and Novice (NOV),  $n=10$ , age  $12 \pm 2$  yrs] performed two trials of two specific vertical jump protocols: 1) Changement (CHA), composed by 5 consecutive jumps starting from plié in fifth position, and 2) Echappé (ECH), composed by two cycles of 'echappé' for a total of four jumps (each cycle included a first jump from plié in fifth position to plié in second position and a second jump vice versa). Height (H), Jumping Point Gap (JPG) and Used Area (UA) were measured by means of the Optojump Next system (Microgate, Italy). Differences were assessed through ANOVA for repeated measures ( $p \leq 0.05$ ). **Results** In CHA test, no differences were found for H and UA, whilst differences were seen for JPG ( $p=0.003$ ) between the five consecutive jumps (1st:  $2.4 \pm 2.2$ ; 2nd:  $4.2 \pm 3.6$ ; 3rd:  $4.4 \pm 3.7$ ; 4th:  $5.1 \pm 4.9$ ;  $4.8 \pm 3.8$  cm). Moreover an approach to significance ( $p=0.52$ ) and a difference ( $p=0.42$ ) between groups were found for H (EXP:  $12.3 \pm 2.3$  and NOV:  $14.6 \pm 3.3$  cm) and JPG (EXP:  $3.6 \pm 3$  and NOV:  $4.9 \pm 4.5$  cm), respectively. The ECH test revealed main differences between jumps for H ( $p < 0.001$ ), JPG ( $p=0.003$ ) and UA ( $p < 0.001$ ), while differences between groups emerged for UA ( $p=0.001$ ). Post-hoc analysis maintained differences ( $p < 0.05$ ) between each jump from the fifth position (with a larger occupied area) to the second one (with a smaller area) and vice versa for H and UA. **Discussion** The findings of this study showed as in CHA dancers carried out a control on the jump height in order to maintain their aplomb, trying to limit the medio-lateral displacement (which, however, was significant). In fact, it could be speculated that the higher the jumping height, the higher the JPG value. Moreover, the medio-lateral displacements are also influenced by the dancers' experience. In fact, the NOV group showed both higher H and JPG values compared to the EXP one. Furthermore, the dancers' technical skill is also demonstrated by their ability to perform similar jumps in each of the two echappé cycles (with larger and smaller area, respectively). References Twicchett et al., 2009. *J Strength Cond Res*;23(9):2732-40. Wyon et al., 2011. *Int J Sports Med*;32(11):851-5. Contact e.mannacio@uniroma4.it

### RE-TEST RELIABILITY OF BALANCE TESTS IN PRESCHOOL CHILDREN

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**Introduction** From the first human step to the final step balance is essential to mobility. It is considered to be a fundamental part of motor competence amongst pre-schoolers. However, information about the test-retest reliability of single balance tests remains scarce. Lack of data is apparent on single balance items. Therefore we aimed to study test-retest reliability of commonly used balance tests utilized in German speaking countries. **Methods** We selected three dynamic tests and two static tests, as part of German Motoric Test Batteries (Boes et al., 2004; Zimmer & Volkamer, 1987), a static test as proposed by Ortega et al. (2014; standing on one leg, SOL) and a new dynamic test proposed by SALTO. 16 kindergarten children (all 5 year old) characterized as means (SD)  $115.3$  cm ( $7.0$ ),  $21.9$  kg ( $5.1$ ), 50% girls performed the following tests: walking forward and backwards on a 2 m long/10 cm broad carpet area (MOT4-6), walking forward on a 3 m long/3 cm broad/5 cm high balance beam (SALTO), standing on one leg on a T-beam (KMS 3-6) and on the plain floor (SOL). The retest was performed seven days later. Non-parametric tests were performed with SPSS 23: test-retest reliability with spearman correlation ( $r_s$ ,  $p$ ), item discrimination power with item-total correlation ( $ri(t-i)$ ) and item difficulty as quotient of reached to max possible points multiplied with 100 ( $P_i$ ). **Results** The analyses revealed the following statistics for dynamic balance with MOT 4-6 walking forward  $r_s = .62$ ,  $p = .011$ ,  $P_i = 90.63$ ,  $ri(t-i) = .28$ , walking backwards  $r_s = .40$ ,  $p = .128$ ,  $P_i = 32.8$ ,  $ri(t-i) = .61$ , SALTO  $r_s = .71$ ,  $p = .002$ ,  $P_i = 33.2$ ,  $ri(t-i) = .68$ . Respectively for static items KMS were  $r_s = .54$ ,  $p = .031$ ,  $P_i = 27.7$ ,  $ri(t-i) = .28$  and SOL were  $r_s = .84$ ,  $p < .001$ ,  $P_i = 53.7$ ,  $ri(t-i) = .60$ . **Discussion** In conclusion MOT 4-6 exhibited low to moderate and SALTO moderate to high retest-reliability for dynamic balance items. KMS 3-6 re-



vealed low and SOL high retest reliability for static balance. Regarding a screening and monitoring of balance in 4 to 6 year old children we recommend SOL for static and SALTO for dynamic balance testing. References Boes, K., Bappert, S., Tittlbach, S., & Woll, A. (2004). Karlsruhe's motoric screening for nursery school children (KMS 3-6). *Sportunterricht*, 53(3), 79-87. Ortega, F. B., Cadenas-Sanchez, C., Sanchez-Delgado, G., Mora-Gonzalez, J., Martinez-Tellez, B., Artero, E. G., ... & Ruiz, J. R. (2014). Systematic review and proposal of a field-based physical fitness-test battery in preschool children: the PREFIT battery. *Sports Medicine*, 45(4), 533-555. Zimmer, R., & Volkmann, M. (1987). MOT 4-6: Motoriktest fuer vier-bis sechsjaehrige Kinder: Manual. Weinheim: Beltz. Contact thomas.freudenthaler@sbg.ac.at

## A STUDY OF SPRINT-ASSISTED TRAINING FOR PARA-SWIMMERS

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**Introduction:** Because the outcomes of swimming races are decided by only fractions of a second, many different training methods have been developed to improve performance. One such training method is sprint-assisted training, commonly used by coaches and competitive swimmers to improve the swimmer's ability to apply force over a greater distance. However, the most appropriate assist velocity for challenged individuals in para-swimming is unknown. **Purpose:** To investigate the effects of change in assist velocity for challenged persons in para-swimming. **Methods:** This study evaluated one female Japanese competitive para-swimmer. The subject has a functional mobility para-swimming classification of "S6" for butterfly. This study used a pulling assist system with a velocity meter (Maglischo, 2003), which includes a wire line to pull the subject. The system precisely recorded intracyclic velocity variations during 25 m of maximum effort, with assist mean velocities of 0.0 m/sec (baseline), 1.1 m/sec (Assisted Speed [AS] 1) and 1.2 m/sec (AS 2), respectively. **Results:** In stroke phase, minimum velocity was  $0.53 \pm 0.07$  m/sec and maximum velocity was  $1.42 \pm 0.05$  m/sec at baseline. Minimum velocity at AS 1 and AS 2 was  $0.81 \pm 0.04$  m/sec (vs. baseline, t-test,  $p < .001$ ) and  $0.87 \pm 0.07$  m/sec (vs. baseline, t-test,  $p < .001$ ), respectively; maximum velocity at AS 1 and AS 2 was  $1.38 \pm 0.09$  m/sec (vs. baseline, t-test,  $p = 0.142$ ) and  $1.57 \pm 0.03$  m/sec (vs. baseline, t-test,  $p < .001$ ), respectively. Thus, the minimum velocity (vs. baseline) became larger at AS 1 and AS 2. The maximum velocity (vs baseline) was similar at AS 1, and grew larger at AS 2. Assist velocity AS 1 influenced minimum velocity, and AS 2 influenced both minimum and maximum velocity. **Conclusions:** Identifying the assist velocity that influences minimum speed is the first step in determining the most appropriate assist velocity. This finding may help to develop optimum assist conditions for training competitive para-swimmers. **References:** Maglischo, E. W. (2003). *Swimming Fastest*. Human Kinetics.

## Conventional Print Poster

### PO-CPP-35 Psychology 2

## VISUAL PERCEPTION AND DECISION MAKING IN DYNAMIC ENVIRONMENTS. AN EXPERIMENTAL STUDY IN VOLLEY-BALL

VELENTZAS, K., SCHAPER, T.

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A spiked volleyball with a velocity of  $16.9 \pm 2.4$  m/sec requires approximately 412ms to hurtle into the defense zone (Melrose, Spaniol, Bohling, & Bonnette, 2007). Taking into account the temporal structure and technical/tactical demand of floor defense, perceptual skills are crucial and affect athletes' performance (Neumaier, 1983; Vickers, 2007). The present study aims to provide evidences about the relationship between perceptual strategies and decision making in volleyball and to scrutinize differences in gaze control between athletes of different levels. **Method** For this purpose, female volleyball players participate in our study [novices-NV (N = 15, intermediated-IV (N = 13), German U19 national team (N = 13)]. 48 spike actions recorded from the defender perspective (position 5) were presented in a random order. Reaction time is measured by keyboard entries (Presentation®) and gaze behavior was evaluated by a SMI® eye-tracker. Participants were asked to "read" and enter spikes' direction (five possible choices) on the keyboard as fast as possible. Reaction-time was calculated in relation to the hitting moment. **Results** The analysis of the decisions' accuracy shows no significant differences between groups ( $\chi^2(df = 2, n = 41) = 4.21$ ). However, reaction time decreases significantly on increasing expertise ( $F(2, 41) = 15.88, p < .001$ , Tukey-HSD Post-Hoc (MNV = 478ms; MIN = 206ms; MU19 = -30ms]). Eye tracking data reveal significant shorter fixations for higher expertise ( $F(2, 41) = 4.428, p = .018$ , [(MNV = 237ms : MIN = 203ms); (MNV = 237ms : MU19 = 184ms)] but no differences regarding the number of the fixations. **Discussion** The results of the present study match previous studies partly only. Differences in gaze strategies can't be ascertained. However we found differences regarding the fixations' duration and the reaction time. The results indicate that experts are able collect and actualize information more efficiently by using almost the same gaze strategies as the novices. **Literature** Melrose, D.R., Spaniol, F.J., Bohling, M.E., & Bonnette, R.A. (2007). Physiological and performance characteristics of adolescent club volleyball players. *Journal of Strength and Conditioning Research*, 21, (2), 481– 486. Neumaier, A. (1983). Beobachtungsstrategien und Antizipation bei der Abwehr von Volleyball - Angriffen. *Leistungssport*, 13, (4), 5–10. Vickers, J.N. (2007). Perception, cognition, and decision training. The quiet eye in action. Champaign, IL: Human Kinetics. Contact: k\_velentzas@gmx.net

## TEMPORAL FEATURES OF DIFFERENT MOTOR IMAGERY TASKS FOR YOUNG AND OLDER ADULTS IN LOCOMOTION.

IASEVOLI, L.I, FUSCO, A.I, GALLOTA, M.C.I, PAOLUCCI, S.I, IOSA, M.I, BALDARI, C.I, GUIDETTI, L.I

*Università degli Studi del Foro Italico*

**Introduction** Motor Imagery (MI) is a cognitive process related to the ability to mentally simulate an action without physically execute it. Some author have proposed a new form of MI defined dynamic motor imagery (dMI) that refers to the mental representations of the action performed simultaneously with external movements. The main aim of this study was asses the influence of ageing in dMI and classic motor imagery (sMI) considering different types of walking as forward (FW), lateral (LW) and backward (BW). **Methods** 30 individuals (15 young,  $27.1 \pm 3.8$  years old; 15 elderly,  $65.9 \pm 9.6$  years old) were asked to imagine moving (sMI) towards a target positioned at the distance of 10 meters for the three locomotion condition. The same participants were also asked to imagine the same locomotor condi-

tions accompanied by a stepping in place (dMI). After that, individuals really moved (real locomotion, RL) towards the target. The duration of required tasks were recorded by means of a chronograph digital timer stopwatch. A 2x3x3 ANOVA with age (young and elderly) as between tasks (sMI, dMI, RL) and condition (FW, BW, LW) as between factor. Results The main effect of age was close to statistical significance ( $p=0.055$ ), as performances of elderly were slightly slower than young adults. Both task and condition factor, as well as to their interaction ( $p<0.01$ ) significantly affected performances. The time spent in FW for sMI was slower compared dMI in young ( $p=0.0051$ ) and elderly ( $p=0.0037$ ) despite both resulted not significantly different from RL. Also the performances in LW for sMI resulted significantly lower than dMI performances ( $p<0.001$ ) and RL ( $p<0.001$ ) while RL and dMI performances were not significantly different ( $p=0.140$ ) as well as for FW ( $p=0.099$ ) and BW ( $p=0.438$ ). The same pattern was found in BW. Discussion Our results showed that age affected only marginally the requested performances. The temporal similarity between sMI and RL are preserved in young and older people for simple and FW. In FW, BW and LW our results confirmed a better time accuracy of dMI, significantly closer to RL, compared sMI. Hence, when the mental perception of timing is added the spatial updating of information, given by the stepping in place, could furnish feedbacks to obtain similar times, both in young and older adults. The changes determined by aging in the biomechanics of walking patterns seem not to be reflected in the mental processing of usual movement. References Guillot, A., et al. 2005. Influence of environmental context on motor imagery quality. *Biology of Sport*. Guillot, A., et al. 2013. Coupling movement with imagery as a new perspective for motor imagery practice. *Behavioral and Brain Functions*. Iosa, M et al., 2012. Walking there: environmental influence on walking-distance estimation. *Behavioral Brain Research*.

### **BEHAVIOR OF COPING STRATEGIES IN SYNCHRONIZED SWIMMERS AT DIFFERENT TIMES.**

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1:USJT (São Paulo, Brazil), 2:UQT-R (Québec, Canadá), 3:UNIP (São José do Rio Pardo, Brazil), 4: Paineiras Club Morumbi (São Paulo, Brazil)

Introduction Coping strategies can be understood as volitional actions, both cognitive and behavioral damage to deal with situations of threat or challenge, the evidence in the sporting context. In this sense, the objective was to verify the behavior of coping levels of 8 styles at different times. Methods Attended by 23 synchronized swimmers (SS) in infant classes ( $S = 13$ ) and youth ( $S = 10$ ) aged between 9 and 15 years ( $12.13 \pm 1.98$ ), participants from 2 SS tournaments, known as time 1 (T1) and time (T2). An educational intervention was given by a judge on the important assessment items to athletes 24 hours before to T2. This judge did not act in any of these two moments. So the T1 and T2 differed with the implementation of this intervention. The coping levels were tested through the inventory of Coping for athletes in competition situation in T1 and T2. This inventory consists of two dimensions Coping Orientation (CO) and Guidance to Removal (GR), which include eight sub-dimensions, 4 EO (Reevaluation, Direct Action, Social-Support, Self-Control) and 4 OA (Aggressive Action, Denial, Distraction, Action Inhibition). Normality ensuring the distribution and reliability ( $0.89 < \alpha < 0.88$ ) of the data ( $0.88 \pm 0.05$ ), one Student t test for paired samples was used to compare possible significant differences in T1 and T2. Results The results found in 10 tested pairs ( $-2.40$

### **DEVELOPMENTAL DIFFERENCES IN ACHIEVING PSYCHOSOCIAL DEVELOPMENTAL TASKS AND PSYCHOLOGICAL COMPETITIVE ABILITY AMONG MALE JAPANESE ATHLETES**

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Introduction Psychological competitive ability (PCA) refers to a trait that enables athletes to compete to the best of their ability (Tokunaga, 2001), which is a necessary trait for excelling in sports. Takenouchi and Oohata (2015) demonstrated that the achievement of psychosocial developmental tasks (PDTs) was related to PCA of athletes. However, developmental differences in the relationship between the achievement of PDTs and PCA have not been clarified. Therefore, these developmental differences were investigated in male Japanese athletes. Methods Male athletes responded to a questionnaire assessing five PDTs: trust, industry, identity, intimacy, and psychological weaning, which were selected based on developmental theories, such as by Erikson (1959). Moreover, athletes' PCA was evaluated using the Diagnostic Inventory of PCA for Athletes (Tokunaga & Hashimoto, 2000) that assesses five factors: volition for competition, mental stability and concentration, confidence, strategic ability, and cooperation. Junior high school ( $n = 119$ ), high school ( $n = 102$ ), and college athletes ( $n = 169$ ) provided valid data. Results Multiple regression analyses indicated that trust, industry, intimacy, and psychological weaning significantly predicted the total PCA score in junior high school athletes, industry in high school athletes, and industry, identity, and intimacy in college athletes. The results of college athletes have been previously published (Takenouchi & Oohata, 2015). Discussion Industry was related to PCA in all developmental stages, suggesting that it was critical for improving PCA. Trust and psychological weaning are considered to be PDTs that start to engage in relatively early developmental stages, and therefore they were related to PCA in junior high school athletes. Identity is assumed to be well developed during late adolescence and therefore it was related to PCA in college athletes. Intimacy, which includes intimacy with the same and opposite sexes, is assumed to be a PDT at relatively early and late developmental stages, respectively. Therefore, intimacy was considered to be related to PCA in junior high school athletes and PCA in college athletes. These results suggest that PCA of athletes develop as they sequentially achieve PDTs related to each developmental stage. References Erikson, E. H. (1959). *Identity and the life cycle*. New York: International Universities Press. Takenouchi, T., & Oohata, M. (2015). Proceedings of the 14th European Congress of Sport Psychology, 382-383. Tokunaga, M. (2001). *Japan J. Phys. Educ. Hlth. Sport Sci.*, 46, 1-17. Tokunaga, M., & Hashimoto, K. (2000). *Diagnostic Inventory of PCA for Athletes*. Fukuoka, Japan: Toyophysical. Contact: takenouchi@nagoya-u.jp (Takenouchi, T.)

### **MENTAL TOUGHNESS AND SELF-AFFIRMATIONS FOLLOWING PERCEIVED THREAT**

MEGGS, J., LAZARUS, L.

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Mental toughness is arguably a prerequisite for sporting success and is a collection of cognitive, affective and behavioural components that allow an individual to remain in pursuit of their goals, despite threats or adversity. Self-affirmation theory provides a cognitive framework for understanding individual differences in response to perceived threats. The current study sought to apply SAT to understanding how mentally tough people respond to. A cross-sectional design including 82 sports people was used to examine individual differences in responses to a perceived social threat. Participants were asked to think of a perceived threat either in within sport (loss of a sporting title) or elsewhere in their lives (rejected by a social circle) and were asked to write a short essay about the experience. Next, participants

were given an opportunity to engage in direct self-affirmation (write about why social relationships/experiences are important to them), indirect self-affirmation (write about why another core value was important to them) or to disengage (indicating defensive processing). Overall, those high in global mental toughness tended to engage in direct self-affirmation significantly more than those with lower levels of mental toughness. Other findings included that those who had the highest level of commitment were those who engaged fully in the social threat exercise and engaged in direct self-affirmation. Whereas, those people who did not engage with the social threat (they chose not to reflect/respond to this manipulation) but then also engaged in indirect self-affirmation, had the highest levels of emotional and life control. In conclusion, it appears that mental toughness is a multidimensional construct and different cognitive processes underlie each individual characteristic of mental toughness. Self-affirmation theory can shed some light on these cognitive differences.

**14:00 - 15:00**

## Mini-Orals

### MO-PM28 Training Effects

#### THE EFFECTS OF MUSCLE ACTION, REPETITION DURATION AND LOADING STRATEGIES OF A WHOLE-BODY, PROGRESSIVE RESISTANCE TRAINING PROGRAMME ON MUSCULAR PERFORMANCE AND BODY COMPOSITION IN TRAINED PERSONS

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**Introduction** Previous research has shown higher surface electromyography (sEMG) amplitude and motor unit (MU) activation (measured by intramuscular spike-amplitude-frequency (ISAF) histograms) for concentric (CONC) compared to eccentric (ECC) muscle actions where loading strategies are equated (Moritani, et al., 1987). As such, ECC training has been of interest as a result of the capacity to use increased loading strategies or reduce metabolic cost (Vogt and Hoppeler, 2014). However, research has produced equivocal results with regard to eccentric (ECC) only compared to traditional resistance training (RT). When considered in relation to load- and repetition duration-accentuated (ECC) training strategies (Hortobágyi, et al., 2001; and Dias, et al., 2015, respectively), as well as the use of isolated, isokinetic and isoinertial RT methods there is a relative dearth of literature considering multi-joint, multi-exercise RT interventions. **Methods** The present study considered fifty-nine male and female participants, with > 6 months RT experience, randomly divided in to 3 gender counterbalanced groups; ECC only (ECC, n=20), repetition duration-accentuated ECC (ECC-A, n=20), and traditional (CON, n=19) performing full body, effort matched RT programmes 2 d.wk<sup>-1</sup> for 10 weeks. Outcomes were muscular performance including absolute muscular endurance and predicted 1-repetition maximum (RM), in addition to body composition. **Results** No significant between groups differences were identified for change in muscular performance measures for leg press or pull down exercises, or for body composition changes. Analyses revealed a significantly greater improvement for CON compared to ECC groups ( $p < 0.05$ ) for change in absolute muscular endurance for the pull-down exercise. Effect sizes for muscular performance changes were moderate to large for all groups and exercises (0.75-2.00). **Discussion** The present study supports previous research that ECC only RT produces similar improvements in muscular performance to traditional training where intensity of effort is controlled. For strength coaches and athletes with limited time resources and engaging in sport-specific skill training, the present study supports that a time efficient manner of uncomplicated RT appears an efficacious approach to improving muscular performance. **References** Dias CP, Toscan R, de Carnargo M, Pereira EP, Griebler N, Baroni B, Tiggemann CL. (2015). Age, 37, 99. Hortobágyi T, Devita P, Money J, Barrier J. (2001). *Med Sci Sports Exerc*, 33, 1206-1212. Moritani T, Muramatsu S, Muro, M, (1987). *Am J Phys Med*, 66, 338-350. Vogt M, Hoppeler HH. (2014). *J Appl Physiol*, 116, 1446-1454. Contact James.fisher@solent.ac.uk

#### CARDIORESPIRATORY EFFECTS OF ONE-LEGGED HIGH-INTENSITY INTERVAL TRAINING IN NORMOXIA AND HYPOXIA

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**Introduction** Although there is no consensus about an optimal training method to enhance VO<sub>2</sub>max, nevertheless training of small muscle groups and repeated exposure to hypoxia seem to be promising approaches (Esposito et al., 2011; Burtcher et al., 2004). Therefore, this study was aimed at gaining innovative insights into the effects of small muscle group training in normoxia and hypoxia. **Methods** Thirteen healthy participants were randomly assigned to the hypoxic (HG, N=7) or normoxic (NG, N=6) training group. Both groups completed nine high-intensity interval training sessions in 3 wks. The NG performed the training in normoxia (FIO<sub>2</sub>: 0.21; ~ 600 m) and the HG in hypoxia (FIO<sub>2</sub>: 0.126; ~ 4500 m). Each session consisted of 4 x 4 min one-legged cycling at 90% of maximal heart rate separated by 4 min recovery periods. Before and after the intervention period, VO<sub>2</sub>max and peak power output were assessed in a laboratory cycling test. **Results** Peak power output significantly improved within both groups ( $9.6 \pm 4.8\%$  and  $12.6 \pm 8.9\%$  for HG and NG, respectively) with no significant interaction ( $p=0.277$ ). However, VO<sub>2</sub>max only significantly increased after training in hypoxia from  $45.4 \pm 10.1$  to  $50.0 \pm 9.8$  ml/min/kg ( $10.8 \pm 6.0\%$ ;  $p=0.002$ ) with no significant interaction ( $p=0.146$ ). The maximal O<sub>2</sub>-pulse improved within the HG and demonstrated a significant interaction ( $p=0.040$ ). **Discussion** Nine sessions of one-legged cycling training significantly improved VO<sub>2</sub>max and peak power output. The results of the present study showed that local muscle group training performed in hypoxia did not improve exercise tolerance to a greater extent than normoxic training. However, training under hypoxic conditions may generate greater effects on VO<sub>2</sub>max than a similar training in normoxia. The sample size may have been too low and the training period too short to detect differences between HG and NG. **References** Burtcher, M., Pachinger, O., Ehrenbourg, I., Mitterbauer, G., Faulhaber, M., Pühringer, R. and Tkatchouk E. (2004) Intermittent hypoxia increases exercise tolerance in elderly men with and without coronary artery disease. *International Journal of Cardiology* 96 (2), 247-254. Esposito, F., Reese, V., Shabetai, R., Wagner, P. D. and Richardson, R. S. (2011) Isolated quadriceps training increases maximal exercise capacity in chronic heart failure: the role of skeletal muscle convective and diffusive oxygen transport. *Journal of the American College of Cardiology* 58 (13), 1353-1362.

## EFFECTS OF A STAIR DESCENDING EXERCISE ON DELAYED ONSET MUSCLE SORENESS OF THE LOWER LIMBS AND ASSOCIATED MUSCLE DAMAGE

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**Introduction:** Effects of cadence during stair descending exercises on the lower limbs are different in the first and second halves of the stance phase (Tanabe et al., 2015). Knee joint extension muscles in the first half of the stance phase are stretched as cadence increases; therefore, the burden on the lower extremities increases. However, the burden on the knee extension muscle decreases with cadence in the second half of the stance phase. The aim of this study was to clarify the effect of cadence at different times during a stair descending exercise on the DOMS in the lower limbs. **Methods:** The subjects were 8 healthy Japanese male adults (age:  $21 \pm 1$  years, height:  $173.7 \pm 4.7$  cm, weight:  $69.3 \pm 9.3$  kg, BMI:  $23.0 \pm 2.7$ , mean  $\pm$  SD). Each subject signed an informed consent form. The subjects performed a stair descending exercise comprising 207 steps and 10 round trips. They used an elevator to return to the beginning of the movement. Cadence exercise conditions were 90 steps/min (90-condition), 110 steps/min (110-condition), and 130 steps/min (130-condition). The condition order was random. The subjects had a 15% body weight load. Measurements included maximal isometric strength, thigh circumference (muscle damage indices), and muscle soreness. Muscle soreness was determined based on the visual analog scale. Measurements were taken before exercise, immediately after exercise, and on post-exercise days 1–4. **Results and Discussion:** There was a significant negative correlation between the peak DOMS score and isometric maximum strength changes immediately after exercise and 4 days later in the 110-condition ( $p < 0.05$ ). There was also a significant positive correlation between the peak DOMS score and thigh circumference changes immediately after exercise and 4 days later in the 110-condition ( $p < 0.05$ ). There were no significant changes in the peak DOMS and muscle damage indices in the 90- and 130-conditions. This suggests that DOMS and muscle damage indices do not always match. DOMS was rapidly expressed and slowly subsided in the 90- and 130-conditions. Muscle soreness immediately after and 12 h after exercise was significantly higher in the 90- and 130-conditions in comparison with the 110-condition. These results suggest that DOMS was suppressed during the stair descending exercise with a cadence of 110 steps/min. **Conclusion:** This study revealed that the stair descending exercise burden on the lower limbs is reduced when the cadence is 110 steps/min. **References:** Tanabe Y, Mizukami M. (2015). *Journal of Physical Therapy Science*, 30(2), 207-212.

## BODY HEIGHT AFFECTS INCREASE IN ARTERIAL STIFFNESS FOLLOWING ACUTE RESISTANCE EXERCISE

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**Introduction** The increase in arterial stiffness is an independent risk factor for future cardiovascular disease (Safar and London. 2000). Resistance training is recommended to increase muscle strength and mass (American College of Sports Medicine. 2009). However, it has been reported that resistance exercise increases arterial stiffness (Devan et al. 2005). Recently, it has been reported that lower body height is related to a higher risk in cardiovascular morbidity and mortality compared with tall individuals in the meta-analysis (Paajanen et al. 2010). The purpose of this study was to investigate whether body height affects change in arterial stiffness following acute resistance exercise. We hypothesized that lower body height emphasizes increase in arterial stiffness following acute resistance exercise. **Methods** Nine healthy men (age,  $24.9 \pm 1.5$  years) performed five sets to exhaustion at intensity of 80% of one repetition maximum for unilateral biceps curl. Blood pressure (SBP, MBP and DBP), heart rate (HR) and carotid-femoral pulse wave velocity (cfPWV; index of aortic arterial stiffness) were assessed before exercise, immediately after exercise, and 30 min after exercise. **Results** There were no changes in blood pressures and HR during experiment. The cfPWV significantly increased only 30 min after exercise ( $p < 0.001$ ). Body height was associated with the change in cfPWV following 30 min of resistance exercise ( $r = -0.67$ ,  $p < 0.05$ ). Moreover, the multivariate stepwise linear regression analysis revealed that body height independently related to the change in cfPWV following 30 min of resistance exercise ( $\beta = -0.67$ ,  $p < 0.05$ ). **Discussion** Previous study reported that lower body height is related to a higher risk of cardiovascular morbidity and mortality compared with tall individuals (Paajanen et al. 2010). This study showed that body height affects the change in arterial stiffness following acute resistance exercise. We firstly suggest that high body height suppresses the increase in aortic arterial stiffness following resistance exercise. **Conclusion** The present study suggests that high body height suppresses the increase in aortic arterial stiffness following acute resistance exercise. **References** Safar and London. 2000. *J Hypertens*. 18(11):1527-35. American College of Sports Medicine. 2009. *Med Sci Sports Exerc*. 41(3):687-708. Devan et al. 2005. *J Appl Physiol*. 98(6):2287-91. Paajanen et al. 2010. *Eur Heart J*. 31(14):1802-9. Contact tagawakaname@gmail.com

## EFFECT OF NANO-PLATINUM HARMONIZED FIBRES ON RECOVERY AFTER TRAINING

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**Introduction** There is a wide but also controversial range of recovery strategies so that none of them is generally accepted. Quite differently to the common strategies the clothing manufacturer VENEX implemented nano-platinum harmonized technology (PHT) fibers containing DPV567-F into their clothes called recovery wear. DPV567 demonstrated T-cell proliferation (Ghoneum et al. 2014) and is assumed to increase parasympathetic activity when wearing PHT containing clothes. Thus, the purpose of the study was to investigate the effect of recovery wear on performance parameters, Creatinkinase activity (CK) and subjective pain intensity (PI), regeneration-condition (RC) and sleep quality perception (SQ). **Method** In a cross-over design 14 strength trained males performed two training sessions including 200 maximal jumps in the morning and ten sets of squats with the 10 repetition maximum in the afternoon. Performance testing (CMJ, Drop Jump (DJ), maximum voluntary contraction (MVC) of the knee extensors), CK, PI, RC and SQ were done before the first training, after first training, before second training, after second training and 24, 48 and 72 hours after first training. The participants had to wear either recovery wear (R) or a placebo product (P) during one hour after first training and during the 3 nights after the training day. A 6 week washout phase was in between the two testing blocks. **Results** Since this is an ongoing study the preliminary results are based on 10 subjects that completed both testing blocks yet. Compared to baseline before the training sessions all performance parameters (CMJ, DJ, MVC) showed a significant decrease after both training sessions (MVC decrease  $22 \pm 13\%$  (R) and  $33 \pm 10\%$  (P);  $p < 0.05$ ), but no difference was observed between groups (R vs. P), neither for fatigue nor for recovery. However, we found significantly reduced subjective pain intensity in the R-Group  $5 \pm 1$  (24h) and  $6 \pm 2$  (48h) compared to the P-Group  $7 \pm 1$  (24h) and  $7 \pm 2$  48 hours after training (scale 1-10). Similarly, compared to P-Group  $3 \pm 2$  (24h),  $3 \pm 2$  (48h) and  $5 \pm 2$  (72h), subjective RC was significantly improved in the R-Group  $4 \pm 2$  (24h),  $5 \pm 2$  (48h) and  $7 \pm 1$  72 hours after training. Finally, the R-Group ( $8 \pm 1$ ) reported better SQ in the third night after training in comparison to P-Group



(7±2). Discussion Due to lacking differences between groups concerning the performance testing it is assumed that there is no immediate effect of the PHT wear on recovery from training induced fatigue. On the other hand subjective ratings demonstrated an effect towards recovery wear and especially SQ showed a difference in the third night after training. This might indicate that the PHT recovery wear needs some time to have a meaningful effect on performance. References Ghoneum M, Pan D., Katano H. (2014). JSM Nanot & Nanom, 2(2), 1031. Contact Fridolin.zinke@rub.de

### DOES THE HEALTH PROMOTION PROGRAM SKIPPING HEARTS HAS A LONG-TERM EFFECT ON SPEED AND SPEED-STRENGTH IN CHILDHOOD AND ADOLESCENCE?

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Motor skills of children decreased in the last years as a result of physical inactivity. Therefore, intervention approaches with the objective of improving good basic motor skills are getting more and more important. One of these approaches is the health promotion project "Skipping Hearts", which was evaluated in 2012/13 (N=1493) and showed short-term positive effects on basic motor skills (Oberhoffer et al., 2015). Although many intervention programs are published only a few long-term studies can be found. Thus, the aim of this survey was to find out whether there is a long-term effect in speed and speed-strength. 191 children (Age t3 in years: CG: 12,1±0,1; SH-B: 12,1±0,1; SH-CH: 12,1±0,1 / height t3: CG: 153,5±1,3 cm; SH-B: 155,0±0,8 cm; SH-CH: 155,0±1,2 cm / weight t3: CG: 43,0±1,8 kg; SH-B: 43,4±0,8 kg; SH-CH: 44,3±1,3 kg) of the skipping hearts population were included in a third measurement (t1 initial examination; t2 after 4 month; t3 after 3 y). 97 children received a 90 minutes Basic Workshop (SH-B), 55 the Champion Program (SH-CH) with additional 10 units (à 45 minutes), respectively. The remaining 39 children served as a control group (CG). The 20-meter sprint (time in sec), countermovement jump (cmj; height in cm), standing long jump (distance in cm) and tapping (number of foot contacts in 4 seconds) were used as examination parameters. Statistical analysis was performed with a two-way repeated measures ANOVA. Every group improved after 3 years in 20-meter sprint (t1/t3 : CG 4,10±0,05 sec / 3,68±0,04 sec; SH-B 4,01±0,03 sec / 3,61±0,21 sec; SH-CH: 4,12±0,05 sec / 3,76±0,05 sec), cmj (t1/t3: CG: 21,72±0,51 cm / 26,64±0,80 cm; SH-B: 21,95±0,41 cm / 25,71±0,47 cm; SH-CH: 19,81±0,61 cm / 25,28±0,71 cm), standing long jump (t1/t3: CG: 123,34±2,58 cm / 162,18±3,20 cm; SH-B: 126,56±1,91 cm / 157,58±2,02 cm; SH-CH: 117,44±3,15 cm / 148,87±4,00 cm) and tapping (t1/t3 CG: 20,73±0,71 / 28,87±0,57; SH-B: 21,94±0,53 / 28,51±0,54; SH-CH: 21,94±0,53 / 28,51±0,54). The statistical analysis showed significant differences between the groups concerning standing long jump and tapping. The health promotion project "Skipping Hearts" seems to have only short-term effects on motor skills like speed-strength in childhood and adolescence. The missing long-term effect can be explained physiologically. Clearly, the amount of training in the defined time period does not result in physiological improvements in the body unless a change in behavior patterns can be achieved. Therefore, in the long run intervention programs should focus more on the change of behavior patterns. Oberhoffer R, Schulz T, Postler T. (2015). Dtsch Z Sportmed., 66, 175. Contact: tobias.engl@tum.de

### CHANGES IN RELATIVE EXERCISE INTENSITY DURING A TWO HOURS ENDURANCE RACE USING A TANDEM-BICYCLE FOR EXERCISE

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Background: It was reported that the exercise intensity of the front saddle of a tandem bicycle was greater than the rear saddle. We verified this theory by evaluating a 2-h endurance tandem race. The purpose of this study was to compare the relative exercise intensity of the front and rear saddles. Methods: Two healthy male subjects (front saddle: age, 23 years; height, 173 cm; body weight, 80 kg; and peak oxygen uptake, 43.9 ml/kg/min and rear saddle: height, 161 cm; body weight, 72 kg; and peak oxygen uptake, 45.1 ml/kg/min) volunteered for this study. They performed ten laps around a 3.7-km track. In the race, the rated perceived exertion (RPE), heart rate, blood pressure, and rectal temperature were measured every three laps. Urinary catecholamine (adrenalin, noradrenalin, and dopamine; creatinine correction) was measured before and after the race. The relative exercise intensity was calculated as the average heart rate of one lap. The ambient air temperature was 5°C and humidity was 57%. Results and Discussion: The mean speed of one lap was 21.9 km/h. In the front and rear saddles, the mean heart rate was 152 ± 2 bpm and 139 ± 7bpm, relative oxygen uptake (%VO2peak) was 77.6 ± 5.8% and 72.6 ± 5.8%, RPE was 14.0 and 13.3, blood pressure was 154/74 ± 14/5 mm Hg and 150/70 ± 5/1 mm Hg, and rectal temperature was 38.4 ± 0.3°C and 38.1 ± 0.2°C, respectively. Urinary adrenalin, noradrenalin, and dopamine in the front saddle before the race were 13.9, 97.7, and 330.0 ng/mg Cr. After the race, these levels were 27.2, 169.3, and 355.2 ng/mg Cr. In the rear saddle before the race, levels were 15.9, 152.8, and 797.2 ng/mg Cr. After the race, they were 24.2, 168.3, and 632.9 ng/mg Cr. In the front saddle, the mean values of all measured variables were successively higher compared to the rear saddle during the tandem race. The difference between the front and rear saddle was about 6% of relative exercise intensity, and these differences were because of the handle, brake, and gear operations and wind pressure. Conclusion: The relative exercise intensity of the front saddle was higher than that of the rear saddle during the 2-h tandem race. [The Ministry of Education, Culture, Sports, Science and Technology, Grant-in-Aid for Scientific Research (15K01509)]

### IS HIGH-INTENSITY INTERVAL TRAINING ASSOCIATED WITH HIGHER DROPOUT?

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INTRODUCTION: Regular exercise is known to prevent cardiovascular disease and a wide range of other health problems, yet a large proportion of adults in European countries are insufficiently active with 25-50% of individuals dropping out of an exercise program within the first six months [2]. Given that lack of time is the most common barrier to exercise, time-efficient exercise interventions are needed. High-intensity interval training (HIT) is a useful strategy and has been demonstrated to improve fitness and health parameters with substantially lower time effort compared with traditional continuous aerobic training. However, HIT may be inappropriate for sedentary individuals given its strenuous character [1,3]. Due to a lack of data on dropout in HIT-studies, this study assessed HIT-intervention trials with sedentary individuals that reported dropout. METHODS: Electronic databases (MEDLINE, PubMed, Google Scholar) were searched for research articles published from 2000-2015. Inclusion criteria were sedentary/untrained individuals or subjects with or without known

cardiovascular disease/risk factors, aged >18 yrs, trial duration  $\geq 3$  weeks, information on dropouts/completers and a detailed description of the HIT-protocol. Dropout was defined as the proportion who completed the study. Associations were assessed by Spearman correlation coefficients. RESULTS: 52 studies (mean duration:  $9.5 \pm 4.5$  weeks) with 898 subjects (mean age:  $43 \pm 17$  yrs) were included in the analysis. Mean dropout rate was 9.3%. Dropout was associated with longer session time ( $p=0.36$ ,  $P<0.05$ ), exercise volume/week ( $p=0.33$ ,  $P<0.05$ ), total exercise volume/study ( $p=0.50$ ,  $P<0.001$ ) and study duration ( $p=0.45$ ,  $P<0.001$ ). Dropout was greater in studies using treadmill/running protocols (12.7%) compared to cycle-protocols (6.1%,  $P<0.05$ ). Participant age and exercise intensity were not associated with dropout. CONCLUSION: Dropout in HIT appears to be lower compared to traditional exercise programs. Given the association between HIT-volume and dropout rate, future studies should identify the minimally effective dose of HIT needed to improve health status. Such efforts would be important to increase sustainability and public health impact. REFERENCES: 1)Biddle SJ, Batterham AM (2015). High-intensity interval exercise training for public health: a big HIT or shall we HIT it on the head? *Int J Behav Nutr Phys Act*, doi: 10.1186/s12966-015-0254-9. 2)Buckworth J, Dishman RK (2002). Interventions to change physical activity behavior. Exercise Psychology, Human Kinetics Editions. 3)Hardcastle SJ, Ray, H, Beale L, Hagger MS (2014). Why sprint interval training is inappropriate for a largely sedentary population. *Front Psychol*, doi:10.3389/fpsyg.2014.01505. Contact: dejan.reljic@medma.uni-heidelberg.de

## VALIDITY OF THE FITBIT CHARGE HR AND GARMIN FORERUNNER 225

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**Introduction** The amount of multi-component sports and physical activity watches available on the consumer market is rising dramatically due to an increasing awareness of the benefits of physical activity (PA) for health. As the modalities of PA determine the effect on all-cause mortality, an adequate measurement of PA is needed to guide PA behavior. Therefore we aimed to evaluate and compare the validity of two different commercially available PA devices: Fitbit Charge HR and Garmin Forerunner 225. **Methods** Eighteen healthy adults ( $n=13$  females) aged 18-40 years performed a predefined treadmill protocol twice. First, a familiarization session to determine the walking speeds needed to achieve moderate and high exercise intensities. Second, a 50 minute session consisting of 5' sitting, 5' standing, 10' walking at 4 km/h, 10' walking at an intensity of 4-6 METs and 10' walking at an intensity of  $\geq 7$  METs. Each walking bout was separated by a standardized rest period. During the session, participants wore a Jaeger Oxycon Mobile for breath-by-breath analysis to allow calculation of EE by indirect calorimetry (= criterion method) and a Fitbit Charge HR and Garmin Forerunner 225 on the left arm. Participants were videotaped to allow for manual counting of the steps taken during the session. Paired t-tests, Wilcoxon signed ranks tests and Bland-Altman assessment for agreement were done to compare the devices with the gold standard. **Results** The Fitbit HR showed no significant differences in comparison with indirect calorimetry or video analysis ( $207.7 \pm 25.0$  kcal vs  $206.4 \pm 34.6$  kcal;  $p=0.768$  and  $3357 \pm 184$  steps vs  $3336 \pm 158$  steps;  $p=0.44$ ). Bias was 1.31 kcal (limits: -90.7, 93.3) and 20 steps (limits: -198, 239). There was no statistically significant difference for EE between the Garmin and the criterion method ( $248.5 \pm 84.0$  kcal vs  $206.4 \pm 34.6$  kcal;  $p=0.064$ ) whereas the estimated number of steps from the Garmin was significantly lower ( $2750 \pm 489$  steps vs  $3337 \pm 158$  steps;  $p<0.001$ ). Bland-Altman assessment resulted in a bias of 42.1 kcal (limits: -118.4, 202.6) and -587 steps (limits: -1477, 303). **Discussion** To our knowledge, this is the first study to evaluate the validity of these wrist worn PA devices. Our results concur with previous studies that examined the validity of other Fitbit devices and also reported accurate estimation of EE and step counts. 1.2. The Garmin Forerunner 225 seems less valid to measure accurately EE and steps. **References** 1. Takacs J, et al. (2014). (5):496-500. 2. Diaz KM, et al. (2015). *Int J Cardiol*. 185:138-40. This project has received funding from the European Union's Horizon 2020 Framework Programme for Research and Innovation Action under Grant Agreement no.643491. PATHway: Technology enabled behavioural change as a pathway towards better self-management of CVD ([www.pathway2health.eu](http://www.pathway2health.eu)).

## Mini-Orals

### MO-PM18 Physiology: Mixed Session

#### DIVING AND METABOREFLEXES

TOCCO, F., MAGNANI, S., PINNA, V., SAINAS, G., PALAZZOLO, G., CORONA, F., DI GIACOMO, A., MANNONI, M., VANNI, S., GHIANI, G., CRISAFULLI, A.

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**Introduction** Diving reflex (DR) is characterized by bradycardia and vasoconstriction of selected vascular beds. The result is a reduced cardiac output (CO) with a maintained blood pressure. Conversely during exercise the peripheral accumulation of metabolic end-products caused a stimulation of group III and IV nerve-endings in involved muscles, known as muscle metaboreflex (MM), which is able to improve myocardial performance (Crisafulli et al., 2003). The aim of study was to assess hemodynamic changes during simultaneous activation of MM and DR in a laboratory setting. **Methods** A group of trained divers underwent the following protocol randomly assigned: A) Post-exercise muscle ischemia session (PEMI): 3 min of resting followed by 3 min of arm cranking exercise at 30% of  $W_{max}$ , followed immediately by 3 min of PEMI on the same arm induced by inflating a tourniquet to 200 mmHg. 3 minutes of recovery was further allowed after the cuff was deflated, for a total of 6 minutes of exercise recovery. B) Control exercise recovery session (CER): the same rest-exercise protocol used for A followed by 6 min of recovery without inflation. C) DR session: the same rest-exercise protocol used for A followed by 1 min of breath-hold (BH) with face immersion in cold water. D) PEMI-DR session: the same protocol used for A with 60 seconds of BH with face immersion in cold water during the first minute of PEMI. SV, heart rate (HR) and CO were collected by means of impedance method. Mean blood pressure (MBP) and systemic vascular resistance (SVR) were also calculated. Differences among conditions were studied by means of the analysis of variance (ANOVA) for repeated measures. **Results** At the end of apnoea HR was decreased in condition C and D respect to A (-38.8% and -33.7% vs. +8.7%;  $p<0.05$ ). Since SV increased at the same time point ( $C=+57.6\%$  and  $D=+41.1\%$  vs.  $A=+12.8\%$ ;  $p<0.05$ ) thus CO decreased during C and D and rose in A (-6.1% and -6.2% vs. +25.2% respectively;  $p<0.05$ ). The outcome was a substantial maintaining of MBP. **Conclusion** Results addressed to the hypothesis that DR overrode the MM in our setting. This outcome is quite different by findings of Tocco et al. (2012) who found a particular cardiovascular response in the second phase of simulated dynamic apnoeas when a delayed increase in myocardial performance and SV occurred and obscured the cardiovascular effects of the DR. Further researches are desirable to clarify hemodynamics during simultaneous diving and exercise. **References**

Crisafulli A, Scott AC, Wensel R, Devos CH, Francis DP, Pagliaro P, Coatts AJS, Concu A, Piepoli MF. (2003). *Med Sci Sports Exerc*, 35, 221-228. Tocco F, Crisafulli A, Melis F, Porru C, Pittau G, Milia R, Concu A. (2012). *Eur J Appl Physiol*, 112, 543-554. Contact: [filippo.tocco@tiscali.it](mailto:filippo.tocco@tiscali.it)

### COMPARISON BETWEEN TWO DIFFERENT METHODS TO ASSESS STROKE VOLUME DURING DRY STATIC APNOEA

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**Introduction** During apnoea the sympathetic and parasympathetic components of nervous system work simultaneously to achieve a hemodynamic response called diving response (DR). Classically, DR leads to bradycardia and vasoconstriction of selected vascular beds. The result is a reduced cardiac output (CO) with a maintained blood pressure. Considering that stroke volume (SV) changes during apnoea have been poorly investigated in the past, we set this study to estimate SV by means of two indirect methods in elite divers performing dry static apnoea. **Methods** Sixteen elite divers (8-Females) were enrolled during the AIDA team world championship 2014. Each diver performed 3 minutes of eupnoea (REST), followed by breath-hold (BH) in air until reaching physiological break-point and 3 minutes of recovery. Hemodynamics during rest and immediately after BH in air (REC) was assessed by means of simultaneous echocardiography and impedance cardiography (IC). Echocardiographic evaluation of SV (SVE) were obtained by subtracting end systolic volume (ESV) to end diastolic volume (EDV). Impedance and ECG recorded traces were analyzed employing a digital chart recorder and processed to calculate SV (SVI). The method is described in detail in previous work (Crisafulli et al., 2008). SV values obtained with the two methods were compared by means of two-way ANOVA. Moreover, the Bland and Altman (1986) plot was carried out to estimate agreement between methods. **Results** Two-way ANOVA revealed no differences between IC and echocardiography measurements ( $59.94 \pm 12.12$  vs.  $60.01 \pm 11.1$  at REST and  $59.75 \pm 13.01$  vs.  $56.15 \pm 10.76$  at REC respectively,  $p > 0.05$ ). The Bland and Altman plot showed that the 95% limits of agreement (SVI-SVE) were within +26.04 and -25.9 ml at REST and +42.6 and -35.2 ml at REC. **Discussion** Bland-Altman plot analysis suggests an acceptable measurement agreement between the two methods at REST (Bias 0.07), instead results were more ambiguous at REC. Actually, limits of agreement were wide and the average of the differences was not close to zero (Bias 3.68). Disagreement at REC probably is determined to the difficult to take echocardiography images immediately after the BH. **References** Crisafulli A, Milia R, Lobina A, Caddeo M, Tocco F, Concu A, Melis F. (2008). *Exp Physiol*, 93, 447-457. Bland JM, Altman DG. (1986). *Lancet*, 1, 307-310. Contact: [saretta84.m@gmail.com](mailto:saretta84.m@gmail.com)

### HISTORY AND APPLICABILITY OF THE LACTATE SHUTTLE HYPOTHESIS

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**Introduction** For almost a century lactate has been regarded as a dead-end metabolite, a fatigue agent and the product of oxygen-limited (anaerobic) metabolism. As the 1970's approached, sophisticated biochemical analyses and isotope tracer technology were introduced into studies of physiology and metabolism and new thinking affected articulation of the Lactate Shuttle (LS) hypothesis (Brooks 1984, Brooks 2009). **Methods** Assays of lactate concentrations in exercising rodents showed white muscle [lactate] > arterial [lactate] > white muscle [lactate] (Baldwin et al 1977). Radiotracer studies on exercising rats showed lactate production and oxidation to significantly exceed glucose disposal owing to the role of muscle glycogen. Studies with stable isotope tracers on resting and exercising humans confirmed results on rats and other mammals. The major effect of training was to improve lactate clearance via oxidation, although lactate was the main gluconeogenic precursor (Messonnier et al 2013). Western blotting, immunoprecipitation and confocal, laser-scanning microscopy showed the presence of lactate transporters (MCTs) in plasma and mitochondrial membranes (Hashimoto et al 2007). Measurements metabolite exchange across working muscles (Bergman et al 1999) and brains (Brooks and Martin 2014) showed simultaneous uptake and production of lactate, but not glucose. Results Lactate fluxes down concentration and pH gradients owing to presence of a mitochondrial lactate oxidation complex (mLOC). Realization that lactate was a major metabolic fuel and gluconeogenic precursor led to lactate polymers being included in sports drinks and strata for the incubation of stem cells. LS theory has been incorporated into cancer research where disrupting cell proliferation and tumor growth by blocking MCTs is being evaluated. And, in the field of neurobiology and critical care medicine the use of lactate to provide direct (oxidative) and indirect (gluconeogenic) support to traumatic brain injury (TBI) patients (Brooks and Martin 2014). **Discussion** Although controversial at its inception the LS Concept has survived intellectual and experimental scrutiny. Understanding the LS is key to understanding metabolic regulation. **References** Baldwin KM et al. (1977). *J Appl Physiol*, 43, 2, 288-291. Bergman B et al (1999). *J Appl Physiol*, 87, 1684-1696. Brooks GA (1984). *Comp Physiol & Biochem*, A, 208-218. Brooks GA (2009). *J Physiol*, 587, 23, 55-91. Brooks GA Martin NA (2014). *Front Neurosci*, 8, 408, 1-13. Hashimoto T et al. (2007). *FASEB J*, 21, 10, 2602-2612. Messonnier LA et al. (2013). *J Appl Physiol*, 114, 11, 1593-1602. Contact [gbrooks@berkeley.edu](mailto:gbrooks@berkeley.edu)

### HEART RATE RESPONSE AND LACTATE ACCUMULATION IN JUNIOR HANDBALLERS DURING ION TRIAL MATCH PLAY

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**Introduction** Handball is a high intensity team game, mostly dependent on aerobic metabolism but interspersed by fast running, jumping, and throwing the ball that greatly tax anaerobic metabolism. Heart rate response considered as the best indicator of cardiovascular stress whereas lactate accumulation may give an idea about the metabolic demand of the game. **Methods** Thirteen junior (U18) Indian handballers were the participants of this study. VO<sub>2</sub>max, maximal heart rate (HR<sub>max</sub>), and heart rate at lactate threshold (HRLT) were determined on treadmill by graded exercise protocol. HR was continuously recorded by telemetry at an interval of 5 s, throughout the match. Fingertip blood samples were collected at 15 min, 30 min, 45 min, and 60 min of the match. Data were collected from 4 selection trial matches. Each match was played in two halves (30 min x 2), separated by 10 min interval. **Results** VO<sub>2</sub>max, HR<sub>max</sub>, and HRLT of the handballers (n=13) are  $51.6 \pm 3.9$  ml/kg/min,  $199.3 \pm 4.1$  beats/min, and  $172.3 \pm 7.4$  beats/min respectively. Mean HR of BACK are significantly higher than PIVOT in both the halves of the matches. However, no significant difference was found between 1st and 2nd half of the matches. BACK spent nearly 20% of the total time of match play above the lactate threshold level, which is significantly higher than PIVOT (13.1%). Mean HR for each 5 min of play may vary widely from 149.1 to 169.8 beats/min during the game but such variation does not exist for every 15 min of play (159.1 to 163.5 beats/min). Blood lactate levels of BACK are higher than PIVOT at 30 min, 45 min, and 60 min, although only 45 min value is significantly higher. Peak HR ( $191.6 \pm 4.1$  beats/min) of the subjects attained during match play was significantly less than their HR<sub>max</sub> ( $172.3 \pm 7.4$  beats/min). **Discussion** Although intermittent and high-intensity in nature, handballers, in majority

of the time, play in the low-intensity zone such as low-intensity running, walking or jogging (Povoas et al., 2012; Karcher and Buchheit, 2014). Longer sprints and distance covered by BACK, than PIVOT, is responsible for higher mean HR in BACK. This may also be responsible for higher lactate accumulation in BACK. Frequent sprints, jumps, and throw for defense and attack allow BACK to play more time above the HRLT intensity when compared to PIVOT. Probably, the total number of attacks by both the teams, sprints, slow movements, jumps and throws are fairly equal in each 15 min of play but vary widely for each 5 min of play. Cardiovascular stress in handball, not even occasionally, reaches its tolerance limit

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## DIFFERENCES IN PHYSIOLOGICAL VARIABLES IN ELITE WRESTLERS

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**Introduction** Previous studies have discussed the differences in lactate (LH) before and after bouts of Free Wrestling and Greco-roman Wrestling (Kraemer, Fry et al., 2001; Nilsson, Csörgö et al., 2002; Karninčić, Tocilj et al., 2009; Barbas, Fatouros et al., 2011; Chino, Saito et al., 2015). Nevertheless, few studies have investigated the variation in aerobic characteristics (Yoon, 2002). The aim of this study was to compare Free Wrestlers and Greco-roman Wrestlers during recovery, specifically investigating the LH and aerobic variables. **Methods** Twenty-three elite male wrestlers, [13 Free Wrestlers (FW) and 10 Greco-roman Wrestlers (GRW), body weight 60–120 Kg], participated in the present study. Blood samples were taken all in the first, third and seventh minute of recovery. Also, aerobic variables were controlled during the recovery period. Student's t test were utilized to compare means between FW and GRW. **Results** The results of this study did not show any significant differences in LH, maximum oxygen consumption, maximum carbon dioxide production, maximum ventilatory rate, rating expenditure rate and breath frequency between Free Wrestlers and Greco-roman Wrestlers ( $p > 0.05$ ). **Discussion** To our knowledge, there is currently no literature investigating the differences in LH and aerobic variables in recovery between FW and GRW. Few articles discuss the differences in physical fitness between these two modalities, achieving significant results only in certain tests (Demirkan, Kutlu et al. 2014). Others compare recovery in other modalities; some authors found differences in LH peak and in LH recovery between long distance, sprint and middle distance athletes (Bret, Messonnier et al. 2003; Vucetic, Mozek et al. 2015). Additionally, LH peak and LH recovery were different between karate athletes of distinct levels (Ravier, Dugue et al. 2006). However, our results did not show differences in LH and aerobic variables recovery between the two modalities of wrestling, this could be due the modalities studied being similar in time and technique. LH variation appeared between the modalities when duration differences were significant. **References** Barbas I, et al. (2011). Eur J Appl, 111(7): 1421-1436. Bret C, et al. (2003). IJSM, 24(2): 108-113. Chino K, et al. (2015). JSSM, 55(4): 290-296. Demirkan E, et al. (2014). J Hum Kinet, 41(1): 245-251. Karninčić, et al. (2009). JSSM, 8(3): 17-19. Kraemer W, et al. (2001). MSSE, 33(8): 1367-1378. Nilsson J, et al. (2002). J Sports Sci, 20(11): 939-945. Ravier G, et al. (2006). IJSM, 27(10): 810-817. Vucetic V, et al. (2015). JSCR, 29(4): 1057-1063. Yoon J. (2002). Sports Med, 32(4): 225-233. Contact edu.rubiocastillo@gmail.com

## THE PHYSIOLOGICAL PROFILES OF SAUDI ELITE JUDO ATHLETES

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One of the most highly physiologically demanding combat sports is Judo, which requires an excellent level of physical fitness in order to be successful in international competitions. Therefore, the aim of this study was to assess the physiological profiles of Saudi elite judo athletes. 14 judo athletes (mean  $\pm$  SD, age,  $17 \pm 4$  years; body mass,  $66.7 \pm 21$  kg; height,  $160.2 \pm 13.6$  cm) performed the Special Judo Fitness Test (SJFT) and a maximal multistage 20-m shuttle run test to estimate maximal oxygen consumption ( $\text{VO}_{2\text{max}}$ ). Body fat percentage (BF%) was determined by bioelectrical impedance scale. Hand grip strength was measured by hand grip dynamometer and flexibility was determined by using Sit-and-Reach Test. The mean ( $\pm$ SD) of the index of the SJFT and  $\text{VO}_{2\text{max}}$  were  $16.2 \pm 1.6$  and  $42.5 \pm 8.5$  (ml/kg/min), respectively. The mean ( $\pm$ SD) of BF%, hand grip strength, and flexibility were  $24.1 \pm 7.2$  (%),  $31.4 \pm 11.5$  (kg), and  $34.6 \pm 6.7$  (cm), respectively. It is concluded that the SJFT was lower and BF% was higher in Saudi Judo athletes, compared to international elite Judo athletes.

## ROLE OF ATP INFUSION IN POST-EXERCISE FOREARM VASCULAR CONDUCTANCE RECOVERY

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**Introduction** Adenosine receptors appear to have a role in the post-exercise attenuation in cutaneous blood flow (McGinn et al., 2014). However, there is limited data evaluating the effect of exogenous administration of adenosine (ADO) and adenosine triphosphate (ATP) on the recovery forearm blood flow after moderate intensity exercise. The aim of this study was to evaluate the influence of ATP and ADO infusions on post-exercise blood flow during the first minute of recovery. We hypothesized that exogenous administration of ADO and ATP would accelerate the decrease in post-exercise muscle blood conductance. **Methods** Forearm blood flow (FBF) was measured using Doppler ultrasound during brachial artery ATP (n=9;  $30.1 \pm 4.4$  years) and ADO (n=9;  $29.4 \pm 4.4$  years) infusions. Participants performed a rhythmic handgrip exercise at 20% of the maximal voluntary contraction for four minutes. Rest and exercise trials were performed under saline infusion (saline) to serve as the control. During the ATP and ADO infusions measurements were recorded at minute 5 (trial 1), 30, 60, 120 and 150 (trial 5). FBF ( $\text{ml} \cdot \text{min}^{-1}$ ) was determined from the simultaneous measures of brachial artery mean blood velocity and diameter. Forearm vascular conductance (FVC;  $\text{ml} \cdot \text{min}^{-1} \cdot 100 \text{mmHg}^{-1}$ ) was calculated. **Results** ATP infusion increased significantly FBF and FVC at trial 1 ( $541.96 \pm 36.14$ ;  $606.61 \pm 42.05$ , respectively) and 5 ( $559.08 \pm 61.43$ ;  $595.73 \pm 74.43$ , respectively) compared to saline ( $280.51 \pm 47.81$ ;  $309.5 \pm 50.29$ , respectively) during the first minute of recovery. The recovery slopes calculated as percentage of the maximum value of FBF during ATP versus saline infusion were  $-0.35 \pm 0.23$  (trial 1),  $-0.89 \pm 0.18$  (trial 5) vs.  $-1.05 \pm 0.11$ . The slopes of FVC were  $-1.09 \pm 0.07$  (saline),  $-0.38 \pm 0.20$  (trial 1) and  $-0.97 \pm 0.21$  (trial 5). The slopes of FBF and FVC were similar between saline and trial 5 ( $p > 0.05$ ), while trial 1 was significantly lower compare to saline ( $p < 0.05$ ). FBF and FVC during ADO infusion were similar among trial 1, trial 5 and saline during the first minute of recovery. The recovery slope of FBF ( $-0.75 \pm 0.15$ ,  $-0.53 \pm 0.11$ ,  $-0.75 \pm 0.18$ , respectively) and FVC ( $-0.88 \pm 0.20$ ,  $-0.55 \pm 0.07$ ,  $-0.85 \pm 0.17$ , respectively) calculated as percentage of the maximum value was similar among saline, trial 1 and trial 5. **Discussion** Even though the adenosine receptors play a major role in cutaneous vascular conductance post-exercise, our results show that ADO does not have significant effects on the post-exercise FVC recovery. However, ATP seems to play a role in post-exercise FVC during recovery. **References** McGinn R, et al. (2014). J Physiol, 592(12), 2667-2678. Contact anabelen.peinado@upm.es



**LOWER LIMB AND ENERGY EXPENDITURE DURING CONSECUTIVE DAYS OF A MILITARY LOAD CARRIAGE TASK**

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**Introduction** During military exercises, moderate intensity exercise accompanied by heavy load carriage may last for prolonged periods of time (>2hrs), with tasks which may take place over repeated days (Blacker et al, 2010). The energy expenditure of the task and localised muscle fatigue needs to be considered as they are both potential factors which could determine performance outcomes, according to conventional endurance exercise models. The aim of this study was to investigate the relationship between lower limb performance and changes in estimated energy cost of heavy load carriage over consecutive days of exercise. **Methods** Fourteen participants (8 males: 88.8 Kg  $\pm$  16.8 Kg, 188.72cm  $\pm$  8.5cm; 6 females: 63.4kg  $\pm$  12kg, 164.2 cm  $\pm$  8cm) walked on a level treadmill carrying 32kg across webbing, backpack and rifle, at a speed of 5.4km-h<sup>-1</sup> for two hours on two consecutive days. During trials respiratory gases were assessed (Oxycon Pro: Germany) and used to estimate energy expenditure of the task at 30 minute intervals. Peak torque (PT) of lower limbs was assessed pre and post load carriage on day one and day two using isokinetic dynamometry (Biodex System 4, USA) for plantar and dorsi flexion (assessed at 0, 120, 60 °-s<sup>-1</sup>) and for knee flexion and extension (assessed at 0, 180, 60 °-s<sup>-1</sup>). **Results** Estimated energy expenditure at 30 minutes on day 1 equated to ~42 kJmin<sup>-1</sup> this value increased by ~5% when compared at the same period on day 2. The end of day 2 was 12% higher than the end of day 1 (P<0.05). From the start of the protocol to the end of day 2, significant reductions in PT (range 10-29%) were observed in ankle dorsi-flexors at 60 and 120°-s<sup>-1</sup> and knee flexors and extensors at 60 and 0°-s<sup>-1</sup>. These changes were significantly related to changes in energy expenditure during the two day task; dorsi flexors at 60 (r = -0.68; p<0.05) and 180°-s<sup>-1</sup> (r = -0.748; p<0.05), knee extensor (r = -0.6 and -0.76; p<0.05) and flexor (r = -0.65 and -0.676; p<0.05) at 0°-s<sup>-1</sup> and 60°-s<sup>-1</sup> respectively. **Discussion** Two consecutive days of heavy load carriage resulted in substantial decreases in peak torque in specific lower limb muscle groups. These changes were associated with increased energy demands of the task. These findings could help to identify a conditioning strategy associated with economical movement under load carriage conditions. Moreover this could have implications for injury prevention in a military cohort. **References** Blacker, S.D., Fallowfield, J.L., Bilzon, J.L. and Willems, M.E., 2010. Neuromuscular function following prolonged load carriage on level and downhill gradients. *Aviation, space, and environmental medicine*, 81(8), pp.745-753. Contact j.scales895@canterbury.ac.uk

**PERIODISED AND NON-PERIODISED TRAINING FOR MARATHON RACING BY MILITARY CADETS**

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**INTRODUCTION** Resistance training practices using periodisation models have shown to elicit better results compared to non-periodised resistance training (Prestes et al., 2009). However, there is lack of scientific information regarding the use of periodisation models on cardiorespiratory endurance performance. Thus, the purpose of this study was to compare periodised and non-periodised training by military cadets aiming at participation in the same marathon event. **METHODS** One hundred and fifteen (115) male military cadets (matched for marathon race time) with (mean $\pm$ SD of age, height and body mass: 21.3 $\pm$ 1.8 years, 177.0 $\pm$ 6.0 cm and 72.1 $\pm$ 6.4 kg respectively) were randomly divided into five groups (n=23 for each group). The linear periodised (LP), reverse linear periodised (RLP), block periodised (BP), non-periodised intensity focussed (NPI) and non-periodised volume focussed (NPV) group. The training programme was carried out five days per week for a period of ten weeks and involved various forms of running (low-pace, cross-country, intense) and a standardised resistance training program. Training volume was also recorded for each group. Following training all military cadets participated in a marathon race and time was recorded via a BibTag (MYLAPS, NL) timing system. **RESULTS** Analyses of variances showed a significant effect of group on post-pre marathon time difference (Mdiff) (p=0.001). Post-hoc revealed Mdiff to be significantly different in the NPV group (Mdiff=1.6 $\pm$ 5.2) compared to the BP (Mdiff=-5.0 $\pm$ 5.7; p=0.001) and RLP (Mdiff=-3.6 $\pm$ 4.9; p=0.015) groups. All other between group comparisons showed no significant results. A significant relationship existed between the average weekly training involving intense running and Mdiff (r=-0.242; p=0.009). More specifically, the average amount of intense running over the first 5 weeks of training correlated to Mdiff (r=-0.268; p=0.004) rather than the average amount of intense running during the final 5 weeks (p=0.256). Once corrected for average intense running in week 1-5, the significance of the group effect on Mdiff was reduced (p=0.049). **DISCUSSION** BP and RLP training showed to be the most effective periodisation strategies for improving marathon race performance in a group of military cadets. The amount of time spent at high intensity during the first 5 weeks of this 10 week program seems to be the main factor causing the group effect. This study therefore suggest that a large body of intense running should be scheduled in the early period of training before the event using a block periodised or reversed linear periodised training schedule. **REFERENCES** Prestes J, De Lima C, Frollini AB, Donatto FF, Conte M. (2009). *J Strength Cond Res*, 23(1), 264-274. **CONTACT** n.jongerius@leedsbeckett.ac.uk

**Mini-Orals****MO-BN06 Motion Analysis 1****ACCURACY OF JOINT ANGLES USING MARKERLESS SILHOUETTE-BASED TRACKING AND HYBRID TRACKING VS. TRADITIONAL MARKER BASED TRACKING**

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**Introduction** Markerless tracking is seen as a potential method to make movement analysis quicker, simpler and better available in many different areas of biomechanical application. Since this technology is still new in the fields of sports, markerless systems have to be evaluated for sufficient accuracy to serve as a valid tool. Therefore, the aim of this study was to assess the accuracy of the new silhouette-based tracking software "Simi Shape" for markerless and hybrid tracking versus traditional marker based tracking. **Methods** Specific joint movements and complex sports movements have been analyzed simultaneously using marker, silhouette and hybrid tracking (silhouettes + markers). Angles of shoulder, elbow, hip, knee and ankle joint have been compared using the three different methods by means of Spearman correlation coefficient and standard deviation of angle difference. In case of insufficient results based solely on measurements with markerless tracking, hybrid tracking solutions have been assessed additionally. **Results** Markerless tracking shows highly

accurate results for knee, ankle and shoulder movements in the sagittal plane ( $r_s = >0.9$ ). Using hybrid tracking comparable results could be achieved for all angles in all planes. Reasons for accuracy problems based on markerless tracking have been identified to occur mainly if segment rotations do not cause the silhouette to change. In this case hybrid markersets have been provided to improve the accuracy of these segment rotations. Discussion The results of this study indicate markerless and hybrid tracking to be efficient methods in terms of accurate joint angle data assessment, which present a promising technology in areas of sports and medical motion analysis. As this study only compared markerless/hybrid data with marker data for one single subject, further research should provide more information about methodological difficulties concerning intra- and inter-tester reliability in-between and between days using the different methods. As no accurate marker placement is needed for markerless or hybrid tracking this method might be superior compared with marker based systems in terms of reliability. Contact: philipp@simi.com

## **AUTOMATED VIDEO-BASED ANALYSIS OF GAIT USING DIRECTIONALLY-GROUPED CUBIC HIGHER-ORDER LOCAL AUTO-CORRELATION**

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In kinematical analysis of human gait, motion capture technologies are commonly used. Motion capture systems are commercially available for measuring kinematical characteristics of parts of interest during a variety of activities, recording and representing the data in real time or in delayed time. However, such technologies have been often used in experimental context, but not in practical context. In recent years, on the other hand, video-based time-motion analysis employing computer vision and pattern recognition techniques have attracted a great deal of attentions by virtue of the applicability in practical context. This paper presents a model-free and marker-less video-based system for time-motion analysis of human gait. The core technology utilized in the system is a motion feature extraction method called directionally-grouped cubic higher-order local auto-correlation (DgCHLAC) and has already been proposed by the first author (2011). This method follows the preprocessing in which the input color image sequences are segmented into either 1 (moved) or 0 (static) by using the Otsu's threshold selection method. For motion recognition tasks, Kobayashi and Otsu (2006, 2009) have proposed a scheme of adaptive vision system employing cubic higher-order local auto-correlation (CHLAC) motion features. They successfully applied the proposed method to gait recognition using the NIST gait dataset which was the largest one available. Their scheme outperformed the other existing approaches in all probes at that time. DgCHLAC motion features are obtained by classifying and integrating CHLAC components into predefined directions and positioned as meta-features over CHLAC. The present method can automatically extract motion characteristics such as orientation and speed of a moving object. In addition to such functions, the method possesses the following properties: the method requires neither prior knowledge, heuristics about objects nor time-consuming computational cost, as well as CHLAC. Applying the DgCHLAC motion features, the proposed system automatically extract some characteristics, such as durations of more detailed phases in walking cycle, number of steps and displacement speed. For performance evaluation of the proposed system, some public gait datasets consisting of videos captured by a stationary camera were used. As experimental results, each phases in level straight walking automatically segmented by the proposed method were shown. The proposed method could yield preferable results in the walking scenes after stand-walk transfer. The experimental results for temporal gait characteristic extraction showed the effectiveness of the DgCHLAC method for time-motion analysis of human gait. These results present the potential prospect of our approach toward development of gait analysis systems.

## **ACCELERATION OF THE WEAPON HAND DISCRIMINATES BETWEEN ELITE AND NON-ELITE FENCERS**

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Introduction Fencing is influenced by physiological determinants such as speed, endurance and strength. Movement analysis of upper and lower limbs is useful to analyze performance in fencing. Especially velocity of the weapon hand is related to the level of the fencer. Due to theoretical and methodological reasons, it seems advantageous to measure acceleration of the weapon hand. However, it is not known if acceleration is also a characteristic of top level fencers. To this end, we analyzed if acceleration of the weapon hand distinguishes between elite and non-elite fencers. Methods 31 male épée fencers of the German national team were examined. The group consisted of  $n = 18$  international level (elite) and  $n = 13$  national level (non-elite) fencers. The elite fencers were further divided into three subgroups, according to their national qualification outcome. 16 infrared markers of a 3D-Motion-Capture-System (AS 300, Lukotronic/Steinbichler, Austria) were attached to important landmarks of the body. Two markers at the wrist and the dorsum of the weapon hand were of interest. The system recorded movements and calculated the velocity of the weapon hand. Three different attacks were analyzed, namely touch, lunge, and flèche. A custom-built fencing dummy with 10 target areas was used during the experiment. Each attempt was triggered randomly by an optical signal of the target area by a green light. Then the fencer had to attack the target area as explosively and quickly as possible. For each attack the subjects had five attempts. By mathematical differentiation of the markers' velocity data, the acceleration of the weapon hand was obtained. Data was smoothed using a moving average filter. Results Elite fencers showed a significantly higher acceleration of the weapon hand than non-elite fencers in all three attack modes ( $p < 0.001$ ). There was no significant difference between the three subgroups of elite fencers. The flèche proved to be the movement with highest acceleration values throughout all groups. These values were significantly higher than those of the lunge and slightly higher than the touch. Discussion The results demonstrate that acceleration of the weapon hand distinguishes elite from non-elite fencers. This is a relevant result, because acceleration is easier to be measured than velocity and is furthermore a better indicator for explosiveness and initial speed. Since acceleration of the weapon hand was not related to performance within the elite group, it remains unclear if improvements in acceleration above a certain threshold will help to improve performance. Conclusion We conclude that acceleration of the weapon hand is a determinant of fencing performance. Since it is easily to be measured, it has potential to become a part of routine performance analysis.

## IDENTIFYING THE ROLE OF COCKING PHASE DURING JUMP THROWING IN HANDBALL USING 3D KINEMATIC ANALYSES

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**Introduction** In handball throwing, acceleration phase is very important and the most researchers focused on it. Although, it depends on the cocking phase, there is a lack of research that regarding to determine the role of cocking phase during jump throwing in handball. Therefore, this study aimed to determine the role of cocking phase using 3D kinematic analyses. **Methods** Ten Handball players participated in this study (age:  $20.8 \pm 1.21$  years; body mass:  $82.8 \pm 8.57$  kg; height:  $189.6 \pm 8.65$  cm). After 15-minute warm-up, the participants completed jump-throws from the 7-m penalty line after three running steps. A total of five successful attempts were recorded for each participant, one minute rest between attempts. The best attempt was selected for 3D analyses. Eight synchronised high-speed cameras were used at a 100 Hz frequency. SIMI 3D motion analyses system was used for capture and analyses. The 3D coordinates were the X (medio-lateral), Y (anterior-posterior) and Z (vertical) directions respectively. **Results** There are significant correlations between ball velocity with linear and angular kinematics (displacement, velocity, acceleration) at cocking phase more than acceleration and following phases, displacement of COM Y ( $r=0.710$ ,  $p<0.05$ ), velocity of COM Y ( $r=0.838$ ,  $p<0.01$ ), shoulder velocity ( $r=0.686$ ,  $p<0.05$ ), velocity of COM Y at acceleration phase ( $r=0.892$ ,  $p<0.01$ ). **Discussion** Results emphasised the role of cocking phase, according the strong correlation significant between displacement and velocity in the anterior-posterior dimension (movement direction) with ball velocity. Furthermore, the relationship of cocking displacement and velocity indicated to these contributions to increase both of displacement and velocity in the acceleration phase to gain maximum work and power. In addition, shoulder velocity is one of the important parameters that associated with the increase of ball release (Wagner et. al., 2011). **References** Wagner, H., Pfusterschmied, J., Duvillard, S. P. v., & Müller, E. (2011). Performance and kinematics of various throwing techniques in team-handball. *Journal of Sports Science and Medicine*, 10(1), 73-80. Contact [abdelrahman.akl@alexu.edu.eg](mailto:abdelrahman.akl@alexu.edu.eg)

## EFFECT OF 24 DAYS BASEBALL THROWING ON THE BALL SPEED AND KINEMATICS IN NON-SKILLED THROWER

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**Introduction** For the skilled throwers, it is revealed that trunk segment twist, shoulder internal rotation, elbow extension and wrist flexion angular velocity at release contribute the translational velocity of the fingertip (VF) at the release (Hirashima 2007). On the other hand, it is unknown whether non-skilled thrower's contribution to VF (C-VF) at release of each angular velocity was similar to the skilled thrower's characteristics or not. If non-skilled thrower's characteristic of C-VF at release differ from skilled throwers, we need to capture how non-skilled throwers improve throwing performance in long term. Therefore, we investigated the ball speed, as a throwing performance outcome, and C-VF at release on novice for throwing during 6weeks throwing practice. **Method** One female volunteer participated in this study. As a task, the subject was required to throw a baseball 60 trial as possible as fast in a day and performed this task 24 days (4 days per week), thus, total number of throwing trials were 1440. Marker coordination data attached to subject's body and baseball were collected during throwing. The ball speed, subject's segment angular velocity and joint angular velocity was calculated from marker coordination data and then the VF at release and C-VF at release of selected angular velocity was also calculated. **Results** The ball speed and VF at the last throwing (1440 trial) increased approximately 50% compared to them at first throwing (1 trial). The C-VF of elbow extension angular velocity were highest of all measured angular velocity in 6 weeks. Later phase in this experiment, C-VF of angular velocity of shoulder internal rotation and trunk segment twist were higher than early phase. **Discussion** On the early phase, even though VF and C-VF of angular velocity of shoulder internal rotation, wrist flexion and trunk segment twist were half or less of skilled throwers, C-VF at release of elbow extension angular velocity was similar to value of skilled throwers. This result would support previous study that forceful throwing the ball of non-skilled throwers mainly use the elbow extension movement at release (Atwater 1979). In conclusion, we were able to capture the characteristics of long term change and C-VF at release on non-skilled thrower. **Reference** Hirashima M. Kudo K. Watarai K. Ohtsuki T. (2007). *Journal of Neurophysiology*, 97(1), 680-691 Atwater A. (1979). *Exercise and Sport Science Review*, 7, 43-85 Contact [Peishin0530@gmail.com](mailto:Peishin0530@gmail.com)

## REPRODUCIBILITY OF A TENNIS SERVE PROTOCOL

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**INTRODUCTION** Serve in modern tennis game is a real offensive weapon for players. In kinematic analysis, it is the most studied stroke of this game because it is the only stroke played in a closed skill. Players have a maximum of control on this stroke. It is unclear whether 3D kinematic tests are reproducible for the same player under identical conditions and if a familiarization session is necessary. In practice, with professional players, who have little time available to perform tests, familiarization sessions are difficult. The aim of our study is to measure the reproducibility of a 3D serve protocol test. **METHODS** Nine tennis players (righties, regional level,  $20 \pm 2$  years) were asked to hit first flat serves in a  $1 \text{ m}^2$  area placed on the 'T' zone of deuce diagonal of the tennis court. Two identical tests are performed one week apart. For each test, we selected the three best serves of the 25 trials (with the highest speed and the highest accuracy). Kinetics measurements were performed using a 3D analysis system (Codamotion), a force platform (Kistler) and a radar gun. 28 markers were placed on the players' bodies to measure kinematics of the movements: ankles, knees, hips, trunk, shoulder, elbow and wrist dominant side. We measured ball speed, leg drive, linear velocity of the racket and joints, joints range of motion and maximum angular velocities at different positions (armed, maximum external rotation and impact) (1). **RESULTS** All analyzed parameters (linear speeds of racket and joints, leg drive force, joint angles and angular velocities) are reproducible with exception of a small part of them. Our study shows that 5,7% (7 of 122 measurements) joint position parameters and 8,3% (4 of 48 measures) angular velocity parameters are not reproducible from a session to another. **DISCUSSION** Various errors sources encountered in 3D analysis can justify the presence of non-reproducible parameters (2-3). However, after this work, we can state that the established protocol provides reproducible results when analyzing the tennis serve. **REFERENCES** 1. Tubez, F., Forthomme, B., Croisier, J., Cordonnier, C., Bröls, O., Denoël, V., Joris, M., Grosdent, S., Schwartz, C. (2015). Biomechanical Analysis of Abdominal Injury in Tennis Serves. A Case Report. *Journal of Sports Science and Medicine*, 14, 402-412. 2. Cappozzo, A., Catani, F., Leardini, A., Benedetti, M. G., & Della Croce, U. (1996). *Clinical Biomechanics*, 11, 90-100. 3. Reischmidt, C., Van den Bogert, A. J., Nigg, B. M., Lundberg, A., & Murphy, N. (1997). *Journal of Biomechanics*, 30, 729-732. **CONTACTS** e-mail : [Francis.Tubez@ulg.ac.be](mailto:Francis.Tubez@ulg.ac.be)

## FLEXOR HALLUCIS LONGUS MUSCLE MECHANICS DURING HUMAN WALKING

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**Introduction** Flexor hallucis longus (FHL) is a deep ankle plantar flexor muscle that, according to cadaver studies [1, 2], works rather isometrically during walking. We aimed to examine in-vivo the fascicle length changes of FHL muscle during overground walking at different speeds. **Methods** Ten healthy men walked overground at three different speeds (preferred (p) speed, 30% slower (s) and 30% faster (f) than preferred speed). Fascicle length change was recorded with ultrasonography at 80 Hz. One-way repeated measures ANOVA was used to test the differences between maximum length, minimum length, range and mean fascicle velocity across the stance and push-off phases of each walking speed. The minimum level of statistical significance was set at  $P < 0.05$ . **Results** Maximum, minimum and range of fascicle length did not change with speed in the stance or push-off phase. In both phases, mean fascicle length change velocity increased significantly with speed ( $F=14.835$ ,  $P_{sp}=0.015$ ;  $P_{sf}=0.004$ ; and  $F=12.451$ ,  $P_{sp}=0.033$ ,  $P_{sf}=0.01$ ,  $P_{pf}=0.045$ , in stance and push-off, respectively). **Discussion** During the whole stance phase we found that FHL fascicles worked at approximately the same length. Our results support previous cadaver findings [1, 2] that FHL muscle works near-isometrically during walking, which is associated with economical muscle work. We also found that with increasing walking speed, fascicle length change velocity increased but the operating range was similar. Although healthy subjects were examined in this study, the possibility to measure FHL mechanics in vivo may enable the study of impairments such as Achilles tendinopathy or flatfoot which have been found to be associated with altered FHL electrical behaviour [3] or morphology [4], respectively. **References** [1] Hofmann CL, Okita N, and Sharkey NA. (2013). *Clin Biomech*, 28, 686-691. [2] Kirane YM, Michelson JD, and Sharkey NA. (2008) *Foot Ankle Int*, 29, 367-377. [3] Masood T, Kalliokoski K, Bojsen-Møller J, Magnusson PS, Finni T. (2014). *Clin Biomech*, 29, 564-570. [4] Angin S, Crofts G, Mickle KJ, Nester CJ. (2014). *Gait & Posture*, 40, 48-52. Contact [anamaria.a.peter@jyu.fi](mailto:anamaria.a.peter@jyu.fi)

## LOWER EXTREMITY BIOMECHANICS DURING FORWARD STEPPING MOVEMENTS IN BASEBALL CATCHERS

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**Introduction** The catcher should receive as much attention as a pitcher does in determining the factors involved in infield defense (Barzun, 1973). In a baseball game, catchers make more throws than other position player. Baseball coaches' main focus to maintain fast yet proper footwork, align the front shoulder with target, take out the ball quickly and pass it out in an actual situation (Fortenbaugh et al., 2010). Therefore, the aim of the present study was to investigate the lower extremity biomechanics involved forward stepping throwing and non-stepping movements in squatting postures. **Methods** Healthy college baseball catchers ( $n=12$ ) were recruited for the study. An eight-camera Expert Vision Raptor motion analysis system (Motion Analysis Corp., Santa Rosa, CA, USA) was used to collect the position of the reflective markers at a sampling rate of 500 Hz. The tri-axial measurement of ground reaction force of catcher's pivot foot is carried out with two force plates (1000 Hz) made by Kistler Instrument Corporation (Type 9281B: 2 sets, Kistler Instrument Corp, Winterthur, Switzerland). **Results** A number of significant differences were seen between the forward stepping throwing and non-stepping throwing, most notably ball speed (forward stepping throwing:  $29.36 \pm 3.63$  m·s<sup>-1</sup>; non-stepping throwing:  $25.734 \pm 2.03$  m·s<sup>-1</sup>) ( $p = 0.000$ ). In pivot foot, the adduction and abduction of knee and hip joint in non-stepping throwing were significantly greater than forward stepping movement ( $p=0.000$ ). When forward stepping movement is performed, the upward-forward ground reaction force of the pivot foot is significantly greater than in non-stepping throwing ( $p = 0.000$ ), and this difference continues to the stride period. **Discussion** In a previous study by Plummer and Oliver (2013), catchers passed the ball on knees. It was found that when lower limbs could not perform footwork, they were able to contribute little to energy generation in ball-passing movement, which put more loading on upper limbs and increased injury risk. Through forward stepping movement, this study identified that the greater upward-forward ground reaction force in the pivot foot appeared at the stride phase to push off and generate the driving force. Moreover, previous investigators founded Weight-shift (forward stepping) throwing caused the flexion angle for greatest hamstring activation in the midst of the stride phase and pivot throwing occurred directly after the stride phase (Plummer and Oliver, 2014). To sum up, which is a possible reason for the higher ball speed and less injury risk in forward stepping movement. These information suggested helpful when training and developing efficient throwing mechanics. **References** Barzun, J. (1973) God's country and mine. Connecticut: Greenwood Press Reprint. Plummer, H. A., & Oliver, G. D. (2014). The relationship between gluteal muscle activation and throwing kinematics in baseball and softball catchers. *Journal of Strength & Conditioning Research*, 28(1), 87-96. Contact E-MAIL: [yichian423@gmail.com](mailto:yichian423@gmail.com)

## Mini-Orals

### MO-PM12 Neuromuscular Physiology

#### REACTION TIME IN THE PERIPHERAL VISUAL FIELD IN THE DIFFERENT DEPTHS

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**Introduction** Many studies showed the reaction time (RT) took longer in the peripheral visual field than the central one (Ishigaki, 1983; Osaka, 1976; Ando et al., 2005) and the RT for the peripheral visual field is much longer when attention is paid to the central field. However, it has not been clear whether the RT in the peripheral visual field is different in depth. The purpose of this study is to examine the reaction time in the peripheral visual field that is different in depth from the central visual field. **Methods** Fifteen college students participated in the experiments 1 and 2. A head-mounted display was used to do the central task (CT) and peripheral task (PT). In the CT a character (either a number or an English letter) was presented in the center, the position of 50cm in depth, at random every second and the participants were asked to answer how many times the number was shown. In the PT, eight balls were shown at a view angle of 30 degrees in the eight different directions, at a 50cm depth in the experiment 1. In the experiment 2, they were presented in the four different directions, at a 20cm or 80cm depth. The RT was measured until participants perceived the change from a white ball to red one and pushed the button corresponding to each position of the ball. The electroencephalogram (EEG) at Cz, and the horizontal and vertical electro-oculogram (EOG) were recorded. **Results** The RT in the horizontal direction decreased significantly relative to the RT in the vertical



direction in the experiment 1. In the experiment 2, the RT at a 20cm depth decreased significantly relative to the RT at a 80cm depth. The vertical EOG (indicating eye blinking) changed 1.3 seconds after the ball turned to red. The event-related potentials (ERPs) appeared 0.4 seconds after the ball turned red, but there were no significant differences in the directions. Discussion The experiments showed that the RT was shorter (1) in the right and left directions and (2) on the front side. One of the reasons for (1) would be that binocular visual field was wider in the horizontal direction than the vertical one. (2), on the other, would be because the balls on the front side come into view more easily and because the apparent size of balls on the front side is bigger than that on the back side in the virtual reality world. The EOG suggested that the eye blink might be related to the change of characters but it tended to be inhibited when the characters and the balls happened to change simultaneously. References Ishigaki H. (1988). AIT Associated Repository of Academic Resources, 18, 65-71. Osaka N. (1976). Perceptual and Motor Skills, 43, 603-606. Ando S., Kida N. and Oda S. (2005). Perceptual and Motor Skills, 95, 747-751. Contact [yumiko@is.oit.ac.jp]

## THE EFFECTS OF SENSORIMOTOR TRAINING AND WHOLE BODY VIBRATION ON PATIENTS SUFFERING FROM CHEMOTHERAPY-INDUCED PERIPHERAL NEUROPATHY

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Chemotherapy-induced peripheral neuropathy (CIPN) is a highly prevalent and clinically relevant side-effect of chemotherapy. Depending on the agent, 60-90%[1] of patients are affected. The motor and sensory symptoms, not only severely diminish patients' quality of life, but represent a decisive limiting factor for medical therapy, consequently affecting the clinical outcome. To date approved and effective treatment options are lacking[2]. Promising results have now been achieved with specific exercise interventions[3]. Our objective was therefore, to analyze the effects of sensorimotor training (SMT), as well as a further neuromuscular stimulating exercise intervention, whole body vibration (WBV)[4], on the relevant side-effects of CIPN. We conducted a prospective, four-armed, randomized, controlled trial, to evaluate the feasibility and effects of SMT and WBV on patients with a neurologically confirmed CIPN. Patients (N=40) were randomized either into one of the intervention groups or a control group and matched by gender and age with a healthy control. The intervention groups had to participate in the supervised exercise regime at least twice a week for six weeks. Primary endpoint was the patient reported reduction of CIPN related symptoms. Secondary endpoints were balance control, nerve conduction velocity and amplitude, peripheral deep sensitivity, Achilles- and Patellar tendon reflex, proprioception, quality of life, CIPN-related pain and the level of activity. Patients in both exercise interventions (SMT and WBV) profited. They were able to reduce symptoms and regain functions comparable to healthy controls. Both groups showed improved reflexes, peripheral deep sensitivity and quality of life in comparison to the control group. The interventions targeted slightly different symptoms. SMT for instance, induced higher performance in balance control while WBV was more efficient regarding peripheral deep sensitivity. Further results will be ready for presentation at the conference. We conclude that SMT and WBV are not only feasible in patients with CIPN but also behold a large potential that is of high clinical relevance, to reduce CIPN-related symptoms and improve patients' quality of life. 1. Stubblefield MD, Burstein HJ, Burton AW, et al. NCCN task force report: management of neuropathy in cancer. Journal of the National Comprehensive Cancer Network : JNCCN 2009;7 Suppl 5:S1-S26; quiz S7-8. 2. Wonders KY, Reigle, B.S., Drury, D.G. Treatment strategies for chemotherapy-induced peripheral neuropathy: potential role of exercise. Oncol Rev 2010;4:117-25. 3. Streckmann F, Kneis S, Leifert JA, et al. Exercise program improves therapy-related side-effects and quality of life in lymphoma patients undergoing therapy. Annals of oncology : official journal of the European Society for Medical Oncology / ESMO 2014;25:493-9. 4. Streckmann F, Rittweger J., Baumann F.T. Bewegungsempfehlungen bei Chemotherapie-induzierter Polyneuropathie Bewegungstherapie und Gesundheit (B&G) 2014;30:179-82. f.streckmann@dshs-koeln.de

## PROLONGED VIBRATION TO VASTUS INTERMEDIUS INFLUENCES FORCE FLUCTUATION OF QUADRICEPS FEMORIS DURING A LOW-LEVEL FORCE-MATCHING TASK

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Introduction When attempting to match a target during steady contraction, afferent inputs from Ia fibers in muscle spindles are essential to control the generated force. Prolonged vibration has been applied to muscle-tendon units to manipulate the synaptic input from Ia afferents onto  $\alpha$ -motor neurons (Roll et al., 1989). Vastus intermedius muscle contributes up to 50% of knee extension torque from quadriceps femoris during low-level torque generation ( $\leq 20$  Nm) (Zhang et al., 2003). Thus, the present study aimed to test the hypothesis that prolonged vibration to vastus intermedius increases force fluctuation of quadriceps femoris during a low-level force-matching task. Methods Nine healthy men ( $25.1 \pm 4.3$  years) performed a submaximal force-matching task of isometric knee extension before and after mechanical vibration to superficial region of vastus intermedius for 30 min. The force-matching task involved knee extension for 15 s to match target forces displayed on a monitor. The target force was 2.5%, 10%, and 30% of maximal voluntary contraction (MVC). Force fluctuation was determined by coefficient of variation (CV) of force. Surface electromyography (EMG) from four synergists of quadriceps femoris was recorded (Watanabe & Akima, 2009), and then the EMG amplitude and frequency were calculated. Results After prolonged vastus intermedius vibration, the CV of the force at 2.5%MVC was significantly increased, but CVs at 10% and 30%MVC were not significantly changed. EMG amplitudes of four muscles of the quadriceps femoris at each target level were not significantly changed after the prolonged vibration. A significant decrease in EMG frequency at 2.5%MVC was observed in vastus intermedius following the vibration. Discussion Application of prolonged vibration to vastus intermedius increased force fluctuation of quadriceps femoris during a very low-level force-matching task. This supports the present hypothesis. The finding suggests that prolonged vastus intermedius vibration modulates Ia afferents onto  $\alpha$ -moto neuron loop, and torque-dependent contribution of vastus intermedius influences the fluctuation of knee extensor force. An increase in low-frequency EMG signal is influenced by alterations in firing rate of motor units (Broman et al., 1985). Thus, a reduction in the EMG frequency at 2.5%MVC may indicate that modulation of the firing rate of motor units of vastus intermedius affects the steadiness of quadriceps femoris. References Broman H, Bilotta G, De Luca CJ. (1985). J Appl Physiol, 58,1428-1437 Roll JP, Vedal JP, Ribot E. (1989). Exp Brain Res, 76, 213-222 Watanabe K, Akima H. (2009). J Electromyogr Kinesiol, 19, e280-e289 Zhang LQ, Wang G, Nuber W, Press, M, Koh L. (2003). J Orthop Res, 21, 565-571 Contact a-saito@aoni.waseda.jp

## CORTICOSPINAL AND TRANSCALLOSAL MODULATION OF BILATERAL AND UNILATERAL CONTRACTIONS

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**Introduction** Bilateral deficit (BLD), a phenomenon of a reduction in the amount of force from a single limb during bilateral actions, has been studied extensively but the underlying mechanisms remain obscure. Interhemispheric inhibition (IHI) through the transcallosal pathway may be responsible for the occurrence of the phenomenon (Oda & Moritani 1995). Bilateral (BL) training may reduce BLD and athletes who perform predominantly BL actions (e.g. weightlifters) have been shown to exhibit even bilateral facilitation (BLF) (Howard & Enoka 1991). Conversely, unilateral (UL) training may increase the magnitude of BLD and thus athletes from sports where performance is ultimately limited by UL force production (e.g. long jumpers) may exhibit greater magnitude of BLD. Therefore, if IHI is truly the underlying cause of BLD it is of interest whether the nature of IHI is reflective in the magnitude of BLD. **Methods** 20 male subjects were recruited (ALL) and additionally split into three groups: bilateral (5 weightlifters, 2 powerlifters), unilateral (4 long jumpers, 1 high jumper) and control. Subjects performed maximal UL and BL isometric knee extensions during which electrical stimulation and both contralateral (c) and ipsilateral (i) transcranial magnetic stimulation were performed. Variables of interest included peak torque for calculation of bilateral index (BI), RMS EMG for calculation of BI in EMG activity (BI<sub>EMG</sub>), voluntary activation level (VA), motor evoked potentials (cMEP and iMEP), and silent periods (cSP and iSP). **Results** Significant BLD was observed only for ALL (BI =  $-8.76 \pm 13.43$ ,  $p = 0.009$ ), but not for any of the groups. No BLD was noted in EMG activity and no parallelisms between force and EMG BIs were found. VA was significantly higher during BL compared to UL contractions ( $\sim 97\%$  vs.  $93\%$ ,  $p = 0.045$ ), with no differences between groups. MEPs and iMEPs during BL were significantly bigger ( $\sim 6\%$ ,  $p = 0.042$ , and  $27\%$ ,  $p = 0.005$ , respectively) than during UL contractions with no differences between groups. No differences in cSP and iSP were noted regardless of grouping. **Discussion** BLD was observed only for ALL, but not for the subgroups, likely due to poor testing specificity. Unaltered SPs do not support the concept of inhibition at the cortical level in relation to BLD. On the other hand, higher cMEP, iMEP and VA values during BL when compared to UL could indicate involvement of some facilitatory mechanisms. However, we cannot exclude the possibility of inhibition located upstream of the primary motor cortex or at the subcortical level. **References** Oda, S., Moritani, T. (1995). *Eur J Appl Physiol* 72, 1-5. Howard, J., Enoka, R. (1991). *J Appl Physiol* 70, 306-316. Contact jakob.skarabot@gmail.com

## EXAMINING THE RELATION OF CEREBRAL LATERALIZATION, HAND PREFERENCE AND GRIP STRENGTH IN ELITE FENCING ATHLETES

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**Introduction** Cerebral Lateralization is defined as the anatomical and functional differentiation between the right and left hemispheres of the brain. Each hemisphere has different functions and the dominant hemisphere fulfils its duties better than the other. One of the hemispheres being heavier than the other is an anatomical lateralization; however, the hand preference, which shows the functional asymmetry related to the brain best, is accepted as a functional cerebral lateralization. The grip strength in hand functions is a significant function for the continuity of daily life activities. Therefore, the grip strength is accepted as an objective measurement in performance evaluation of the upper extremity. Accordingly, the goal of this study is to examine the relation of cerebral lateralization, hand preference and grip strength in fencing, which provides health, endurance, speed, strength, agility, flexibility, balance, reflexes, coordination, intuition, timing ability, quick thinking and decision-making for your body. **Methods** 117 elite fencing athletes, attended Interuniversity Fencing Championship, voluntarily participated in the study whose ages range from 18 to 25. Hand preference was confirmed by Oldfield Survey and evaluated between +100 and -100 according to the Geschwind Score. Two sportsmen were excluded from the study as they were ambidextrous. In the intergrouping comparisons right-handed and dominant right-handed were grouped as right-handed, left-handed and dominant left-handed were grouped as left-handed. Hand grip strength was measured by Jamar hydraulic dynamometer. Data was evaluated after it was transferred to the SPSS for Windows 21.0 programme. Average values were shown as "arithmetic average \* standard deviation". In the intergrouping comparisons Mann-Whitney U and Pearson correlation analysis were used. Analysis results were evaluated in the 95% confidence interval. Correlation factor was adopted as 0.000-0.250 weak or none, 0.251-0.500 intermediate, 0.501-0.750 strong, 0.751-1.000 very strong relationship. **Results** 48.1% of the subjects attended our study were dominant right-handed, 40.3% were right-handed, 10.2% were left-handed and 1.4% were dominant left-handed. Dominant hand grip strength was 44.2 for the right-handed and 43.9 for the left-handed. For the nondominant hand it was in order of 42.8 and 41.5. **Discussion** This functional laterality may due to the dominance of left hemisphere. The results were compared to those in literature. It is significant to make similar evaluations intended for hand and hand performance on more subjects and different ages and different competition categories in which hand performance is improved by active use. **References** Oldfield R.C., The assessment and analysis of handedness the Edinburgh Inventory, *Neuropsychologia* 1971;9, 97-114

## ACUTE EXPOSURE TO MODERATE ALTITUDE INCREASED SPINAL EXCITABILITY

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**2:** University of Granada, Department of Physical Education and Sport, Granada, Spain **Introduction** Muscle power output (PO) during rapid actions, such as bench-press, could be enhanced at altitude (Feriche et al., 2014). The main reasons were attributed to a reduction in the aerodynamic resistance. Since 50 m front crawl time also improves at moderate altitude compared to sea level, the reduction in the external resistance could only partly account for improved PO. Improvement in PO has been mainly attributed to muscular, e.g. hypertrophy and neurological factors; e.g. enhanced firing frequency of motoneurons (MN) and enhanced spinal reflexes. Increased spinal excitability was already observed in artificial hypoxic condition (Delliaux, Jammes, 2006). Accordingly, increased MN excitability could be one of the mechanisms, which enhance rapid power production in altitude. To date, little is known about the consequence of acute exposure to hypobaric hypoxia - HP (i.e. moderate altitude) on spinal excitability, measured as changes in H-reflex amplitude. Therefore, our study was designed to test the effect of acute exposure (15 min to 6 hour) to moderate altitude on alpha-motoneuron excitability at rest. **Methods** Fifteen male and female physical education students ( $22 \pm 2$  years,  $69 \pm 8$  kg,  $176 \pm 6$  cm) participated in the study. Hmax/Mmax ratio of the soleus muscle was measured every three hours (11:00am, 14:00pm, 17:00pm) on two consecutive days in normoxia - NO and HP (2230 m.a.s.l.). Control H-reflex amplitude was always measured at 8:00am in NO. Fifteen minutes before the first measurements (at 11:00 am) participants ascended in altitude. **Results** Control Hmax/Mmax ratios were  $0.39 \pm 0.16$  and  $0.38 \pm 0.17$  ( $P > 0.05$ ). At 11:00am ratio increased

in HP (~48%) and NO (~13%; both  $P < 0.05$ ). The increment was greater in Hypo compared to NO ( $P = 0.058$ ). Three and six hours later a decrement (both ~10% and  $P < 0.05$ ) in ratio was observed in HP, however ~27% (at 14:00pm) and ~20% (at 17:00pm) higher ratio (both  $P < 0.05$ ) was still observed compared to control. In NO ratio slightly increased at 14:00pm and stayed the same at 17:00pm. There were no differences in ratios at 14:00am and 17:00pm between NO and HP. Discussion It seems that acute HP induced initial facilitation of the H-reflex. Although, after three hours a reduction in HP was observed (compared to initial value in HP), the ratio was still a little higher than in NO (~27% vs ~23%;  $P > 0.05$ ). Initial facilitation may result from the direct effects of hypoxemia on the supraspinal structures controlling the H-reflex (Delliaux, Jammes, 2006). References Delliaux S, Jammes Y. (2006). *Muscle Nerve*, 34, 754-61. Feriche B, García-Ramos A, Calderón-Soto C, Drobic F, Bonitch-Góngora JG, Galilea PA, Riera J, Padial P (2013). *PLoS One*, 9, e114072. Contact katja.tomazin@fsp.uni-lj.si

## EFFECTS OF THREE WEEKS OF WINGATE-TYPE HIGH-INTENSITY INTERVAL TRAINING ON MUSCLE FATIGUE AND RYR1 EXPRESSION

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**Introduction** High-intensity interval training (HIIT) is a time-efficient training paradigm eliciting similar skeletal muscle molecular adaptations as traditional forms of endurance training (Gibala et al. 2006). Recently, neuromuscular alterations induced by a single HIIT session were found to be similar between recreationally active participants and elite-endurance athletes (Place et al. 2015) while the sarcoplasmic reticulum  $\text{Ca}^{2+}$ -channel (ryanodine receptor 1; RyR1) integrity was changed only in recreationally active participants. We now trained recreationally active subjects for three weeks with HIIT to investigate whether this would improve RyR1 integrity. **Methods** Eight healthy and recreationally active males ( $27 \pm 6$  years,  $77 \pm 8$  kg) volunteered to participate in nine HIIT sessions (3 sessions per week) consisting of initially four and later six 30-s "all-out" cycling bouts (i.e. Wingate) interspaced by 4 min of rest. An incremental cycling test (+1W every 2 s) was performed before and after the 3 week training. For the first and last HIIT sessions, knee extensor neuromuscular function was evaluated before and immediately after as well as 24 h after. Maximal voluntary contraction (MVC) force was assessed and 100-Hz paired electrical stimulations (PS100) were delivered during and following each MVC to assess central and peripheral fatigue. Muscle biopsies were collected from the vastus lateralis before and 24 h after the first and last training sessions. RyR1 protein expression was analyzed with Western blots. Data are presented as mean  $\pm$  SD. **Results** Nine HIIT sessions resulted in an  $8 \pm 5\%$  increase in maximal power output during the incremental test. Similarly, the overall work performed during one HIIT session was increased by  $8 \pm 6\%$ . Interestingly, this greater work led to a similar reduction in MVC ( $-41 \pm 20\%$ ) and PS100 ( $-49 \pm 22\%$ ) forces immediately after a HIIT session. The maximal voluntary activation level remained unaltered at all time points. Preliminary data suggest that RyR1 expression was decreased 24 h following the first HIIT session, while it was less altered after the 9th HIIT session. **Conclusion** Nine HIIT sessions were sufficient to substantially improve recreationally active participants' endurance performance. Interestingly, the preliminary molecular data suggest that this performance improvement is accompanied by improved RyR1 integrity. References Gibala et al. *J Physiol* 575.3: 901-911, 2006 Place et al. *PNAS* 112: 15492-15497, 2015 Contact daria.neyroud@unil.ch

## EFFECTS OF ELECTROSTIMULATION ON MUSCLE OXYGENATION AND MUSCLE CONTRACTILE PROPERTIES

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**Introduction** Neuromuscular electrostimulation (NMES) is well known for its variety of applications, such as strength training, rehabilitation and post-exercise recovery. However, the effects of NMES on muscle oxygenation (OXY) and muscle mechanical response are poorly understood. The aim of this study was to investigate the effects of NMES on muscle oxygen saturation and muscle contractile properties. **Methods** The motor point of the vastus medialis was determined in nine physically active men (age:  $23.0 \pm 3.7$  years, height:  $178.1 \pm 5.8$  cm, body mass:  $71.9 \pm 3.9$  kg) and electrodes placed to apply a NMES protocol. The NMES protocol consisted of 5 cycles of 72 seconds (1s contraction/1s recovery), with a total of 36 contractions per cycle at 40Hz. The intensity was set at the individual tolerable limit. Additionally, measurements of tensiomyography (TMG, Dm: maximum displacement; Td: delay time; Tc: contraction time) were taken before the NMES protocol (PRE), 30 seconds after the end of each cycle (NMESn), and every 5 minutes during the 30 minutes recovery (POSTn). A muscle oxygen saturation monitor was placed on the vastus lateralis during the experiment. **Results** Dm was higher in NMES1 than in PRE ( $8.36 \pm 1.39$  vs  $7.21 \pm 1.46$ ,  $P < 0.05$ ). Td and Tc were lower in NMES1 than in PRE ( $20.84 \pm 1.57$  vs  $21.77 \pm 1.09$ ,  $P < 0.05$ ; and  $21.76 \pm 2.70$  vs  $22.87 \pm 2.71$ ,  $P = 0.07$ , respectively). Neither of the following TMG measurements of the NMES cycles were significantly different from PRE. During recovery only Td was significantly different in POST5 compared to PRE. The differences in oxygen saturation between PRE and the five NMES cycles were, respectively: +1.7%, -19%, -15.3%, -12.3%, -12.3% ( $P < 0.05$  for NMES2,3,4,5). **Conclusion** Dm increment and Tc and Td decrease suggest a better muscle contractile function after only one NMES cycle. However, further NMES cycles did not improve muscle contractile function, probably due to the progressive increase of fatigue. However, the decrease of the oxygenation on the vastus lateralis during the NMES cycles could suggest muscle co-activation and also significant muscle stimulus as a result of the NMES protocol. In conclusion, one single NMES cycle may improve muscle contractile properties. Moreover, the NMES protocol demanded a significant muscle oxygen desaturation. CONTACT: r.laza@alumnos.upm.es

## NEUROMUSCULAR ELECTRICAL STIMULATION SUPERIMPOSED TO A NUMBER OF SIT-TO-STAND MOVEMENTS REDUCES ASYMMETRICAL LOWER EXTREMITY LOADING EARLY AFTER ACL RECONSTRUCTION

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**Introduction** It has been recently shown that asymmetrical lower extremity loading, as early as one month after surgical reconstruction of the anterior cruciate ligament (ACL), is a predictive factor of long-term functional recovery (Labanca et al. 2015). Neuromuscular electrical stimulation (NMES), in combination with functional movements, has the potential to contrast asymmetrical loading since the early phases of rehabilitation. The aim of this study was to investigate the effects of introducing NMES superimposed to a number of sit-to-stand movements (STS), as early as two weeks after surgery, on lower limb asymmetrical loading. **Methods** Nine patients with Tegner Activity Scale level 5, who were ACL reconstructed using bone-patellar tendon-bone graft, underwent 60 days of a traditional physiotherapy protocol and were randomly assigned to one of the 3 groups: the first group (NMES+STS) underwent an additional treatment based on superimposing NMES of the quadriceps femoris muscle to an increasing number of STS movements, from the 15th to the 60th day after

surgery; the second group (STS only) underwent an additional treatment based on an increasing number of STS only; the third group received no additional treatment (NAT). Patients were assessed for lower limb asymmetrical loading by recording ground reaction force during a STS on two force platforms 15, 30 and 60 days after surgery. In addition, maximal voluntary isometric contraction (MVIC) was measured in the knee extensor muscles 30 days after surgery. Side to side symmetry was quantified for peak forces during STS and MVIC using the limb symmetry index (LSI), which was calculated as the ratio between the involved and uninjured limb expressed as a percentage. Results Thirty days after surgery, patients in the NMES+STS group had higher STS LSI than patients in the STS only and in the NAT group ( $86.7 \pm 3.8$ ,  $59.2 \pm 21$  and  $57.3 \pm 1\%$ , respectively). Sixty days after surgery, patients in the NMES+STS group had higher STS LSI than patients in the NAT group ( $94.8 \pm 3.3$  vs  $52.5 \pm 3.9\%$ ), with no differences with the STS only group. Sixty days after surgery, patients in the NMES+STS group had higher MVIC LSI than patients in the STS only and in the NAT group ( $70.6 \pm 2.5$ ,  $54.0 \pm 5.7$  and  $45.5 \pm 5.0\%$ , respectively). Discussion These preliminary pilot data suggest that NMES superimposed to STS is an effective treatment to reduce asymmetrical lower extremity loading early after ACL reconstruction. References Labanca L, Laudani L, Menotti F, Rocchi J, Mariani PP, Giombini A, Pigozzi F, Macaluso A (2015) Am J Phys Med Rehabil DOI: 10.1097/PHM.0000000000000369

## Mini-Orals

### MO-PM13 Pulmonary & Cardiovascular Physiology

#### VO<sub>2</sub>, VCO<sub>2</sub> AND VE BETWEEN-DAY RELIABILITY OF THE VYNTUS CPX METABOLIC CART DURING PROGRESSIVE CYCLING

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Previously, the Oxycon Pro (Jaeger) has been found both reliable and valid compared to the Douglas Bag method (DB) (1, 2, 3). The Vyntus CPX (CareFusion) has been developed to replace the Oxycon Pro. To our knowledge, the Vyntus CPX has yet to be evaluated for reliability, which was the aim of this study. 6 male subjects (age =  $28 \pm 2.3$  yr (mean  $\pm$  SD), height =  $1.81 \pm 0.04$  m, weight =  $75 \pm 3.5$  kg,  $VO_{2max} = 59.4 \pm 5.8$  mlO<sub>2</sub>/kg/min) performed graded cycling trials (Cyclus 2). First, the subjects exercised for 3x6 min at ~55%, 65%, 75%  $VO_{2max}$ . After 15 min of rest, a  $VO_{2max}$  test was performed starting at ~75%  $VO_{2max}$  with 25 W/min increments until volitional exertion. The trial was repeated after 24 hours.  $VO_2$ ,  $VCO_2$  and  $VE$  were recorded as 30 sec means of breath-by-breath data and analyzed on the last minute of each stage. Before each trial, gas calibration and manual flow calibration was performed with a 3L syringe (Hans Rudolph). Inter-trial reliability was investigated at each exercise intensity by mean  $\pm$  SD and CV of difference and repeated measures two-way ANOVA (Bonferroni correction), and across intensities by Pearson correlation (R<sup>2</sup>) and Bland Altman plots with Limits of Agreement (LoA) corrected for repeated measures (4). Mean  $\pm$  SD [CV] inter-trial differences were:  $VO_2$  (ml/min) = ( $2413 \pm 121$  [5.0],  $2929 \pm 87$  [2.9],  $3398 \pm 77$  [2.2],  $4485 \pm 100$  [2.2]);  $VCO_2$  (ml/min) = ( $2150 \pm 132$  [6.1],  $2655 \pm 90$  [3.4],  $3181 \pm 124$  [3.9],  $5169 \pm 315$  [6.1]); and  $VE$  (L/min) = ( $56 \pm 2.7$  [4.9],  $71 \pm 5.2$  [7.3],  $86 \pm 3.6$  [4.1],  $170 \pm 3.6$  [3.3]) at ~55%, 65%, 75%  $VO_{2max}$ , respectively. Bias (LoA) [R<sup>2</sup>] across intensities were:  $VO_2$  (ml/min) =  $-10$  ( $-206$ ,  $185$ ) [0.98];  $VCO_2$  (ml/min) =  $-25$  ( $-391$ ,  $341$ ) [0.97]; and  $VE$  (L/min) =  $1.2$  ( $-7$ ,  $10$ ) [0.99]. While there were no differences between test days, significant differences between intensities were found for all parameters. The CV was less than or equal to previously reported results with Oxycon Pro (1). Results showed strong correlations with similar bias but more narrow LoA for  $VO_2$  and  $VE$  and wider for  $VCO_2$  compared to previous results with DB (5). The wider LoA for  $VCO_2$ , depended largely on a single outlier, removing this would result in similar LoA as for  $VO_2$ . Some of the observed differences might be explained by physiological variation or measurement accuracy, which according to the manufacturer is 3%. Mixing chamber could reduce LoA, but would limit analysis of  $VO_2$  kinetics (2). We conclude that the Vyntus CPX produces reliable breath-by-breath measurements between days. 1. Carter and Jeukendrup, Eur J Appl Physiol, 2002 2. Foss and Hallén, Int J Sports Med, 2005 3. Rietjens et al., Int J Sports Med, 2001 4. Bland and Altman, J Biopharm Stat, 2007 5. Crouter et al., Eur J Appl Physiol, 2006

#### VO<sub>2</sub>-KINETICS AT AND ABOVE MAXIMAL LACTATE STEADY STATE INTENSITY

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**VO<sub>2</sub>-KINETICS AT AND ABOVE MAXIMAL LACTATE STEADY STATE INTENSITY** Introduction: "Anaerobic threshold" has been considered as the highest intensity at which a steady state of oxygen uptake ( $VO_2$ ) occurs (Pringle & Jones, 2002). However, in previous studies, various methods have been used to identify "anaerobic threshold". The "maximal lactate-steady-state" has often been referred to as "gold standard" to determine endurance capacity, which is corresponding to "anaerobic threshold" of individuals (Baron et al., 2003). To our knowledge, only few studies exist which deal with  $VO_2$  kinetics at MLSS-intensity. The aim of this study was to investigate, whether "maximal lactate-steady-state" reflects the highest intensity at which a  $VO_2$ -steady-state can be found. Methods: Following the method of Heck et al. (1985), 46 subjects underwent several 30-minutes constant load tests on a cycle ergometer to evaluate "maximal lactate-steady-state" (in our case: no lactate increase of more than 0.5 mmol.l<sup>-1</sup> within the last 20 minutes). According to Bell et al. (2001) a 3-component model was utilized to estimate the exponential increase of  $VO_2$ . The MLSS-test (MLSS) and the test just above MLSS-intensity (MLSS+1) were analyzed to evaluate the above mentioned question. Wilcoxon-Test and Interclass Correlation were used for statistical analyses. Results and Discussion: There was no significant difference ( $p > 0.05$ ) in  $VO_2$ -behavior between the both tests (MLSS vs. MLSS+1). Only a minimal increase of  $VO_2$  was detected at MLSS-intensity: median 0.048 ml.kg<sup>-1</sup>.min<sup>-1</sup> (quartile 1: 0.032, quartile 3: 0.089) and MLSS+1: median 0.041 ml.kg<sup>-1</sup>.min<sup>-1</sup> (quartile 1: -0.003, quartile 3: 0.073). The Interclass Correlation coefficient of 0.94 shows very high accordance of the  $VO_2$  kinetics at both intensities. Therefore the main finding of our study is that  $VO_2$  reaches a steady state at MLSS-intensity as well as at intensities just above MLSS-intensity, demonstrating that MLSS-intensity does not describe the maximum load at which a  $VO_2$  steady-state occurs. References: Baron, B., Dekerle, J., Robin, S., Neviere, R., Dupont, L., Matran, R., Vanvelcenaher J. Robin, H. & Pelayo, P. (2003). Maximal Lactate Steady State Does Not Correspond to a Complete Physiological Steady State. Int J Sports Med 24 (8), 582-587 Bell, C., Paterson, D. H., Kowalchuk, J. M., Padilla, J. & Cunningham, D. A. (2001). A comparison of modelling techniques used to characterise oxygen uptake kinetics during the on-transient of exercise. Exp. Physiol. 86 (5), 667-676 Heck, H., Mader, A., Hess, G., Mücke, S., Müller, R. & Hollmann, W. (1985). Justification of the 4-mmol/l Lactate Threshold. Int J Sports Med 06 (03), 117-130



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## RELATIONSHIPS BETWEEN HEART RATE AND OXYGEN UPTAKE

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**Introduction.** Measuring the energetic demands of habitual commuter cyclists is essential to create more accurate methods for measuring active commuting so as to be able to objectively determine the impact that cycle commuting can have on population health. Heart rate (HR) can be used as an indicator of aerobic processes while commuter cycling as long as the relationship between oxygen uptake (VO<sub>2</sub>) and HR is established in laboratory conditions. However in the field, environmental aspects might introduce effects of stress that change the relationship. Thus measurements need also to be performed in the field in order to explore the HR-VO<sub>2</sub> relationship between the two conditions. **Methods.** Metabolic measurements were performed in the laboratory as well as in the field using 20 habitual commuter cyclists (10 males and 10 females) aged  $44 \pm 3$  yrs. A validated stationary as well as a portable metabolic system was used (Rosdahl et al. 2010; 2016; Salier-Eriksson et al. 2012). A comparison was made between the laboratory and field conditions of the HR-VO<sub>2</sub> relationship. **Results and Discussion.** Based on the average heart rate, the measured oxygen uptake was about 2.5 % lower (n.s.) than the expected levels based on the steady state HR-VO<sub>2</sub> relationships in the laboratory. Thus, the results indicate that the HR-VO<sub>2</sub> relationships in the field were comparable to those measured in the laboratory on a group level. However, relatively large individual differences were found. **References** Rosdahl, H., Gullstrand, L., Salier Eriksson, J., Johansson, P. & Schantz, P. 2010. Evaluation of the Oxycon Mobile metabolic system against the Douglas bag method. *Eur J Appl Physiol* 109 (2):159-71. Rosdahl, H., Salier Eriksson, J. & Schantz, P. 2016. Validation of data collected with mobile metabolic measurement systems over time during active commuting. *Proceedings of the 21st Annual Congress of The European College of Sport Sciences*, Vienna, Austria, 6-8 July (Abstract). Salier Eriksson, J., Rosdahl, H. & Schantz, P. 2012. Validity of the Oxycon Mobile metabolic system under field measuring conditions. *Eur J Appl Physiol*, 112 (1): 345-355.

## SKIN BLOOD FLOW RESPONSES TO LOCALLY DELIVERED ACETYLCHOLINE FOLLOWING A 10-DAY HEAT ACCLIMATION PROGRAM

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**Introduction** It is well established that individuals who undergo chronic heat exposure have improved ability to thermoregulate, especially while exercising in a hot environment (Corbett et al., 2014). It is believed that skin blood flow plays an integral role in this adaptation; however, the specific mechanism(s) by which skin blood flow during exercise is augmented following a period of heat acclimation remains unclear (Lorenzo and Minson, 2010). Therefore, the aim of this study was to examine the effects of heat acclimation on skin blood flow responses to locally applied acetylcholine. **Methods** Eleven trained male cyclists [mean $\pm$ SD maximal oxygen uptake:  $56.8 \pm 7.4$  mL.kg<sup>-1</sup>.min<sup>-1</sup>; peak power output:  $351 \pm 53$  W] underwent a heat acclimation programme consisting of 10 days of cycling (maximum 90 min.day<sup>-1</sup>) in a hot environment (40 °C, 50 % RH) to elicit isothermic heat strain (target rectal temperature: 38.5 °C). Iontophoresis was used to apply acetylcholine (1 w/v %) to the volar forearm and non-glabrous finger 24 to 48 hours before and again after the heat acclimation. Laser Doppler flowmetry was utilised to measure changes in skin blood flow presented as percentage change from baseline (i.e. prior to iontophoresis) and area under the curve. **Results** Heat acclimation was confirmed by reduced thermal and cardiovascular strain during subsequent exercise in the heat. Not all participants could receive an iontophoresis charge in the finger; these participants were therefore excluded from the analyses leaving an n of 8. Skin blood flow and local temperatures at baseline were similar ( $p > 0.05$ ) before and after the heat acclimation. Acetylcholine evoked similar responses before ([maximum change from baseline] finger:  $515 \pm 241$  % (n=8), forearm:  $1716 \pm 661$  %) and after (finger:  $600(353)$  %;  $p = 0.34$ , forearm:  $1963 \pm 1090$  %;  $p = 0.27$ ) the heat acclimation intervention. Similarly, no differences ( $p > 0.05$ ) in area under the curve were observed in the forearm or finger. **Discussion** Endothelial reactivity remained unchanged in response to transdermal application of acetylcholine after a 10-day heat acclimation program. Acetylcholine mediates increases in skin blood flow via multiple pathways, with a profound role for prostanooids and lesser roles for nitric oxide, especially at the lower doses (Lorenzo and Minson, 2010). Therefore, further studies examining the role of other pathways, including nitric oxide, on the enhanced skin vasodilatory response after heat acclimation are required. **References** Corbett J, Neal RA, Lunt HC, Tipton MJ. (2014). *Sports Med*, 44, 1323–1331. Lorenzo S, Minson CT. (2010) *J Appl Physiol*, 109, 1736 –1743. Contact Joe.costello@port.ac.uk

## THE EFFECTS OF MUSCLE BLOOD FLOW RESTRICTION DURING RUNNING TRAINING ON MEASURES OF ENDURANCE PERFORMANCE

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**Introduction:** Performing weight training sessions in combination with blood flow restriction (BFR) has been shown to improve muscle mass and strength. However little is known of BFR effects when performed during aerobic training. The purpose of this study was to determine the effect of BFR performed during sessions of moderate-intensity running on endurance performance and physiology. **Methods:** Sixteen recreationally trained, males and females (age  $24.9 \pm 6.9$  years, height  $172.9 \pm 7.8$  cm, weight  $75.1 \pm 13.8$  kg) initially completed an incremental treadmill test to determine peak running velocity and Maximum Oxygen uptake; participants also completed a time to exhaustion test (TTE) at peak running velocity. Participants were pair-matched and randomly assigned to either a BFR training group or a control (CON) training group for 4-weeks of training. Both training groups completed eight sessions of the same progressive training regime consisting of 2-3 sets of 5-8 minute (30 seconds work, 30 seconds rest) runs at 80% of individual peak running velocity. Subjects in the BFR group completed all training with lower limb BFR using elastic knee wraps. Percentage changes in performance and physiological measures (Mean  $\pm$  90% confidence limits) pre to post training were estimated and the magnitudes of changes interpreted using the effect size statistic (ES). **Results:** Maximal Oxygen uptake increased in both the BFR ( $6.3 \pm 3.5\%$ ) and CONS ( $4.0 \pm 3.3\%$ ) groups following training with only trivial differences between groups (ES=0.18). Similarly TTE increased by  $26.9 \pm 9.3$  % and  $17.0 \pm 6.4\%$  respectively for the BFR and CON groups. Effect size analysis indicated small beneficial improvements in peak running velocity (ES= 0.34) and TTE (ES= 0.31) in favor of the BFR group compared to CON. Analysis of heart rate data obtained during training indicated that the BFR group exercised at a higher (ES=1.3) percentage of their peak heart rate in comparison to the CON group ( $76.0 \pm 5.0\%$  vs  $69.8 \pm 5.1\%$ ) despite

both groups training the same relative running velocity. Discussion: Sessions of moderate intensity interval training with, and without blood flow restriction improves physiology and performance measures in recreationally trained individuals. Using BFR during training appears to confer additional small but potentially beneficial improvements in several endurance performance measures compared to CON despite only trivial differences in physiological adaptation. The beneficial adaptations observed with BFR may be related to its effects on exercise heart rate during training or local muscle adaptations caused by metabolic acidosis. Further research is required to elucidate the likely adaptive mechanisms responsible for performance improvements. Contact: cpaton@eit.ac.nz

## CLASSIFICATION OF INDIVIDUAL BODY FUNCTION BY METABOLIC RESPONSE

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Introduction: The purpose of this study is to reveal the individual body function by using metabolic response. Methodology: Seven volunteer athletes that were three short distance athlete and four long distance athletes were cooperated. Three different metabolic tests were performed with seven athletes. The first of all, the step exercise were performed for determining other two individual metabolic functions that were known as the aerobic threshold (Aer-T) and as the anaerobic threshold (An-T) in seven athletes. After the step exercise test, athletes performed two different metabolic tests that were steadied the load in the Aer-T level and were steadied the load in the An-T level. Results and Discussion: The metabolic functions of athlete are classified by the distance of a period between the Aer-T and An-T. Short distance athletes had longer period of appearance time in the Aer-T and An-T than long distance players. Aer-T in the short distance athletes appeared earlier than long distance athletes. However, the An-T of long distance was appeared lately that near by VO<sub>2</sub>max level. There were hardly found differences in the VO<sub>2</sub>max among each athletic event players. Short distance athlete had longer period between Aer-T to An-T than the period of long distance athlete. In both group, long time steady state about 20 min appeared in the load of Aer-T. In the load level of An-T, long distance athlete continued 20 min or more times, on the other hand, short distance athlete finished their performance not to reach until 20 min. However, even in long distance athletes, their oxygen consumptions reached almost maximum. Therefore, as a future training target, it need to be improved for more longer performance period than the current metabolic level in each athlete. For example, the performance of current metabolic level of An-T should be expected to achieve as level as the Aer-T.

## METABOLIC OPTIMIZATION OF THE BASKETBALL JUMP-SHOT

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Introduction Due to its mixed physical-technical-tactical nature, basketball like other team sports needs attention on likely relationships between all its facets, e.g., metabolic power and technical skill. A common fundamental is the Jump-Shoot (JS), which can be shot both when just come off the bench and when fatigued by previous actions. Our aim was to study the effect of different metabolic power conditions on successful JS percentage (JS%). Methods 22 male (Under 17) basketball players (age 15.7±0.9 y, height 179±6.9 cm, mass: 66.4±9.2 kg, sport experience 7.9±1.0 yrs). The participants threw JSs under three randomized testing sessions one week later than a Yo-Yo Intermittent Recovery test level 1 (Yo-Yo IR1) (Castagna et al, 2008) administered to measure HRMAX as a proxy of maximal metabolic power. All sessions consisted in 10 consecutive JSs from five different significant field spots 5-m far from the basket (two counter clockwise "laps") at different heart rates (HR): rest (0HR), after warm-up (HR at 50%HRMAX [50HR], 80%HRMAX [80HR]). The same procedure was repeated one week later to evaluate measures reliability. After a 15' standard warm-up running each participants threw 10 consecutive JSs sessions at different HRs (0HR - 50HR - 80HR). Each HR (continuously monitored with Cardio-SuuntoTM) was achieved by low/high intensity shuttle running (15+15 m). Reliability of the shoot accuracy measure at 0HR, 50HR and 80HR was assessed by Intra-class Correlations Coefficient (ICC) according to a previous study (Padulo et al, 2015). A one-way ANOVA within subjects was performed to check for the differences between the three sessions with post-hoc LSD test. The level of statistical significance was set at p<0.05. Results ICC showed a good reliability at 0HR (0.89), 50HR (0.92) and 80HR (0.95). Yo-Yo IR1 HRMAX was 195.6±6.1 bpm. ANOVA showed difference in JS% over sessions (F(1,20)=4.257 and p=0.018) with 660 JSs. LSD test did not show any significant 0HR-50HR JS% difference (-9% and p>0.05), while 80HR elicited significantly lower values with respect to both 0HR and 50HR (-41 and -28% with p=0.006 and p<0.05, respectively). Discussion Our study provided two practical indications to keep high JS%: 1) preliminary warm-up does not improve JS%, because the 0HR-50HR difference was not significant; and 2) 80HR decreases JS% significantly, providing therefore scientific support to the usual behavior by players, who aim always at resting as much as possible between game-play pauses. References Castagna C, Impellizzeri FM, Rampinini E, D'Ottavio S, Manzi V. (2008). The Yo-Yo intermittent recovery test in basketball players. J Sci Med Sport, 11, 202-208. Padulo J, Attene G, Migliaccio GM, Cuzzolin F, Vando S, Ardigò LP. (2015). Metabolic optimisation of the basketball free throw. J Sports Sci, 33, 1454-1458. Contact sportcinetic@gmail.com

## EFFECTS OF BODY POSITION ON EXERCISE CAPACITY AND PULMONARY VASCULAR PRESSURE-FLOW RELATIONSHIPS

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Background: Echocardiography coupled to cardiopulmonary exercise testing (CPET) is integrating clinical practice for the evaluation of unexplained dyspnea. However, there still is a problem of standardization as we do not know if maximal exercise capacity (VO<sub>2</sub>max) can be reached on an echocardiographic exercise table and in a supine position as used during right heart catheterization. Secondly, it remains unclear if exercise stress measurements of the pulmonary circulation and the right ventricle must be expressed either as a function of workload, oxygen uptake (VO<sub>2</sub>) or cardiac output (CO). The relationship between these variables is considered linear but may vary with body position. In particular, one does not know the relationship between workload and VO<sub>2</sub> in the semi-recumbent position with lateral tilting during exercise echocardiography. Methods: We therefore revisited the relationship between VO<sub>2</sub>, CO and workload in 26 healthy subjects (13 men/13 women, 23 ± 2 years, 172 ± 10 cm, 67 ± 11 kg). All subjects performed 3 randomized incremental cardiopulmonary exercise tests with measurement of cardiac output in different positions: upright (on a classical cyclo-ergometer), semi-recumbent (on an echocardiographic exercise table tilted 35° to the left), and supine position (cycling table). The CPET were performed with a warm-up of 3 min at 60W for men and 30W for women and workload increase 30W/min for men and 20W/min for women. Gas exchange was registered every 5 seconds (HypAir, Medisoft, Dinant, Belgium). Cardiac output was measured during last 30 seconds of each step by echocardiography (CX50 CompactXtreme Ultrasound System; Philips, Amsterdam, The Netherlands). Results: VO<sub>2</sub> max was

not affected by the CPET body position (upright:  $43 \pm 10$  ml/min/kg, semi-recumbent:  $43 \pm 10$  ml/min/kg ; supine:  $42 \pm 9$  ml/min/kg) as well as maximal CO (upright:  $18.4 \pm 3.4$  l/min, semi-recumbent:  $18.5 \pm 3.5$  l/min, supine:  $18.4 \pm 3.1$  l/min) while the maximal workload was lower in the semi-recumbent position compare to the other positions (upright:  $240 \pm 75$  W, semi-recumbent:  $215 \pm 71$  W,  $p < 0.01$ , supine:  $233 \pm 68$  W) and maximal heart rate was higher on upright position (upright:  $189 \pm 11$  bpm, semi-recumbent:  $181 \pm 11$  bpm, supine:  $180 \pm 13$  bpm). There is no significant difference in final RER. Conclusion: The important finding of the present study is that the gold standard of the evaluation of aerobic exercise capacity  $\text{VO}_{2\text{max}}$  remains valid in different body positions such as used in clinics, while maximum workload is not. Because CO is increased in response to increased metabolic rate rather than mechanical work and is not affected by body position as well, we recommend that measurements of the right ventricle and the pulmonary circulation during exercise be titrated as a function of  $\text{VO}_2$  or CO in place of workload.

## Mini-Orals

### MO-BN04 Biomechanics: Mixed Session

#### ON THE EFFECT OF SITTING POSITION, IN SIMULATED CROSS-COUNTRY SIT-SKIING

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1: Mid Sweden University, Swedish Winter Sports Research Centre 2: Swedish Ski Association, Cross-Country Skiing Introduction In Cross-country sit-skiing (CCSS), athletes with severe reduced trunk control are mainly seated with the knees higher than the hip (KH; arm and trunk powered). However this posture is hypothesized to have high risk for lower back and shoulder injuries. Therefore, a new seat was created where the knees were lower than hip and the trunk frontal supported (KL), to improve spinal curvature. Thus, the aim of this study was to examine performance between these two different sitting positions. Methods 10 female abled-bodied elite cross-country skiers (age  $25.5 \pm 3.8$  years (mean  $\pm$  standard deviation), height  $1.65 \pm 0.05$  m and weight  $61.1 \pm 6.8$  kg) were tested on a skiing ergometer (ThoraxTrainer, ThoraxTrainer A/S, Kokkedal, Denmark) in a 30 s all-out test (WIN), a submaximal incremental test with 3-6 levels of 3 min (SUB), and a maximal 3 min time-trial test (MAX). The SUB and MAX tests were monitored breath-by-breath with a stationary metabolimeter (Quark CPET, COSMED, Italy). Aerobic metabolism and gross efficiency were computed from oxygen uptake, and anaerobic metabolism were estimated from net blood lactate concentrations. Muscle oxygenation saturation ( $\text{SmO}_2$ ) in right vastus lateralis (VL) was monitored with NIRS methodology (Moxy Monitor, Fortiori Design LLC, Minnesota, USA). Results Higher performance (W·kg<sup>-1</sup>) was observed for KH both in WIN (KL:  $1.13 \pm 0.33$ , KH:  $1.40 \pm 0.30$ ) and MAX (KL:  $0.67 \pm 0.14$ , KH:  $0.88 \pm 0.19$ ) compared to KL ( $p < 0.01$ ). No differences were observed in breathing rate, cycle rate, oxygen consumption or aerobic metabolic rate neither in SUB nor MAX. The KH position showed higher gross efficiency and lower anaerobic metabolic rate and minute ventilation.  $\text{SmO}_2$  was higher for KH compared to baseline bench ( $12.2 \pm 7.2\%$ ) whereas no difference was observed between baseline and KL position ( $3.2 \pm 5.5\%$ ). During SUB levels 1-4, higher  $\text{SmO}_2$  was observed for KH compared to KL when normalizing data with baseline bench ( $p < 0.05$ ). Discussion This study showed that abled-bodied athletes perform better and have higher efficiency in KH compared to KL. The position using larger part of the body (joint range of motion and amount of active muscle mass) have higher gross efficiency, lower lactate concentration and lower ventilation, also shown by Lajunen (2014). It was also concluded that  $\text{SmO}_2$  was higher in KH compared to KL, and thus there might be a smaller risk for injuries in the legs connected to circulation. This study of abled-bodied athletes have the potential to serve as a control for future studies of para-athletes. References Lajunen K (2014). Effect of sitting posture on sit-skiing economy. Bachelor's thesis, University of Jyväskylä. Contact Marie.Ohlsson@miun.se

#### LIMB SYMMETRY INDEX AND LEG DOMINANCE IN AUSTRIAN YOUTH SKI RACERS

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Introduction Alpine skiing is a sport with high demands on physical fitness of the lower extremities. Identifying asymmetries between legs is important for performance and injury prevention. Limb asymmetries greater than 10% may indicate a higher injury risk (Abrams et al., 2014). The aim of this study was to analyze the limb symmetry index (LSI) in Austrian youth ski racers and its implication for testing the lower limb dominance. Methods Sixty Austrian youth ski racers (39 males, 21 females; age:  $12.5 \pm 1.2$  years; body mass:  $43.5 \pm 8.7$  kg, body height:  $153.5 \pm 8.7$  cm) performed 3 different one-leg tests: stability test (ST), speedy jump test (SJT) (Hildebrandt et al., 2015) and Y-Balance test (Y-BT) (Smith et al., 2015). The LSI was calculated for each test ( $\text{LSI} = \text{dominant/non-dominant} \times 100$ ). LSI results were categorized in 4 ranges: within 10% (1st), 15% (2nd), 20% (3rd) and above 20% (4th). Additionally, 3 tests were performed to identify the subjective dominant leg. The normal distribution was assessed using Shapiro-Wilk. ANOVA with repeated measurements (Bonferroni correction) was performed. Statistical significance was set at  $p < 0.05$ . Results No significant differences were found in the LSI between the 3 one-leg tests ( $p > 0.05$ ). At least 90.0% of the subjects were in the 1st range (SJT and Y-BT). For ST, 53.3% of participants were in the 1st, 18.3% in the 2nd, 13.3% in the 3rd and 15% in the 4th range. According to the 3 subjective tests for leg dominance, for 92% the right leg was the subjective dominant leg. When comparing the results of the 3 subjective dominant leg tests to the LSI test results, the subjective tests identified the dominant leg correctly only in 55% (ST), 63.3% (SJT) and 55% (Y-BT) of the subjects respectively. Discussion Austrian youth ski racers do not have limb asymmetries in most tests. The asymmetry range was within 10% in the SJT and the Y-BT, which indicates a lower rate of injury risk (Abrams et al., 2014). Therefore, it can be concluded that the injury due to lower limb asymmetry of these ski racers is low. However, in the ST, only 53.3% participants were in the 1st range. Additionally, it could be shown that the subjective tests for identifying the dominant leg of Austrian youth ski racers were not precise, since only 55-63% were identified correctly. LSI tests should be included in the test battery of youth ski racers to evaluate leg dominance and asymmetries. References Abrams GD, Harris JD, Gupta AK, McCormick FM, Bush-Joseph CA, Verma NN, Cole BJ, Bach BR Jr. (2014). Orthop J Sports Med, 2(1), 2325967113518305. Hildebrandt C, Müller L, Zisch B, Huber R, Fink C, Raschner C. (2015). Knee Surg Sports Traumatol Arthrosc, 23(5), 1273-1281. Smith CA, Chimera NJ, Warren M. (2015). Med Sci Sports Exerc, 47(1), 136-41.

## GENDER DIFFERENCE IN MUSCULARITY OF THE QUADRICEPS FEMORIS IN VARSITY ROWERS: RELATION TO KNEE ALIGNMENT

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**Introduction** Muscle size of the quadriceps femoris is related to rowing performance (Yoshiga et al. 2002). Our study (Ema et al. 2014) reported that male rowers had unique muscularity among four constituents of the quadriceps femoris: the rectus femoris (RF) volume comparable to untrained men despite 30% greater volumes of the vasti (vastus lateralis, VL; vastus medialis, VM; and vastus intermedius). It is unclear whether such unique musculature also exists in female rowers. There is a gender difference in knee alignment such as Q-angle (Horton and Hall 1989) and knee alignment is one of the factors that influence the quadriceps femoris muscle size in untrained men (Tsakoniti et al. 2008). It is therefore hypothesized that male and female rowers have different quadriceps femoris muscularity, being related to the variability of Q-angle. This study tested this hypothesis. **Methods** A series of magnetic resonance (MR) images of the right thigh were obtained from 26 experienced varsity rowers (n = 13 for each gender) and 20 untrained students (n = 10 for each gender). From the images, muscle volume of each constituent of the quadriceps femoris was determined and normalized to body mass. The Q-angle of the rowers was measured during quiet standing. Ten of the rowers joined a 1-year follow-up survey of MR measurements. **Results and Discussion** In each gender, rowers had significantly greater normalized volumes of the vasti than untrained students, whereas no difference was found for RF. Relative volumes of VL in males and VM in females to those of the total quadriceps femoris were significantly higher in the rowers than untrained students, and vice versa for RF in both genders. There were no gender differences in the fractions of individual muscle volumes in untrained students. The Q-angle was significantly greater in the female than in male rowers. When the data of rowers were collapsed over genders, Q-angle was positively correlated with the percentage of VM volume ( $r = 0.46$ ,  $P < 0.05$ ), and with the ratio of VM to VL ( $r = 0.52$ ,  $P < 0.01$ ). One year of regular competitive training significantly increased volumes of the vasti but not RF. The relative change in VM volume was positively correlated with Q-angle ( $r = 0.65$ ,  $P < 0.05$ ). The results indicate that the rowers' quadriceps femoris muscularity is different between genders, which likely stems from the variability in the knee alignment. **References** Ema R, Wakahara T, Kanehisa H, Kawakami Y. (2014). *Int J Sports Med*, 35, 293-7. Horton MG, Hall TL. (1989). *Phys Ther*, 69, 897-901. Tsakoniti AF, Stoupis CA, Athanasopoulos SI. (2008). *J Appl Physiol*, 105, 800-4. Yoshiga CC, Higuchi M, Oka J. (2002). *Eur J Appl Physiol*, 88, 1-4. Contact i039491@shibaura-it.ac.jp

## TRAINING INDUCED CHANGES IN THE GROUND REACTION FORCE PATTERN OF HIGH KNEE SPRINTING IN TRACK AND FIELD JUMPERS

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**Introduction** A widespread coach belief is that high knee sprinting (HNS) improves the speed components by increasing the stride length and the body's forward propulsion (Thompson et al., 2009; Young, 2012). To the best of our knowledge, there is lack of data regarding the HNS ground reaction force (GRF) pattern. The purpose of the study was a) to compare the HNS GRF pattern between track and field jumpers (TFJ) and untrained controls (CG) and b) to test the TFJ training induced changes. **Methods** Twelve young women TFJ (14 to 19 yrs, elite level for their age category) performed HNS in place (Kistler forceplate, 9286AA, 1000 Hz, 15s, as fast as possible). TFJ were tested during the beginning of the preparation period (Pre) (regular training thereafter) and 5 months later (Post). The CG (n = 12 age matched young women) was tested at same time period as the TFJ. Data included HNS frequency and, for the leading (LdL: limb of initiating knee lifts) and trailing (TrL) limb, respectively, contact time, flight time, peak vertical force, time to peak vertical force, total vertical impulse and reactivity index (flight to contact time ratio). Paired t-tests were used for the differences between TFJ and CG, as well as, between Pre and Post in each group (SPSS, 21.0,  $p < 0.05$ ). **Results** No significant Pre to Post difference was found for CG. In the TFJ, all HNS variables remained unchanged between Pre and Post, except for the increased HNS frequency (Pre: 3.8  $\pm$  0.4 Hz, Post: 4.1  $\pm$  0.2 Hz). Compared to CG, the TFJ had significantly higher frequency only in Post (TFJ: 4.0  $\pm$  0.2 Hz, CG: 3.6  $\pm$  0.6 Hz). In both Pre and Post, TFJ had shorter contact times ( $p < 0.05$ ), greater LdL reactivity index ( $p < 0.05$ ) and, greater LdL impulse ( $p < 0.05$ ). **Discussion** HNS in place shows significant differences between TFJ and untrained CG already at the initiation of the preparation period with the TFJ training induced changes in reflecting a positive outcome for improved speed (Thompson et al., 2009). The advantageous impact of HNS lies in the increased pre-stretch of the gluteus and the hamstrings muscles of the swing leg when the hip joint comes to a position of greater flexion (Schache et al., 1999; Thompson et al., 2009). Together with the greater limb acceleration due to greater angular range of thigh motion, HNS allows an increased GRF during contact phase, which is positively related to increased speed (Schache et al., 1999; Thompson et al., 2009). **References** Schache AG, Bennell KL, Blanch PD, Wrigley TV. (1999). *Gait Posture*, 10, 30-47. Thompson A, Bezodis IN, Jones RL. (2009). *J Sports Sci*, 27, 855-861. Young M. (2012). <http://elitetrack.com/blogs-details-7525/> Email: erousan@gmail.com

## RELATIONSHIP BETWEEN VERTICAL JUMP AND BODY POSTURAL STABILITY IN MALES AND FEMALES AGED 6-18 YEARS

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**Introduction** Body postural stability and vertical jump can be influenced by age, as well as anthropometric characteristics and sport participation (Jallai et al., 2011). However, uncertain correlation between BPS and vertical jump height have also been reported. In pre-pubertal children and adolescents no correlations have been found (Granacher and Gollhofer, 2011), albeit good correlations have been reported in young soccer players (Gualtieri et al., 2009). Thus, the aim of this study was to investigate the relationship between body postural stability and vertical jump height in males and females aged 6-18 years. **Methods** Nine hundred and eighty-five subjects from 6 to 18 years took part in this study (699 males and 286 females). Body postural stability and vertical jump height were measured by balance test (BPS; Libra board, Easytech, Prato, Italia) and countermovement jump test (CMJ; Optojump, Microgate, Bolzano, Italia), respectively. To assess the interaction between sex and among ages, two-way multivariate analysis of variance (MANOVA) was performed. If Wilk's lambda achieved statistical significance, the univariate test (ANOVA) was examined for the individual dependent variables applying a Bonferroni's adjustment of alpha. The partial eta squared (part eta<sup>2</sup>) was used to detect the magnitude of the differences. In order to detect the relationship between BPS and CMJ in males and females, the Pearson Correlation Coefficient controlled by age (partial correlation) was computed. **Results** The two-way MANOVA showed statistical interaction among age and between sex (Wilks lambda=0.96;  $F=2.35$ ;  $p=.04$ ; partial eta<sup>2</sup>=0.20). Univariate analysis of variance found a statistical interaction only for CMJ ( $F=2.35$ ;  $p=.04$ ; partial



$\eta^2=0.20$ ). Partial correlation showed statistical significance in both males ( $r=-0.410$ ,  $p<0.001$ ) and females ( $r=-0.169$ ,  $p=0.01$ ). Discussion The difference between sex and age in CMJ could be explained by the different maturation of nervous, endocrine, muscular, and cardiovascular systems during growth (Roemmich and Rogol, 1995). However, these adaptations did not affect the BPS between sex. The correlation found between BPS and CMJ, especially in males, suggests that training one of these abilities could affect the other one. References Granacher U, Gollhofer A. (2011). *J Strength Cond*, 25(6), 1718–1725. Gualtieri D, Cattaneo A, Sarcinella R, Cimadoro G, Alberti G. (2009). *Sport Sci Health*, 3(3), 73–76. Jallai T, Erelina J, Kums T, Aibast H, Gapeyeva H, Pääsuke M. (2011). *AKUT*, 17, 89–98. Roemmich JN, Rogol AD. (1995). *Clinics in Sports Medicine*, 14(3), 483–502. Contact alessio.rossi@unimi.it

## ELECTROMYOGRAPHIC ACTIVITY DURING SPRINTING ON HORIZONTAL, UPHILL AND DOWNHILL SURFACES

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Electromyographic activity during sprinting on horizontal, uphill and downhill surfaces Paradisis, G.1, Cooke, C.2, Bissas, A.3 1: National & Kapodistrian University of Athens, 2: Leeds Trinity University, 3: Leeds Beckett University Introduction Previous research has shown that sprinting on sloping surfaces provides a unique training stimulus leading to significant improvements in sprinting performance (Paradisis et al., 2009). Whilst kinematic data have been acquired during sprinting on slopes to understand movement patterns associated with positive training adaptations, there are no data on muscle activity during uphill-downhill sprinting to back kinematic driven inferences about muscle conditioning. This study presents comparative qualitative electromyographic (EMG) data for key leg muscles during sprint running on horizontal, uphill and downhill surfaces (30° slope). Methods EMG activity (Mega ME3000P8) was recorded from the vastus lateralis, rectus femoris, biceps femoris, semitendinosus and gastrocnemius (lateral and medial heads) of the right leg of one female participant (age = 24 years, height = 1.68 m, mass = 73 kg). The sprints were filmed with video camera (Kodak EktaPro 1000) at 125 Hz. A qualitative analysis of the raw EMG signal was conducted to observe any differences in muscle activation across the different running conditions. Results and Discussion The EMG activity during horizontal sprints displayed expected patterns for all muscles. Downhill Sprint: The analysis revealed that the downhill slope forced the quadriceps to a shorter and lower activity, compared to horizontal sprinting, throughout the whole stride due to postural changes. On the other hand whilst the activity pattern of hamstrings was similar to the horizontal it is clear that they play a very important role in the generation of the supramaximal speed as the magnitude of their activity, especially during leg recovery, was highly augmented. As to gastrocnemius, both heads showed higher activity, compared to horizontal, during the whole contact phase which infers their critical role as a balancing lever for the whole body and their contribution to longer strides. Uphill Sprint: Compared to other sprints, the quadriceps showed a longer activity period on the ground but with a similar amplitude whereas the hamstrings remained highly active during the whole contact phase in contrast to horizontal and downhill, where their activity had ceased earlier. With the gastrocnemius showing a similar activity to the horizontal, it is evident that quadriceps and hamstrings, especially biceps femoris, contributed significantly to the body propulsion forwards-upwards. Overall, EMG analysis revealed that uphill-downhill training could be beneficial for the conditioning of key leg muscles, especially the hamstrings group given their pattern and size of activity. References Paradisis, G., Bissas, A., Carlton, C. (2009). *Int J Sports Physiol and Perf*, 4, 229-243. Contact gparadi@phed.uoa.gr

## THE EFFECT OF COMPRESSION GARMENTS ON CONTROL FORCE OUTPUT FOLLOWING HEEL-RISE EXERCISE

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Introduction Recently, there has been an increase in the use of compression garments (CG) during exercise to improve performance (Bannet, 2006) and to attenuate exercise-induced muscle damage (Kraemer, 2010). There are reports about the effect of CG on maximal strength (Kraemer, 2010), but in many sports activities, it is more important to control submaximal force output than to exert maximal strength. However, few reports show the effects of CG on control force output. The purpose of this study was to elucidate the effects of CG on control force output after strenuous exercise. Methods Fifteen healthy volunteers completed tasks both with and without CG (control: CON) on two separate days at least two weeks apart. Both tasks included a heel-rise exercise from maximal dorsiflexion to maximal plantar flexion 20 times on one leg. The subjects performed 3 sets and rested for 2 min between sets. Before and after heel-rise exercise, elasticity of the calf muscle and maximal voluntary contraction (MVC) of plantar flexion were measured. As an index of postural control, we also measured the areas of the center of pressure (COP) for both anterior-posterior axis and medial-lateral axis with subjects standing on both legs with eyes closed. To measure steadiness, 20% MVC for plantar flexion torque was held for 20 s as steadily as possible. Results Repeated two-way analysis of variance (ANOVA) (CG/CON × time) indicated a decline in all parameters immediately after heel-rise exercise for both CG and CON. MVC and COP did not show different tendency between CG and CON, but muscle elasticity and steadiness decline was smaller in CG than in CON (muscle elasticity, steadiness:  $p < 0.05$ ). Discussion Despite significant MVC decrease under both CG and CON conditions, steadiness showed a small decline for CG alone. Kraemer et al. (2001) speculated that “dynamic casting” by compression may promote stable alignment of muscle fibers and attenuate inflammatory response and pain. The lack of significant differences between CG and CON for COP results was because the subjects performed heel-rise exercise on one leg, but stood on both legs for measurement of COP. Muscle elasticity showed a difference between CG and CON. Chleboun et al. (1995) stated that CG temporarily decreased swelling and muscle stiffness. In conclusion, CG may have positive benefits for control force output following strenuous exercise. References Bannet A. (2006). *Sports Med*, 36, 781-796. Chleboun GS, et al. (1995) *Arch Phys Med Rehabil*, 76, 744-749. Kraemer WJ, Bush JA, Wickham RB, et al. (2001) *J Orthop Sports Phys Ther*, 31, 282-290. Kraemer WJ, Flanagan SD, Comstock BA, et al. (2010) *J Strength Con Res*, 24, 804-814. Contact emika.kato@jpnspport.go.jp

## Mini-Orals

### MO-PM15 Muscle Damage

#### CHANGES IN BICEPS BRACHII MUSCLE HARDNESS AFTER ECCENTRIC EXERCISE OF THE ELBOW FLEXORS

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**Introduction** Our previous study [1] showed that biceps brachii muscle hardness assessed by a pressure meter (PM) increased by 30-80% at 1-5 days after maximal eccentric exercise of the elbow flexors. Recently, real-time tissue elastography (RTE) is used in many studies to assess muscle hardness changes after exercise including eccentric exercise. However, the relationship between the muscle hardness measured by PM and RTE is not known. The present study compared changes in biceps brachii muscle hardness assessed by PM and RTE after eccentric as well as concentric exercise of the elbow flexors. **Methods** Ten young men performed 5 sets of 10 eccentric contractions (ECC) with non-dominant arm and concentric contractions (CON) with the other arm using a dumbbell set at 50% of their maximal voluntary isometric contraction force (MIF) of the elbow flexors at 90°. The dumbbell was lowered from a flexed (130°) to an extended elbow position (0°) in 5 s for ECC, and lifted from the extended to the flexed position in 3 s for CON. MIF, relaxed (RANG), extended (EANG) and flexed elbow joint angles, passive tension of elbow joint, upper arm circumference, muscle soreness and plasma creatine kinase activity were measured before, immediately after and 1-4 days after exercise for each arm. Biceps brachii muscle hardness was assessed by PM (TK-HS100, Tokushu-keisoku, Japan) and RTE (Prosound F75; Hitachi Aloka Medical, Japan) for both arms at RANG and EANG while the participants were lying on a bed. **Results** Significant and prolonged ( $P < 0.05$ ) changes in all variables were evident after ECC, but the changes were small and returned to the baseline by 1 day post-exercise after CON. No significant changes in muscle hardness assessed by PM were found after CON, but after ECC, muscle hardness measured at EANG increased ( $P < 0.05$ ) from  $21.6 \pm 2.0$  kPa (baseline) to  $30.1 \pm 3.7$  kPa (4 days post-exercise), although no significant changes at RANG (baseline:  $19.4 \pm 1.4$  kPa, 4 days post-exercise:  $20.4 \pm 1.7$  kPa) were evident. RTE showed an increase in muscle hardness indicated by a decrease in strain ratio immediately after CON by 30%, but muscle hardness increased from 1 to 4 days after ECC by 20-28%. No significant correlation between the PM and RTE changes was found. **Discussion** The changes in muscle hardness after ECC were similar to those of the previous study [1], which was very different from the changes in muscle hardness assessed by RTE. It is concluded that muscle hardness assessed by RTE is different from that by PM. This may be associated with the smaller deformation of the skin and muscle tissue in RTE than PM. **Reference** 1) Murayama et al. (2000) EJAP 82:361-7 **Contact:** murayama@z3.keio.jp

#### THE MORPHOLOGICAL ADAPTATIONS OF HUMAN SKELETAL MUSCLE TO ECCENTRIC AND CONCENTRIC RESISTIVE TRAINING ARE REGION-SPECIFIC

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We recently reported contraction-specific muscle adaptations to eccentric (ECC) vs. concentric (CON) resistive training (RT) [1,2]. While these two exercise paradigms yielded similar hypertrophy of the vastus lateralis (VL) muscle, different architectural changes were found at the mid-portion of VL by ultrasound imaging. We here report new findings based on Extended Field of View (EFOV) ultrasonography, enabling the visualisation of entire muscles, showing regional changes in muscle architecture in response to ECC and CON RT. **Methods:** Eleven healthy males were randomized into 3 groups: ECC ( $n=4$ ), CON ( $n=4$ ) or CTRL ( $n=3$ ). CON and ECC groups underwent 8 wks RT at 60% of 1RM. EFOV images were collected from the right VL at baseline and 8-wks to assess Fascicle Length (Lf), Pennation Angle (PA) and Muscle Cross-Sectional Area (CSA). Results were analysed with two-way ANOVA, statistical significance was set at  $P < 0.05$ . Data are presented as means  $\pm$  SD. **Results:** After 8 wks of ECC training, CSA increased at all muscle sites but more so distally, near the MTJ (0-20% Lm) compared to the mid-portion (20-40% Lm) and to the proximal region (40-60% Lm) ( $7.3 \pm 3\%$ ,  $P < 0.01$  vs.  $4.8 \pm 1.6\%$ ,  $P < 0.01$  vs.  $5.3 \pm 1.8\%$ ,  $P < 0.01$ , respectively); no significant changes were observed for CON and CTRL groups at any muscle regions. PA increased after CON and ECC training, with larger increases in the CON group at all regions:  $22.7 \pm 10.0\%$  at 0-20% Lm ( $P < 0.05$ ),  $11.7 \pm 6.0\%$  at 20-40% Lm ( $P = 0.06$ ) and  $6.0 \pm 3.5\%$  at 40-60% Lm ( $P < 0.05$ ). Increases in the ECC group were  $11.0 \pm 4.0\%$  at 0-20% (N.S.) Lm,  $6.0 \pm 4.0\%$  at 20-40% Lm (N.S.) and  $7.0 \pm 3.0\%$  at 40-60% Lm ( $P < 0.05$ ). Lf also increased after training in the ECC group and more so in the distal and central regions,  $8.0 \pm 1.0\%$  at 0-20% Lm ( $P < 0.01$ ) and  $7.5 \pm 3.5\%$  at 20-40% Lm ( $P < 0.05$ ),  $3.0 \pm 3.0\%$  at 40-60% Lm (N.S.). Instead, Lf decreased in the CON group. No changes in CSA, PA and Lf were found in the CTRL group. **Conclusions:** These findings show that human skeletal muscle responds very differently to ECC and CON training, matched for relative load, and that its morphological adaptations are muscle region-dependent. The observation that, in response to a training load of 60% 1RM, muscle hypertrophy only occurred with ECC loading, strongly suggests that one of the most important stimuli for hypertrophy is muscle stretch [3], while this intensity seems insufficient to induce hypertrophy with CON loading. The unprecedented observation that Lf and PA increase more distally suggest that these regions of the VL are more sensitive to mechanical loading. This contention seems supported by our finding that, in response to RT, the activity of mechano-sensitive protein focal adhesion kinase is greater distally than at mid muscle belly [4]. **Funding** by BBSRC (grant no BB/K019104/1) is acknowledged. **References** 1) Franchi MV et al. *Physiol Rep.* 2015;3. pii: e12593. 2) Franchi MV et al. *Acta Physiol.* 2014; 210:642-54. 3) Moore DR et al. *Am J Physiol Endocrinol Metab.* 2005 Jun;288(6):E1153-9. 4) Franchi MV et al. Abstract submitted for ECSS 2016 Congress, Vienna, Austria.

#### CONTRALATERAL REPEATED BOUT EFFECT OF KNEE FLEXOR ECCENTRIC EXERCISE

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**Introduction** An initial bout of maximal eccentric exercise (MaxEC) confers protective effect against muscle damage when the same exercise is repeated. This is referred to as the repeated bout effect (RBE), and has been shown for the elbow flexors (EF) and extensors, the knee flexors (KF) and extensors (KE), and other muscles [1,2]. Some studies showed that the RBE was also evident when the same eccentric exercise was performed by the contralateral EF (3) or KE (4), which is referred to as the contralateral RBE (CL-RBE). We reported in

ECSS 2014 that CL-RBE was evident when the right and left EF eccentric exercise bouts were separated by 1 day, 1 week or 4 weeks, but not by 0.5 hours or 8 weeks. It is not known whether this is also the case for other muscles. The present study investigated the hypothesis that CL-RBE would be still observed when the second bout was performed by the contralateral leg at 1 day, 1 or 4 weeks after the first bout for KF. Methods Untrained young men were randomly placed ( $n=13/\text{group}$ ) to one of three CL-RBE groups based on the interval between bouts; 1 day (1d), 1 week (1wk), and 4 weeks (4wk), or a control group. The control group performed two bouts of 6 sets of 10 maximal KF eccentric contractions with the non-dominant leg in 2-week apart. Other groups performed the same exercise with either dominant or non-dominant KF first followed 1 day, 1 or 4 weeks by the same exercise performed by the opposite KF. Changes in several indirect muscle damage markers before, immediately after and for 5 days after exercise were compared between bouts, and among the groups by a mixed-design two-way ANOVA. Results Changes in maximal voluntary concentric contraction torque, peak torque angle, range of motion, upper thigh circumference, muscle soreness, plasma creatine kinase activity and myoglobin concentration, ultrasound echo intensity and carotid-femoral pulse-wave velocity after the first exercise bout were similar among the groups. The changes in the variables after the second bout were smaller ( $P<0.05$ ) than those after the first bout for the control, 1d and 1wk groups, with significantly smaller changes for the control than the 1d/1wk groups, but without a significant difference between 1d and 1wk groups. Discussion The CL-RBE of the KF was shorter than that found for the EF. The magnitude of the KF CL-RBE was smaller when compared with that of EF. It may be that the shorter and smaller CL-RBE for KF than EF is related to their different exposure to eccentric contractions in daily activities and neurological differences at muscle, spinal and cortical levels. References 1) Chen et al. (2014) EJAP, 114:1183–95. 2) Black & McCully (2008) MSSE, 40:1605–15. 3) Starbuck & Eston (2012) EJAP, 112, 1005–13. 4) Xi et al. (2014) JAP, 115:1473–80. Contact: tcchen@ntnu.edu.tw

## EFFECTS OF PRIOR UPHILL OR DOWNHILL WALKING TRAINING ON DOWNHILL WALKING-INDUCED MUSCLE DAMAGE

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Introduction Walking is the most primary physical activity for humans, and the quadriceps muscles work concentrically and eccentrically during uphill and downhill walking, respectively. It is known that unaccustomed eccentric exercise induces muscle damage, and repeated bouts of eccentric exercise result in much reduced damage after the second bout. Whether prior bouts of concentric exercise exacerbate eccentric exercise-induced muscle damage is unclear. Electromyogram (EMG) median frequency is believed to reflect motor unit recruitment patterns, and reported to decrease during eccentric exercise, suggesting selective damage in fast-twitch fibers, and to be lower during the second compared to the first bout, suggesting more involvement of slow-twitch fibers as a neural adaptation for muscle protection (Warren et al. 2000). This study investigated 1) the effects of prior uphill or downhill walking training on downhill walking-induced muscle damage, and 2) whether it is associated with the EMG median frequency during the exercise. Methods Young males were allocated to an uphill training (UTG:  $n=12$ ), downhill training (DTG:  $n=12$ ), or control (CG:  $n=10$ ) group. UTG and DTG underwent an 8-week (30 min/day, 3 days/week) training program using a treadmill (gradient: +25% or -25%, velocity: 3.5 km/h, load: gradually increased through 8 weeks from 0% of body weight to 20%; added to a backpack). Subsequently, all groups performed 60-min downhill walking trial (-25%, 3.5 km/h, 10%), with EMG from the quadriceps being recorded. Before and for 3 days after the trial, plasma creatine kinase activity and muscle soreness were measured as indirect muscle damage markers. Results Symptoms of muscle damage were only observed in UTG and CG without difference between these groups. EMG median frequency decreased over time during the trial in all groups without any group-difference. Discussion No difference between UTG and CG in the degree of muscle damage suggests that prior uphill walking training does not exacerbate subsequent downhill walking-induced muscle damage. Gleeson et al. (2003) reported an exacerbating effect of concentric training on eccentric exercise-induced muscle damage, but they used an upper arm, which is more vulnerable than legs, and performed full range of motion concentric training, which reportedly results in decreased fascicle length and increase the susceptibility to lengthening (eccentric) contraction. Such factors may account for the different results. Also, the EMG results suggest that median frequency could reflect intra-individual changes, but not inter-individual differences, in motor unit recruitment patterns and cannot explain resulting muscle damage. References Warren et al. (2000) Med Sci Sports Exerc 32:820-829. Gleeson et al. (2003) Br J Sports Med 37:119–125.

## MUSCLE DAMAGE AFTER DOWNHILL-RUNNING WITH BLOOD-FLOW-RESTRICTION

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Introduction Exercise induced muscle damage (EIMD) is commonly assumed to be the result of mechanical stress placed on the muscle tissue. However, there is also evidence showing that metabolic stress is able to induce EIMD in the absence of any meaningful mechanical impact (Chen et al., 2000). The aim of the present study was to investigate if adding metabolic stress to an eccentric exercise protocol results in an increased level of muscle damage markers in the blood. Methods Nineteen healthy male adults were assigned to an intervention (IG;  $n=10$ ) and a control group (CG;  $n=9$ ). Both groups underwent a downhill-running protocol consisting of 4x5 min intervals at a running speed of 9 km/h and a treadmill decline of 20%. Inflatable cuffs were used in the IG to reduce the blood flow during the 4 intervals. Venous blood samples were taken at pre, post, 2 h, 24 h, and 48 h after the protocol and were analyzed for creatine kinase (CK) and myoglobine (Mb). Results The CK activity significantly increased from baseline ( $178\pm110$  IU/L) only in the IG with a peak value at 24 h ( $568\pm373$  IU/L). No such difference was seen in the CG (Pre:  $170\pm133$ ; 24 h:  $318\pm124$  IU/L). By contrast, the Mb values were significantly increased 2 h after the protocol in both groups (IG:  $235\pm102$   $\mu\text{g/L}$ ; CG:  $147\pm58$   $\mu\text{g/L}$ ), when compared to baseline (IG:  $61\pm10$   $\mu\text{g/L}$ ; CG:  $72\pm29$   $\mu\text{g/L}$ ). Nevertheless, there was a clear trend for greater Mb responses in the IG. Discussion Our data indicate that a reduced blood supply during a damaging protocol increased the amount of muscle damage, as evident from two different muscle damage markers (CK and Mb). This stays in contrast to the results of Thiebaud et al. (2014), who concluded that BFR does not affect the EIMD that was induced by low-intensity eccentric contractions of the elbow flexors. In that study no significant differences were found between the restricted and unrestricted condition regarding the maximum isometric force, the range of motion, upper arm circumference, muscle thickness, and muscle soreness. Sudo et al. (2015) even reported that BFR markedly reduced the number of damaged muscle fibers in rats after high-intensity eccentric contractions. That is, in contrast to earlier findings, the present study indicates that BFR increases the amount of EIMD and therefore adds important information on the growing body of literature on BFR-training. References Chen, Y., Serfass, R. C., & Apple, F. S. (2000). European journal of applied physiology, 81(1-2), 114–119. Sudo, M., Ando, S., Poole, D. C., & Kano, Y. (2015). Physiological reports, 3(7). Thiebaud, R. S., Loenneke, J. P., Fahs, C. A., Kim, D., Ye, X., Abe, T., . . . Bembem, M. G. (2014). Acta physiologica Hungarica, 101(2), 150–157. Contact behringer@dshs-koeln.de

### PROTECTIVE EFFECT OF PREVIOUS MARATHON EXPERIENCE ON MARATHON-INDUCED MUSCLE DAMAGE, INFLAMMATION AND MUSCLE SORENESS

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**Introduction** Delayed-onset-muscle-soreness (DOMS) is characterized by its occurrence after unusual exercise or eccentric exercise, appearance approximately 24 hours after the exercise, peak soreness between 24 and 72 hours after the exercise. On the other hand, other types of exercise-induced muscle soreness exist, such as immediate onset muscle soreness (IOMS), which occurs earlier than DOMS, immediately after exercise. IOMS is frequently observed in exercise involving running, particularly in long distance running, such as the marathon event. Several studies have reported that the repeated bout inhibited eccentric exercise-induced muscle damage and DOMS (Nosaka et al., 2001; Connolly et al., 2002). This study investigated the protective effect of previous marathon experience on marathon-induced muscle damage, inflammation, and IOMS in non-professional full-marathon runner. **Methods** Subjects were 17 (6 Still experienced marathon runners: SE, 11 First time marathon runner: FT) non-professional runners participating in a full-marathon race. Serum creatine kinase (CK), aldolase, aspartate amino transaminase (AST), lactate dehydrogenase (LDH) activities, C-reactive protein (CRP) concentration were measured as well as systemic fatigue and muscle soreness, before, immediately after, and 1 to 2 days after the event. Systemic fatigue and soreness in seven muscle regions were evaluated using a numeric rating scale. **Results** Serum CK activities at the immediately, 1 and 2 day after the marathon, and serum AST activities and serum CRP concentration at the immediately and 1 day in the FT group was significantly higher than before the event, but not significantly in the SE group. Total muscle soreness at the 2 day after the marathon in the FT group still higher than before the event, but not in the SE group. **Discussion** This study revealed that the effectiveness of previous marathon bout on reducing muscle damage, inflammation, and IOMS after the running of a full marathon as well as repeated bout effect on eccentric exercise induced muscle damage and DOMS. **References** Nosaka, K, Sakamoto, K, Newton, M, and Sacco, P. (2001). *Med. Sci. Sports. Exerc.*, Vol. 33, No. 9, 1490-1495. Connolly, D.A.J, Reed, B.V, and McHugh, M.P, (2002). *Journal of Sports Science and Medicine*, 1, 80-86 Contact E-mail address: ishikura.keisuke.fw@tsukuba.ac.jp

### MUSCLE DAMAGE DURING JUNIOR TENNIS TOURNAMENT: EFFECTS OF THE COMBINED RECOVERY METHOD

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**MUSCLE DAMAGE DURING JUNIOR TENNIS TOURNAMENT: EFFECTS OF THE COMBINED RECOVERY METHOD** **Introduction** Tennis movements comprise of acceleration, deceleration and changes in direction. These activities occur with high eccentric contractions of muscles, which are accompanied by symptoms such as muscle damage. The aim of this study was to investigate the muscle damage and the effects of the combined recovery method during junior single tennis tournament. **Method** Sixteen elite tennis players (experimental n=8, control n=8) participated in a 4-day tennis tournament. The experimental group participated in combined recovery method after every match. Blood samples were collected before, immediately after and 48h after the tournament to investigate creatine kinase (CK), lactate dehydrogenase (LDH) and C-reactive protein (CRP) levels. Delayed onset muscle soreness (DOMS) questionnaire was taken before, immediately after every match and 48h after the tournament. **Result** CK and LDH activity in the blood were increased significantly but there were no significant differences in CRP immediately after the tournament comparing to pre tournament. There were no differences on CK, LDH and CRP between the groups during and after the tournament. During tournament DOMS increased significantly in both groups. In the experimental group DOMS scores significantly decreased comparing to control group 48h after the tournament ( $p < 0.05$ ). **Discussion** Our results demonstrated that tennis matches increase significantly blood LDH, CK but not CRP levels. Previous studies have shown that eccentric contractions during sports games can increase CK and LDH enzymes in the blood, which show muscle damage indirectly (Kraemer et al., 2009; Nosaka et al., 2010; Potteiger, Blessing, & Wilson, 1992). Combined recovery method may not changed the blood enzymes but decreased DOMS 48h after the last match Combined recovery can provide an advantage for being ready for the upcoming tournament. **References** Byrne, C., Twist, C., & Eston, R. (2004). Neuromuscular function after exercise-induced muscle damage. *Sports medicine*, 34(1), 49-69. Miliás, G. A., Nomikos, T., Fragopoulou, E., Athanasopoulos, S., & Antonopoulou, S. (2005). Effects of eccentric exercise-induced muscle injury on blood levels of platelet activating factor (PAF) and other inflammatory markers. *Eur J Appl Physiol*, 95(5-6), 504-513. Ojala, T., & Häkkinen, K. (2013). Effects of the tennis tournament on players' physical performance, hormonal responses, muscle damage and recovery. *Journal of sports science & medicine*, 12(2), 240. Potteiger, J. A., Blessing, D. L., & Wilson, G. D. (1992). Effects of varying recovery periods on muscle enzymes, soreness, and performance in baseball pitchers. *Journal of athletic training*, 27(1), 27. Contact: nahitbaylan@yahoo.com

### MORPHOLOGICAL CHARACTERISTICS OF SPORT CLIMBERS

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**Introduction** Sport Climbing has become popular for the last decade. However, there is not sufficient research about physical profiles of sport climbers. Thus, the aim of this study was to clarify the anthropometric characteristics of elite competitive sport climbers. **Methods** Body height, arm span, superior reach span, shoulder and pelvis widths, length and girth of both extremities were measured by the Martin-type instrument and from these data several anthropometric indices were calculated. We collected data from male sport climbers (n=12) aged 18-23 years, whose maximum climbing ability ranged from 6c to 8c in the French scale on lead climbing. Data collected from these climbers were compared with the control data, which is the physical fitness standard value of Japan. Further, we also compared in the following two participant groups. Group 1 (n=7) comprised elite sport climbers who had led a climb of a minimum standard of 8a; and Group 2 (n=5) comprised standard climbers who had climbing abilities below 7c+. **Results** We found that sport climbers have significantly thicker forearm girth ( $p < 0.01$ ) and thinner calf girth ( $p < 0.05$ ). The anthropometric indices which resulted in significant differences between sport climbers and the controls included the ape index ( $p < 0.01$ ; climber  $1.0167 \pm 0.023$ ; standard value  $0.9947$ ) and the upper extremity girth index ( $p < 0.01$ ; climber  $0.9749 \pm 0.0543$ ; standard value  $0.9161$ ). We also found that elite sport climbers have significantly lower body mass ( $p < 0.05$ ), body fat ( $p < 0.05$ ), and thinner arm girth ( $p < 0.05$ ), thigh girth ( $p < 0.05$ ), calf girth ( $p < 0.01$ ) than standard climbers. **Discussion** Sport climbers in this study had significantly higher ape index and upper extremity girth index (forearm girth to arm girth ratio) scores than the controls. This tendency suggests that the development of the upper extremities is an important factor for sport climbing. On the other hand, elite climbers had significantly thinner limbs except the forearms compared with regular climbers. The result



of this study shows that longer upper extremities are fundamental factors for sport climbers, and that a certain amount of muscles, but not too much, for the extremities is needed. Contact hakamadanaoto@gmail.com

## Mini-Orals

### MO-PM16 Sports Medicine & Orthopaedics

#### ENDURANCE TRAINING INCREASES QUADRICEPS OXIDATIVE PROFILE IN COPD: A RCT OF TWO MAJOR TRAINING MODALITIES

IEPSEN, U.W., MUNCH, G.D.W., RUGBJERG, M., ZACHO, M., PEDERSEN, B.K., HELLSTEN, Y., RINGBÆK, T., THANING, P., LANGE, P.

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Exercise is an important countermeasure to skeletal muscle dysfunction in chronic obstructive pulmonary disease (COPD). The two major training modalities in COPD rehabilitation; endurance training (ET) and resistance training (RT) are equally effective at improving muscle strength, exercise capacity and health related quality of life, but the characteristics of muscle fiber type shifting, capillarization and metabolism have not been thoroughly described. Therefore, 30 COPD patients (forced expiratory volume in 1 sec:  $56 \pm 14\%$  of predicted) were randomized to eight weeks of ET or RT. Muscle biopsies (vastus lateralis) were obtained before and after the training intervention to assess muscle morphology, metabolic and angiogenic factors. Symptom burden, exercise capacity, body composition, skeletal muscle blood flow and vascular function were also measured. ET significantly reduced the proportion of type IIa muscle fibers (from  $48 \pm 11\%$  to  $42 \pm 10\%$ ,  $p=0.022$ ) and differed significantly from the RT group at follow-up ( $42 \pm 10\%$  versus  $56 \pm 16\%$ ,  $p=0.040$ ). Anaerobic metabolism (phosphofructokinase content) was only reduced in the ET group ( $p<0.05$ ). Exercise improved symptom burden and exercise capacity in both groups, but no difference between groups. Based on the improved quadriceps oxidative profile, our results suggest ET as the preferred countermeasure to skeletal muscle dysfunction in COPD.

#### CURRENT CONCEPTS OF PHYSICAL ALLERGIES

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**PURPOSE:** It is well known that physical activity is beneficial for people with positive results for physical status and mental wellbeing. However, physical exercise decrease the immune response and may induce a allergy anaphylaxis at some situation as follows. A common example is exercise-induced asthma, exercise-induced urticaria, exercise-induced anaphylaxis and FDEIAn. Generally, anaphylaxis is a severe, potentially fatal, hypersensitivity reaction of rapid onset. It is a dramatic clinical emergency. Actually, there are lots of etiologic factors of anaphylaxis, the principal immunologic triggers are foods, insect stings, and drugs. In recent, physical exercise is also related with the anaphylaxis. In this paper, we present the current views of physiological mechanisms underlying physical anaphylaxis within the context of exercise immunology. we also deals with a detailed 2 kinds of EIA (exercise-induced asthma, exercise-induced anaphylaxis) and exercise prescription and medical treatment for exercise-induced asthma, exercise-induced anaphylaxis and CU (chronic urticaria). **METHODS:** At first, we analyzed and presented the causes, symptoms, pathophysiology, testing, treatment and prescription of exercise-induced asthma, exercise-induced urticaria, exercise-induced anaphylaxis and FDEIAn through many experiments and references. **RESULTS:** Exercise-induced asthma is a typical asthmatic attack which follows a strenuous exercise lasting 5 to 10 minutes in circumstances of dry and cold air situation. Avoid of exercise in that conditions and drug treatment (beta-2 adrenergic agonists) must preferentially be preventive. Physical urticarias are a unique subgroup of CU in which patients develop urticaria secondary to environmental stimuli. Common triggers include cold and heat temperature, water, sunlight and even physical exercise. it is responsible for approximately 20-30% of all cases of chronic urticaria. FDEIAn is induced by different types and various intensities of physical exercise, and this is distinct from food allergy. It is useful to test both in vivo and in vitro an extensive panel of foods. Avoidance of allergenic foods for at least 4 h before exercise has prevented further episodes in all our patients with specific FDEIAn. **CONCLUSIONS:** It is concluded that anaphylaxis remains a continuous challenge for the diagnosis and treatment. The adequate management of anaphylaxis requires rapid diagnosis, implementation of primary and secondary prevention measures, and immediate administration of subcutaneous epinephrine. Furthermore, patient education is necessary to heighten awareness of the sign and symptoms of 2 kinds of EIA and FEDIAN.

#### CORRELATES OF OBJECTIVELY ASSESSED LIGHT PHYSICAL ACTIVITY AND PSYCHOLOGICAL WELLBEING IN RHEUMATOID ARTHRITIS

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**Background:** Epidemiological studies indicate participation in light physical activity (LPA) is positively associated with psychological wellbeing. For patients with Rheumatoid Arthritis (RA), reduced functional ability may result in lower LPA engagement and consequently, compromised mental health (e.g., depression, reduced vitality). In particular, lower-limb functional disability in RA may result in fewer sit ( $\leq 1.5$  METS) to stand ( $> 1.5$  METS) transitions, in turn, contributing towards lower LPA. Given that physical dysfunction is symptomatic of RA, it is also important to determine modifiable correlates of LPA. Autonomy support for PA is reported to be associated with PA engagement, and may represent a malleable target for interventions that seek to promote LPA in RA. **Objectives:** To test a model examining the implications of 1) functional disability and 2) autonomy support for PA, for levels of objectively assessed LPA engagement and associated positive and negative indicators of wellbeing. **Hypotheses:** 1) Self-reported functional ability to 'rise' (from sitting) would negatively predict LPA, via a positive indirect association with objectively assessed sit-to-stand transitions 2) Autonomy support would directly and positively predict LPA, independently of functional disability 3) LPA would positively predict feelings of vitality and be negatively associated with depression **Methods:** RA patients (N=50, Mage =  $55.52 \pm 12.53$ ), completed questionnaires assessing; 1) functional disability to 'rise' (e.g., are you able to stand up from a chair), 2) autonomy support for PA (from a patient-specified important other), 3) depressive symptoms, and 4) subjective vitality. Sit-to-stand transitions and LPA were assessed via 7-days of accelerometry (i.e., number of transitions/day

from <100 counts per min (cpm) to  $\geq 100$  cpm, LPA min/day  $\geq 100$  cpm). Results: Path analyses supported a model ( $X^2(6)=8.62$ ,  $p=.20$ , CFI=.97, RMSEA=.09, in which functional ability significantly negatively predicted the number of sit-to-stand transitions/day, which in turn, significantly positively predicted LPA min/day. A significant positive association between important other autonomy support and LPA was observed. LPA significantly and negatively predicted depressive symptoms ( $R^2=.36$ ), and was positively associated with vitality ( $R^2=.33$ ). Conclusions: Functional disability to rise from a seated position may result in a reduced frequency of sit-to-stand transitions, and contribute towards reduced LPA participation in RA patients. However, important other autonomy support may represent a modifiable target for interventions seeking to promote LPA in RA, independently of the potential negative consequences of functional disability. Subsequently, increasing LPA may hold implications for psychological wellbeing in RA.

### PREVALENCE OF BACK PAIN IN GERMAN ELITE HANDBALL PLAYERS

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**Introduction:** Back Pain is one of the most occurring complaints in sports. Handball is a very intensive contact sport that is associated with mechanical strain on the musculoskeletal system. Especially elite handball players are physically stressed due to high training volume and competition. Consequently this might be related with the development of back pain. This study aims to determine lifetime prevalence (LP) and point prevalence (PP) of back pain in German elite handball players regarding the localization at the spine. **Methods:** N=32 handball players (m=8, f=24,  $18.4 \pm 2.0$  yrs,  $177.2 \pm 7.8$  cm,  $71.8 \pm 9.5$  kg, training volume:  $13.8 \pm 4.1$  hours/week) were asked to fill in an online-questionnaire based on valid Nordic Questionnaire by Kuorinka et al. (1987). Additionally, training volume was collected. X<sup>2</sup>-statistics were used to determine differences in back pain between sexes, the Pearson correlation coefficient was used for analyzing its relation to age, training volume, body weight and height. **Results:** LP of back pain was 84.4%. Regarding different parts of the spine the LP of pain was 53.1% in the neck, 28.1% in the thoracic spine and 81.3% in the lumbar spine. PP of pain in the total back was 25.0% (neck: 15.6%, thoracic: 6.3%, lumbar: 25.0%). Comparison between sexes showed no significant differences. There was a statistical significant correlation for age and PP of low back pain as well as for age and PP of neck pain ( $p < .05$ ) in female handball players. Also for the females training volume and LP of low back pain showed a correlation ( $p < .05$ ). For male players no significant correlations were found. **Discussion:** The results indicate that back pain is a great problem in German elite handball players. Nearly 85% of investigated handball players had back pain at least once in their life. Especially low back pain seems to be problematical in this sample. This is in line with findings in the literature. Tunas et al. (2015) found LP and PP of low back pain in female handball players to be 63% and 26%. In the present investigation LP was much higher compared to this data. One possible reason could be the high competition level of the sample. The results underline the necessity of back pain prevention in elite handball players. **Acknowledgement:** The study was supported by the Federal Institute for Sport Science, Germany (ZMVI1-080102A/11-18). **References:** Kuorinka, I. et al. (1987). *Appl Ergon.* 18, 233-237. Tunas, P. et al. (2015). *Knee Surg Sports Traumatol Arthrosc.*, 23(9):2540-2547. Contact: christopher.surmann@rub.de

### SHOULDER PAIN IN THE SWISS SPINAL CORD INJURY COMMUNITY: PREVALENCE AND ASSOCIATED FACTORS

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**Introduction:** Shoulder pain is a common health problem among persons with spinal cord injury (SCI) that can negatively affect mobility and participation in social life. The aetiology of shoulder problems in persons with SCI is believed to be multifactorial. The aim of this study was to (1) determine the prevalence of shoulder pain and (2) identify factors associated with shoulder pain (including sporting activities as well as sociodemographic and socioeconomic factors, SCI characteristics, health conditions, and mobility independence) in a population based survey. **Methods:** Data was collected in 2012 through a community survey of the Swiss SCI Cohort Study [1]. Swiss residents with SCI aged 16 or older participated in this study (N=1549; age:  $52.3 \pm 14.8$  years; 29% female). Musculoskeletal shoulder pain over the past week (yes/no) as well as other parameters were assessed by self-report. Descriptive data analysis and multivariable logistic regression analysis were used, the latter providing adjusted odds ratios of shoulder pain for sex, age, education, income, SCI aetiology, level and completeness, spasticity, contractures, time since injury, independence in moving 10 to 100 metres, and time spent with sporting activities. The multivariable analysis was adjusted for item non-response (with multiple imputation) and unit-nonresponse (with inverse probability weighting). **Results:** The high overall prevalence of shoulder pain was 36% (95% CI: 33-38). Females had higher odds of shoulder pain as compared to males (odds ratio: 1.89; 95% CI: 1.44-2.47) and when spasticity (1.36; 1.00-1.85) and contractures (2.47; 1.91-3.19) were apparent. In addition, persons with complete paraplegia (1.62; 1.13-2.32) or any tetraplegia (complete: 1.63; 1.01-2.62; incomplete: 1.82; 1.30-2.56) showed higher odds of shoulder pain as compared to those with incomplete paraplegia. Age, education, net equivalent income, etiology, and time spent with sporting activities showed no association. **Conclusion:** Future longitudinal studies will have to search for modifiable factors that are on the causal chain leading to the described associations. **Reference [1]** Brinkhof MWG, Fekete C, Chamberlain JD, Post MWM, Gemperli A, for the SwiSCI Study Group. (2015). Swiss national community survey on functioning after spinal cord injury: protocol, characteristics of participants and determinants of nonresponse. *Journal of Rehabilitation Medicine.* (epub).

### EFFECTS OF AN IN-HOSPITAL EXERCISE INTERVENTION IN CHILDREN WITH LEG'S SARCOMA.

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**Introduction:** Maintaining high levels of physical activity during chemotherapy improves the quality of life of children with sarcoma, as well as their functional capacity, which in turn helps them cope with the treatment (Courneya et al. 2001). The objectives of this study are: 1) to analyze the physical condition of pediatric patients newly diagnosed with sarcoma in lower limbs; 2) to assess the effects of an in-hospital exercise program in the cardiorespiratory and muscular fitness of this population. **Material and methods:** Subjects. 18 children with the aforementioned condition were randomly divided into one of two groups: intervention (exercise; n=9 subjects); or standard care (controls; n=9 subjects). **Study end points.** All children were evaluated at baseline and at end-treatment (neoadjuvant chemotherapy period, average duration  $20(\text{SD} \pm 9)$  wk): 1) on an arm-crank ergometer to measure their peak oxygen uptake ( $\text{VO}_{2\text{peak}}$ ); 2) in an intra-hospital gymna-

sium, to test their 5 repetition maximum (5RM) strength (bench press and lateral row). Combined physical training program. The intervention group performed 3 weekly individually supervised sessions from 45 to 60min duration that included both aerobic arm-ergometer exercise at a heart rate intensity equivalent to the ventilatory threshold and upper-body strength exercises of gradual intensity (3 sets of 15 reps at an initial load ~50% of estimated baseline 1RM). Statistical analysis. We used a two-factor (group and time) analysis of covariance (ANCOVA) with repeated measures. Results We found no significant group ( $p=0.969$ ), time ( $p=0.580$ ) or group\*time (interaction) effect ( $p=0.969$ ) for  $\dot{V}O_{2\text{peak}}$  values. In contrast, we found a significant training-induced benefit for bench press ( $p=0.875$ , 0.026 and 0.001 for group, time and group\*time effect, respectively) and for lateral row ( $p=0.875$ , 0.547 and 0.001 for group, time and group\*time effect, respectively). Discussion and conclusion The exercise intervention had a significant beneficial effect on the children's muscle strength. We believe our data are relevant because the bulk of research has focused on pediatric hematological cancer, particularly acute lymphoblastic leukemia(ALL)(Huang & Ness, 2011) and data are much more scarce on solid tumors, which usually require a more aggressive treatment and have a worse outcome compared with ALL(Balamuth & Womer, 2010). Conclusion The baseline functional capacity of children with leg's sarcoma is very low and such low values further decline with chemotherapy. Combined exercise training has a significant, beneficial impact on the decline in muscle strength that naturally occurs with chemotherapy. References Courneya KS, Friedenreich CM. Framework PEACE: an organizational model for examining physical exercise across the cancer experience. *Ann Behav Med* 2001 01;23(4):263-272. Huang TT, Ness KK. Exercise interventions in children with cancer: a review. *Int J Pediatr*. 2011;2011:461512. Balamuth NJ(1), Womer RB.Ewing's sarcoma.*ancet Oncol*. 2010 Feb;11(2):184-92. Contact juli\_padilla@hotmail.com

## Mini-Orals

### MO-PM30 Performance: Mixed Session

#### DYNAMICS OF AEROBIC CAPACITY AND FORCE-VELOCITY CHARACTERISTICS OF ARM AND LEG MUSCLES IN JUNIOR CROSS-COUNTRY SKIERS

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The goal of our study was to evaluate dynamics of aerobic capacity and force-velocity characteristics of arm and leg muscles in junior cross-country skiers during on-snow training season. Six junior subnational level cross-country skiers (19.3±1.1 years old,  $\dot{V}O_{2\text{max}}$  63.3±5.9 ml/min/kg) participated in 4 physiological test sessions from November to March. Maximal anaerobic power (MANP) of arm muscles was determined in a 10-second maximal effort test by double poling ergometer. Maximal torques of knee extensor muscles at various angular velocities (30 degrees/s – 300 degrees/s) were measured by isokinetic dynamometer. Aerobic capacity (maximal oxygen consumption rate ( $\dot{V}O_{2\text{max}}$ ) and  $\dot{V}O_2$  at blood lactate level (La) 4 mmol/l) was evaluated in incremental tests using double poling ergometer and running treadmill. In the beginning and in the end of the test period volume of m. quadriceps femoris and m. triceps brachii as well as body composition were evaluated by magnetic resonance imaging and anthropometry, accordingly. No MANP increase was found during training period. Knee extensors torque did not change at low angular velocity (30 degrees/s), whereas a decrease (7.8%,  $P<0.05$ ) was found at 300 degrees/s. Initial  $\dot{V}O_{2\text{max}}$  in double poling and treadmill tests were 3.7±0.6 and 4.5±0.6 l/min, accordingly, and did not change during the training period.  $\dot{V}O_2$  at La 4 mmol/l in treadmill test was 3.6±0.8 l/min and also did not change. However,  $\dot{V}O_2$  at La 4 mmol/l in double poling test gradually rose during the testing period from 2.2±0.8 to 2.8±0.7 l/min. Increase of aerobic capacity in incremental double poling test can be explained by initially very low level of aerobic capacity:  $\dot{V}O_2$  at La 4 mmol/l was lower compared with that in treadmill test – 2.2±0.8 and 3.6±0.8 l/min, accordingly. That difference may be associated with low arm muscles training volume over preparation period compared to leg muscles. High volume of leg muscle aerobic training may have negative effect on leg muscle strength and cross-section area. The work was supported by Program № 1.26P from Presidium RAS

#### THE EFFECTS OF SPEED ENDURANCE TRAINING VS. AEROBIC HIGH-INTENSITY INTERVALS ON ENDURANCE PERFORMANCE IN ELITE DANISH ORIENTEERS

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Introduction It is well-known that a short-term period of high intensity training (HIT) is effective in improving endurance performance in trained athletes(Laursen & Jenkins 2002). However, only few studies have been performed in highly trained endurance athletes and therefore the knowledge about the effects of different types of HIT in elite athletes is sparse(Kilen et al., 2014; Denadai et al., 2006). The purpose of the present study was to evaluate five weeks of speed endurance running (SET, n=8) or aerobic high-intensity running (AHI, n=5) in elite orienteers. Methods Performance measures included a short intermittent (4000m) and a field running endurance performance test (8000m),  $\dot{V}O_{2\text{max}}$  and running economy (RE). Further, blood samples pre and post was evaluated for markers of muscle damage and overreaching (LDH, CK, myoglobin, cortisol) and session rating of perceived exertion (session-RPE) was collected after every HIT session. Thirteen elite orienteers (7 female, 6 male), with mean  $\dot{V}O_{2\text{max}}$  of 61.9 ± 3.3 ml  $O_2$ /min/kg and RE of 195 ± 3.2 ml  $O_2$ /min/km performed either SET or AHI two to three times weekly for five weeks combined with regular aerobic low-intensity training. In both groups overall running distance was reduced by 20% compared to the four weeks prior to intervention. SET consisted of 4-12x30-sec. at 90-100% of maximal running distance during a 30-second sprint with 3 minutes of active recovery. AHI consisted of 4-8x4min intervals at an average of 90% of maximal heart rate with 2 minutes of active recovery. Results We found no significant differences in relative changes between groups in running performance,  $\dot{V}O_{2\text{max}}$  and running economy. Short intermittent endurance performance was maintained whereas long endurance performance showed a tendency towards being impaired in both groups. When combining the groups there was a significant improvement in running economy performance ( $P < 0.05$ ).  $\dot{V}O_{2\text{max}}$  was reduced in both SET and AHI ( $P < 0.05$ ) whereas maximal lactate accumulation ( $L_{\text{max}}$ ) increased ( $P < 0.05$ ). Session-RPE was significantly higher in AHI than in SET ( $P < 0.05$ ) while no changes were observed in markers of muscle damage and overreaching. Conclusion In conclusion, five weeks of SET or AHI, impaired long field running performance and  $\dot{V}O_{2\text{max}}$  while short intermittent running performance was maintained and RE improved. References Denadai BS, Ortiz MJ, Greco CC, de Mello MT. Interval training at 95% and 100% of the velocity at  $\dot{V}O_2$  max: effects on aerobic physiological indexes and running performance. *Appl Physiol Nutr Metab*. 2006; Dec;31(6):737-43. Kilen A, Larsson TH, Jorgensen M, Johansen L, Jorgensen S, Nordsborg NB. Effects of 12 weeks high-intensity & reduced-volume training in elite athletes. *PLoS One*.

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## COMPARISON OF FUNCTIONAL MOVEMENT SCREEN RESULTS IN DIFFERENT GROUPS OF ATHLETES

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**INTRODUCTION** The Functional Movement Screen (FMS) consists of seven fundamental functional movement pattern. Each test represents a specific movement within a kinetic chain model and therefore is classed as a Kinetic Chain Assessment. The FMS is supposed to assess the risk of injury by using a cut-off score of  $\leq 14$  points (max. of 21 points). The aim of this study therefore was to investigate, if single tests items of the FMS and/or the overall score are effected by the specific conditioning requirements of different sports. **METHODS** 29 male participants were recruited with 3 different sporting backgrounds – football, climbing and fitness training. The mean age was 26.52 years ( $\pm 5.01$ ) and a BMI of 23.20 ( $\pm 1.95$  kg/m<sup>2</sup>). These different sports were thought to cover a wide range of different conditioning methods and were considered extreme opposites. It was hypothesised that this would have an effect on FMS scoring. The following test batteries were conducted: FMS, FMS Y-balance test (YBT), bio-impedance analysis and grip strength. The subjects were randomised and allocated to groups of different test orders to avoid any distortion or transfer-effects on the test results. **RESULTS** This study found that the climbers performed better in all FMS test items compared to the footballers and the fitness trainees. Results of all participants were in the range of 12-18 points (median: 16 and MV: 15.76  $\pm$  1.53). The climbers achieved the highest score with a median of 17 and a MV of 16.78 ( $\pm$  1.72), whereas the fitness cohort scored a median of 15 and a MV of 15.47 ( $\pm$  1.06) and the footballers had 15 points and a MV of 14.80 ( $\pm$  1.64). Regarding the YBT, the climbers demonstrated the highest score with 104.19% ( $\pm$  6.47), the fitness trainees had 98.82% ( $\pm$  5.37) and the footballers 99.23 % ( $\pm$  3.63). However, this difference was not significant ( $p = 0.074$ ). In the body composition, muscle mass positively correlated with the grip strength ( $p = 0.447$ ) and the FMS score ( $p = 0.473$ ), while fat mass showed a negative correlation to the same parameters ( $p = -0.560$ ). These medium strong correlations are significant with  $\alpha = 0.01$ . **DISCUSSION** Our data confirms that functional and whole body movement concepts such as climbing lead to an even musculoskeletal adaptation with strong components of coordination which was reflected in the FMS results. The overall FMS score was higher in climbers than in the other two groups, but not significantly. The fitness trainees showed average results, while the footballers demonstrated below average results. The only significant differences were demonstrated in single FMS test items which are balance related. This was especially the case in the YBT, which can be explained by the specific requirements of climbing, involving core stability, balance and as such coordination.

## VISUAL STRATEGIES OF TOP LEVEL BADMINTON PLAYERS

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**Introduction** Visual perception and anticipation of athletes in sports have frequently been subject of investigations to discriminate effective visual search strategies with the aim to improve performance in anticipation (a. o. Abernethy & Russell, 1987; Alder, Ford, Causer & Williams, 2014). The gaze behavior of experts and non (or near)-experts is frequently recorded under laboratory conditions using video tapes. The question arises whether this two dimensional stimulus is a valid approach (Mann, Williams, Ward & Janelle, 2007). In the present study, gaze behavior of internationally ranked badminton players and intermediate level club players was investigated under field conditions with real opponents to induce actual reactions of the players. **Methods** The gaze strategies of 4 internationally ranked female doubles players (age 27.5  $\pm$  3.4 years) and 5 intermediate club level players (1 female, 4 male, age 32.6  $\pm$  7.8 years) were analyzed using a mobile eye tracking device (SMI ETG 2, sample rate 60 Hz). The participants returned serves in a simulated doubles match. Their visual search strategies were recorded while executing the return and the gaze direction was analyzed frame by frame during one second before racket-shuttle contact of the serve. The locations of gaze direction were categorized in head, trunk, shoulder, arm, hand, racket head and shuttle. **Results** The locations that were frequently focused on were shuttle, racket head, head, trunk and left hand with noticeable differences between the experts and the near experts. While the club level players focused on the head of their opponents in 28 % of the recorded period, the racket head in 7 % and the shuttle in 17 %, the top players never focused on the head but rather mostly on the shuttle (48 %) and the racket head (28 %). **Discussion** These findings seem to contradict the results of Alder et al. (2014), who used video tapes as stimulus. They reported that participants seldom focused vision on the shuttle but frequently on the right wrist, a location that was not measured at all in the present study. It is presumable that the research conditions influence the outcome of analyses of visual strategies. **References** Abernethy, B. & Russell, D. (1987). The relationship between expertise and visual search strategy in a racquet sport. *Human Movement Science*, 6(4), 283-319. Alder, D., Ford, P. R., Causer, J. & Williams, A. M. (2014). The coupling between gaze behavior and opponent kinematics during anticipation of badminton shots. *Human movement science*, 37, 167-179. Mann, D. T., Williams, A. M., Ward, P. & Janelle, C. M. (2007). Perceptual-cognitive expertise in sport: A meta-analysis. *Journal of Sport and Exercise Psychology*, 29(4), 457. Contact wolf.gawin@hsw.tu-chemnitz.de This project has been funded by the Federal Institute of Sport Science on the basis of a resolution of the German Bundestag.

## FIREFIGHTERS' FIT FOR DUTY SCORE-MODEL

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*Winternat*

**Introduction** Physical capacity has previously been deemed important for firefighters' physical work capacity, and evaluation of fitness for duty is common in the pre-hiring process. Various methods have been used to establish cut-off limits, i.e. normative data or expert judgements. In accordance with government regulation, both full-time and part-time firefighters in Sweden have to pass a medical examination and a test of physical work capacity for permission to execute smoke diving. The physical work capacity test is a pass or fail test: dressed in firefighting protective clothes and breathing apparatus (total weight 24  $\pm$  0.5 kg), six minutes walking with the incline at 8 degrees and treadmill speed of 4.5 km/h is performed. Inclusion of additional physical tests and appropriate cut-off limits is a decision taken by each individual municipality. The aim of the present study was to create a score model for evaluation of fitness for duty in the pre-hiring process of firefighters. **Methods** A total of 128 (64 men and 64 women) subjects: full-time firefighters, part-time firefighters and civilians, were included. Subjects performed five simulated firefighting work tasks and a selected battery six of physical tests including; 500 m rowing, grip strength, endurance bench press, track running 3000 m, standing broadjump and upright barbell row. The combined information from subjective evaluated cut-off limits, breakpoint estimation, checkpoint estimation and percentiles were used to create a score-model



for evaluation of fit for duty. Results The models yielded various cut-off limits on the same physical test, depending on the work task investigated, but all tests were scored on a 1-11 scale. Consequently, the maximum total score was 66 and the minimum total score was 6. The recommended minimum total score of six tests is 36. Discussion In this study we created a score-model for evaluation of firefighters' fit for duty in the pre-hiring process. When pre-hiring physical tests are performed, an easily conducted battery of physical tests is important in order to reduce costs but still maintain high validity and reliability. The score-model is easy to understand, performance gives the same score irrespectively of age and sex and makes it possible for the aspirants to prepare for the included physical tests. Since a specific physical test differs in importance in the prediction of simulated work task performance, the lack of performance in one physical test may not be fully compensated with a higher performance in another physical test. Simplifying and generalizing a method makes it practically usable at the detriment of accuracy on an individual level.

#### **DIFFERENTIATION BETWEEN PERCEIVED EFFORT AND DISCOMFORT DURING RESISTANCE TRAINING: RELIABILITY OF TRAINEE RATINGS OF EFFORT AND DISCOMFORT, AND RELIABILITY AND VALIDITY OF TRAINER RATINGS OF TRAINEE**

STEELE, J., FISHER, J., MCKINNON, S., MCKINNON, P.

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Tools such as rating of perceived exertion (RPE) scales are commonly used in exercise to identify the degree of effort put forth by an individual. RPE scales of many forms have been applied specifically to resistance training (RT) and could be useful tools to determine the degree to which effort as a variable impacts training adaptation. Training to a maximal effort by completing repetitions to momentary muscular failure (MMF) is suggested to be most efficacious in RT but the specific dose response nature of effort is unknown. Thus sub-maximal measures of effort using RPE scales could be useful advancing understanding of this. However, most RPE scales suffer from conflation of perceptions of both effort and discomfort or other physiological sensations by participants. To address this we have developed two adapted 11 point scales (0-10) along with scripts which are designed to encourage participants to differentiate between 'effort' (RPE-E) and 'discomfort' (RPE-D) during resistance training. The aim of this study was to examine the reliability of trainee ratings of perceived effort and discomfort using these scales in addition to the reliability and validity of trainer ratings of effort. Participants underwent 3 RT trials over a period of three weeks consisting of 5 compound exercises (Chest press, pull down, seated row, overhead press and leg press) performed to a self-determined RM (meaning they determined inability to complete further repetitions if attempted i.e. they predicted MMF on the next repetition). A self-determined RM was chosen as the repetition cessation criteria in order to examine the use of the RPE-E and RPE-D scales during submaximal effort, though in some instances during trials participants did reach MMF thus providing a range of efforts to examine. Intra-rater absolute standard error of measurement (SEM) was calculated for trainee RPE-E, trainee RPE-D, and trainer RPE-E. In addition, in a sub set of participants receiving 2 trainer RPE-E assessments, inter-rater absolute SEM was calculated. Finally, validity of trainer RPE-E was examined as SEM between trainer and trainee RPE-E. Intra-rater SEMs from trainee RPE-E ranged from 0.64 to 0.85 pts, trainee RPE-D ranged from 0.60 to 1.00 pts, and trainer RPE-E ranged from 0.56 to 0.71. Inter-rater SEMs for trainer RPE-E ranged 0.25 to 0.66. SEMs for agreement between trainer and trainee RPE-E range from 1.03 to 1.25. Results suggest that the reliability for both trainee measures of RPE-E and RPE-D, in addition to trainer RPE-E is acceptable. Further, trainer RPE-E appeared to have acceptable validity compared to trainee RPE-E. These results suggest that the scales adopted might be used in research examining the dose-response nature of perceived effort independently of perceived discomfort upon outcomes related to RT. It also suggests that trainers might predict a trainees perceptions of effort with acceptable accuracy and thus be able to use such information in programming.

#### **PHYSICAL FITNESS IN YOUNG MALE NON-ATHLETES WITH NORMAL WEIGHT, OVERWEIGHT, AND OBESITY: BMI CATEGORIES DO NOT REFLECT WEIGHT-ASSOCIATED PERFORMANCES LOSSES**

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Introduction There is compelling evidence that physical inactivity and overweight are rising worldwide. Moreover, sedentary lifestyles are adopted at increasingly earlier age (1-4). We examined associations of anthropometric measures and physical performances of sedentary males aged 18-25 years. We tested the hypothesis that weight-associated performances losses are not mirrored by BMI categories and the pinpointed WHO-BMI values of 25 and 30 are inappropriate cut-offs. Instead, we postulated finely graded performance decreases associated with higher waist circumference, body weight, and BMI of non-athletes. Methods Anthropometric, questionnaire, and physical fitness data of 961 inactive men were analyzed. All volunteers performed strength (flexed-arm-hang in chin-up-position) and endurance tests (1000m-run). These performances were compared with respect to 1) WHO-BMI categories: 3 groups with normal weight, overweight, and obese men 2) individual waist circumference, body weight and BMI-values, and 3) BMI-matched groups consisting of overweight men with waist circumferences <94cm or >94cm. Means, standard deviations, and confidence intervals were computed. ANOVA, Duncan Tests, and regressions were used to determine differences and associations between fitness and anthropometric data. Results 1000m-times of normal weight, overweight, and obese men (means±SD: 265±37s; 285±43s; 322±52s) as well as chin-up-times (51.8±20.7s; 31.4±16.5s; 18.2±12.8s) differed significantly between all groups. However, the relations between individual anthropometric and performance data showed smooth declines starting in BMI ranges of 23-27 and revealed no graduations fitting to the BMI categories. The BMI group with smaller waist circumference was significantly fitter than the BMI-matched group with larger waist circumferences (1000m- times: 285±52s; 302±47s; chin-up-times: 29.1±14.3s; 22.2±12.9s). Discussion The results prove that the BMI categories alone are not reliable fitness predictors. Independent from the BMI cut offs 25 and 30 fine graded and continuous performance losses occur. The results of the BMI-matched groups underline the use of waist circumference for health and fitness assessment. With regard to physical fitness promotion and strategy it is important to acknowledge that performances of overweight persons will be reduced even by small weight gains. References Leyk D et al (2008). Dtsch Arztebl Int: 105, 793-800 Leyk D et al (2012). Dtsch Arztebl Int 44, 737-45 Leyk D et al (2012). J Strength Cond Res 26, S15-S22 Leyk D et al (2015). J Strength Cond Res 29, S199-S203 Contact Leyk@dsks-koeln.de

## Mini-Orals

### MO-PM41 Health & Fitness: Children

#### PHYSICAL FITNESS OF CHILDREN AND ADOLESCENTS IN GERMANY: COHORT STUDY OVER A PERIOD OF 6 YEARS

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**Introduction** A high motor performance of children and adolescents is associated with a decreased present and future risk for diseases of the cardiovascular and musculoskeletal system and with a better mental health (Ortega, 2011). This paper reports findings on motor performance (MP) of children and adolescents over a period of 6 years. The data originate from the MoMo Study (2003-2006), which offered the first opportunity to assess MP of German children and adolescents aged 4–17 years on a nationwide representative basis. The study started 2003 – 2006 (baseline) and is part of the German Health Interview and Examination Survey for Children and Adolescents (KiGGS). In 2009-2012 a second representative cohort (wave 1) was tested. **Methods** MP was examined by a comprehensive physical fitness test profile (Woll et al., 2011). In this analysis 7 tests were included covering the relevant dimensions of physical fitness (cardiorespiratory fitness, strength, gross motor coordination, fine motor coordination, and flexibility). The samples consisted of  $n=4,528$  (baseline) and  $n=3,103$  (wave 1) children and adolescents. Data were analysed separately for sex and age groups, so 52 means and confidence intervals (95%) for complex samples were calculated. Effect size was estimated by Cohen's  $d$ . **Results** MP of German children and adolescents did not decrease after 6 years: Analysed over all age groups and both sexes at wave 1, the MP-values increased 24 times significantly and stayed 28 times within the same range. Analysed over all dimensions of MP, the gross motor coordination improved more than other dimensions. Analysed over all age groups the cohort of 6–10 years old children improved more than other age groups. **Discussion** MP of German children and adolescents changed in the right direction within the observed 6 years, but still seem to be clearly below the values in past with non-representative samples (Bös, 2003). In the last 10 years, a lot of health promoting activities started, of which many aimed at elevating the level of MP of children and adolescents. Our results indicate that activities and interventions started making an impact especially within the children in elementary school age. The data of wave 2 (2014 – 2016), which are currently collected, will give more insights in MP of German children and adolescents. **References** Bös K (2003). Erster Deutscher Kinder- und Jugend-sportbericht, 85-107, Hofmann, Schorndorf. Ortega FB, Artero EG, Ruiz JR, España-Romero V, Jiménez-Pavón D et al. (2011). Br J Sports Med, (45), 20–29. Woll A, Kurth BM, Oppert E, Worth A, & Bös K (2011). Eur J Pediatr, 170(9), 1129-42.

#### OVERWEIGHT AND OBESITY ASSOCIATED WITH THE LEVEL OF PHYSICAL FITNESS AMONG EGYPTIAN CHILDREN AGED FROM 6 TO 11 YEARS

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**Introduction** Childhood obesity has more than doubled in children in the past 30 years (WHO, 2014). The problem is global and is steadily affecting many low- and middle-income countries, particularly in urban settings. Therefore, the aim of this study is to investigate the overweight and obesity in children, and the association with the level of physical fitness among Egyptian children. **Methods** Participants were Egyptian children ( $n = 752$ ) boys and girls aged from 6-11 years ( $M = 8.46$ ,  $SD = 1.35$ ) from 13 public primary schools in Assiut city presenting upper Egypt region. The German motor test (DMT) was used to assess the level of physical fitness including speed, strength, coordination, endurance, and flexibility. Children's height, weight, and BMI were measured, respectively. **Results** Prevalence of overweight and obesity was 12.2% and 10.2% respectively. The rate of overweight was the highest at the age of 10 years and decreased with an increase in age, while obesity increased with an increase in age to be the highest at the age of 11 years. The level of physical fitness were significantly associated with children's BMI ( $p=.000$ ). The overweight and obese children showed the lowest achievement in the test items comparing to their peers with highly significant correlation for balance and endurance ( $p=.000$ ,  $p=.001$ , respectively). **Discussion** The overall prevalence on the present study was 22.4%. These results confirm the concern about the rapidity of increasing the prevalence of overweight and obesity in urban environment which has demonstrated a higher percentage comparing to previous studies in Egypt (Hafez AS, et al., 2004; Nora et. al, 2013). By age growing the reduction in physical fitness of overweight and obese children could contribute to negative physical and mental health, and persistence of obesity into adulthood later in life (Castelbon & Andreyeva, 2012). Thus, an intervention programs promoting healthy lifestyle habits, including healthy eating and physical activity, should be offered during the school program and can lower the risk of becoming obese and developing related diseases (CDC, 2014). **References** Castelbon, K., Andreyeva, T. (2012). BMC Pediatrics, 12, 12-28. Centers for Disease Control and Prevention (CDC). (2014). Adolescent and School Health: Childhood Obesity Facts. Hafez AS, EL Amady MY, Hassan NE. (2004). Egypt Journal Community Med, 18:99–170. Nora, El-Said. B., Abeer Abo Barakat, Seham, A. El Sherbini, Haiham, M. F. (2013). Egyptian Pediatric Association Gazette; 61(1):31-36 WHO. (2014). Global Strategy on Diet, Physical Activity and Health. Childhood overweight and obesity. Contact Osama.karim@ovgu.de

#### DIFFERENCES IN BODY COMPOSITION AND OCCURRENCE OF POSTURAL DEVIATIONS IN BOYS FROM TWO RACIAL GROUPS IN SOUTH AFRICA

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**Introduction** Little is known about ethnic differences in developing countries like South Africa, particularly with regard to occurrence of postural deviations and body composition profiles. The aim of this study was to compare the occurrence of postural deviations and body composition among two racial groups in South Africa. **Methods** The sample ( $n = 219$ ) consisted of 79 African boys and 140 Caucasian boys. Anthropometric (BMI and percentage body fat) and body posture measurements were performed. Measurements were taken according to the standard procedures of the International Society for the Advancement of Kinanthropometry (ISAK). A posture grid and the New York Posture Test were used for all postural assessments. **Results** In all three age groups (11 to 13 years) the Caucasian group had a significantly higher BMI and percentage body fat compared to the African group. There were no statistical and practical significant differences in occurrence between age groups. The African group had higher occurrence in most of the deformities with winged scapulae, protruding abdomen and lordosis demonstrating a statistical significance and a practical significance (large effect) with regard to the

Caucasian group. The higher occurrence of kyphosis and pronated feet in the African group was statistically significant, and visible (medium effect) with regard to the Caucasian group. The higher occurrence of flat feet in the African group was statistically significant, but demonstrated a small effect which is not visible. The higher occurrences for uneven shoulders in the Caucasian group was statistical significant and also visible (medium effect) with regard to the African group. Discussion The results of this study support the development of more responsible education and screening programmes in both rural and urban school environment. Early detection and treatment programmes targeted at children, designed to prevent postural diseases from subsequently becoming chronic adult disabilities, should be an important health strategy for the young population. Contact [suzanne.stroebel@gmail.com](mailto:suzanne.stroebel@gmail.com)

### ORGANIZED LEISURE TIME SPORT PARTICIPATION IS ASSOCIATED WITH ACADEMIC ACHIEVEMENTS

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**Abstract** Introduction Many studies show a positive association between sport participation and academic achievements. Most of these studies involve adolescents participating in school sports. This may be affected by the school environment and thus bias the results. Studies on the association between organized leisure time sport participation outside the school environment and academic achievements in preadolescents are scarce, especially where maturity level is controlled for but sports are known to favor the more mature individual. The aim of this study is therefore to examine the relationship between academic achievements and sport participation outside the school environment among preadolescents while adjusting for potential confounding variables. Methods This is a cross-sectional study of 248 nine year old school children. Sport participation was self-reported with parental assistance and results from standardized tests in Icelandic and math retrieved from the National Institute of Education. Fitness was estimated using a graded maximal cycle ergometer test. Results Academic achievements increased with increased sport participation, for both academic subjects. However, one-way ANOVA showed statistically significant association for math only, where the most active group scored higher than the other two less active groups ( $F(2,246) = 4.6, p = 0.01$ ). The statistically significant finding in math was further established in the ANCOVA analysis with sex, age, maturity level, family structure, parental education, adiposity and fitness as covariates ( $F(2, 235) = 3.81, p = 0.02$ ). Discussion After controlling for the confounding effects of maturity level and other covariates, sport participation outside the school environment is related to academic achievements in preadolescents. This study supports the notion that in addition to the many health benefits of sport participation, used here as a proxy for physical activity, it is also related to improved academic achievements. Concerns about time spent in sport participation rather than in academic studies and homework, are unfounded. Contact Elvar Saevarsson University of Iceland [ess13@hi.is](mailto:ess13@hi.is)

### THE COMPARISON OF SCHOOL AND HOLIDAY-BASED SCHEDULES ON SLEEP QUANTITY AND QUALITY, PERCEIVED STRESS AND COPING STRATEGIES IN PRE-ELITE YOUTH ATHLETES.

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Pre-elite youth athletes manage the demands associated with their respective sports in addition to academic studies, social activities and employment. The increased demand to manage their schedules during a school term may negate sleep behaviour and perceived stress in youth athletes. Therefore, the aim of this study was to compare pre-elite athletes' management of school-sport schedules, sleep behaviour and perceived stress between school holidays (low school and sport-based commitments) and during a school term (higher school and sport-based commitments). Ten female pre-elite youth netballers competing at a regional representative level ( $15 \pm 1$  yr) completed two identical data collection periods (January; low school and sport-based commitments and March; high school and sport-based commitments), each for two weeks in duration. During each two-week period, participants wore an Actiwatch for assessment of time in bed, sleep time, onset latency, efficiency, wake after sleep onset (WASO) and number of awakenings. Sleep diaries were also completed to assess subjective sleep quality. Participants completed a daily schedule outlining the type and duration of their respective activities during the fortnight and at the end of each week participants completed a questionnaire regarding the perceived stress, sources of stress and coping strategies. Results demonstrated a significant increase in WASO from January to March ( $P = 0.02$ ), however there were no significant differences between January and March for all remaining sleep variables ( $P > 0.05$ ). Scheduling indicates there was a significant decrease in time spent in social activities ( $P = 0.009$ ), resting ( $P = 0.02$ ) and sleeping ( $P = 0.03$ ) during March compared to January. Additionally, there was an increase in school ( $P = 0.001$ ), homework ( $P = 0.01$ ), sporting competitions ( $P = 0.01$ ) and travelling to sport time ( $P = 0.05$ ) in March compared to January. Stress was significantly elevated in both weeks of March compared to January ( $2.4 \pm 2.1$  and  $2.8 \pm 2.2$  au, vs  $6.7 \pm 1.3$  and  $7.8 \pm 1.0$  au, respectively). Athletes increased the number of people that they relied on to cope with the increased stress during March compared to January ( $P = 0.04$ ). It is suggested that athletes are sacrificing sleep and rest to complete all of their school and sport-based commitments in March, and that may be contributing to an increase in self-reported stress. Pre-elite youth athletes should be aware of a variety of strategies to cope with increased time commitments and stress and be made aware of the negative effects of sleep disruption. Melissa Skein, PhD [mskein@csu.edu.au](mailto:mskein@csu.edu.au)

### DISPLACING SEDENTARY BEHAVIOR WITH PHYSICAL ACTIVITY AND SLEEP: ASSOCIATIONS WITH CHILDHOOD OBESITY

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**Introduction** This study examined the prospective associations of reallocating time spent in different types of sedentary behavior, physical activity and sleep with body mass index (BMI) in children using isotemporal substitution analysis. **Methods** Chinese children in grades 1-3 were recruited into a cohort study in 2009 and were followed up over a two-year period. Reports were gathered from the parents on children's sedentary behavior, sleep duration, and socio-demographic variables. The reported sedentary behavior types were then grouped into three categories: screen time, academic-related activities and other sedentary behavior. Moderate-to-vigorous physical activity (MVPA) and light-intensity physical activity (LPA) was assessed by ActiGraph accelerometry. Isotemporal substitution models were performed to examine the effects of time allocation on BMI. **Results** A total of 672 children (359 boys, mean age at recruitment = 7.6 yr) who had provided valid accelerometer data for at least one assessment time point were included in the analysis. Controlling for covariates and total behavior time, isotemporal substitution models indicated that the displacing of 30 min/day of other sedentary behavior with equal amounts of screen time ( $B = 0.13$ , 95% confidence interval: 0.06, 0.20) and academic-related activities ( $B = 0.09$ , 95% confi-

dence interval: 0.01, 0.17) was associated with higher BMI. Reallocating 30 min/day of MVPA with each of the sedentary behavior variables resulted in increased BMI. Discussion Although isotemporal substitution analysis has previously been used in physical activity research in both adults and children (Aggio et al., 2015; Buman et al., 2014), this study extends previous findings by examining substitution effects of different types of sedentary behavior in children. The substituting of screen time or academic-related activities with other sedentary behavior or MVPA was associated with lower BMI in Chinese children. Unfavorable effects of sedentary behavior on adiposity may be mediated by not only replacing them with MVPA, but also by increasing other unhealthy behaviors, such as snacking. References Aggio D, Smith L, Hamer M. (2015). *Int J Behav Nutr Phys Act*, 12:83. Buman MP, Winkler EA, Kurka JM et al. (2014) *Am J Epidemiol*, 179(3), 323-34. Contact wendyhuang@hkbu.edu.hk

## **MOTOR DEVELOPMENT ASSESSMENT OF TYPICAL CHILDREN WITH MOVEMENT ABC-2: A PRELIMINARY STUDY FOR TURKEY**

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**Introduction** Early childhood period is a sensitive period for children's motor development. If any delays or problems occur in early childhood period, these problems should be diagnosed as early as possible for providing early interventions or movement programs. A variety of motor development tests (such as TGMD-2 and Movement ABC-2) exist to assess children's motor development in the literature (Cools, De Martelaer, Samaey, & Andries, 2009). Majority of the tests has been validated for USA or European children. However, there is no a standardized motor development test that measures children's motor development in Turkey. For this reason, the aim of this preliminary study was to use Movement ABC-2 assessment tool to evaluate typical children's motor development in Turkey and determine the appropriateness of the standard scores for these group of children. **Methods** For the purpose of this study, forty one children (19 Female & 22 Male) with Mage=53 months recruited from an urban area child care center in the capital city of Turkey. The center serves typical young children. Movement ABC-2 was used to assess children's motor development. This test has been used in many studies and preferred to diagnose any motor delays or level of motor development. It consists of three age bands: 1 (3 to 6 years), 2 (7 to 10 years), 3 (11 to 16 years). Manual dexterity, aiming and catching, and balance are the main components of the test. In this study, Age band 1 was used. Total standard scores and percentiles were identified for children in this study. **Results** The mean score for standard score was found as 9.6 with a range of 5 to 13 and for percentile score was found as 45.8 score with a range of 5 to 84. Based on the Movement ABC-2 evaluation, two children were identified in red zone (at or below the 5th percentile) showing the children had a significant movement difficulty. No movement problem has been identified for the rest of children (above the 15th percentile) based on the standard score for total test score. **Discussion** The Movement ABC-2 test might be appropriate to assess motor development of children in Turkey. However, more participants from different regions of Turkey is necessary to confirm validity of the test. Some adjustments might be necessary in the standard or percentile scores. In addition, future studies might focus on the develop appropriate standards in motor development tests for children in Turkey. **References** Cools, W., De Martelaer, K., Samaey, C., & Andries, C. (2009). *Journal of sports science and medicine*, 8(2), 154-168. Contact hurmeric@metu.edu.tr

## **ASPECTS OF VALIDITY AND RELIABILITY OF THE BRUININKS-OSERETSKY TEST OF MOTOR PROFICIENCY-SHORT FORM IN GREEK CHILDREN**

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The Short Fort of the second Edition of the Bruininks-Oseretsky Test of Motor Proficiency (BOT-SF; Bruininks & Bruininks, 2005) is an individually administered tool, broadly used in research and clinical settings for the assessment of the motor proficiency of children and youth, aged 4-21 years. The technical adequacy of the battery is well established in its manual; however, the investigation of the psychometric properties of a tool should precede its application in populations different to the standardization one (Yun & Ulrich, 2002). The aim of the present study was to gather evidence about the validity and reliability of the BOT-SF in Greek children aged 4-7 years, investigating the following criteria: (a) competence of total score to differentiate among age groups, (b) internal consistency, and (c) test-retest reliability. For that purpose, the BOT-SF was administered to 165 children, 4-7 year-old (M=5.7, SD=0.9 years), typically developing children, who were divided in three age groups (4:0-4:11, 5:0-5:11, 6:0-6:11). Thirty-three of the participants were given two trials of the battery by the same assessor, within a 1-week interval. One-way analysis of variance that was applied on the total BOT-SF point score revealed that there were statistically significant differences among the age groups ( $F_{2,162}=84.4$ ,  $p=.000$ ,  $\eta^2=.55$ ). Post hoc comparisons using Bonferroni test, with alpha set at .05, showed that each age group had higher scores compared to the younger ones. Moreover, the Cronbach's  $\alpha$  that was computed in order for the internal consistency to be checked was found .89, while it would have been reduced if any of the items had been deleted. Finally, the intraclass correlation coefficient (ICC) on the total score, that was estimated with a two-way random model and an absolute agreement, yielded a value of .90 (95% confidence interval = .80 and .955), showing an excellent test-retest reliability. From the above results, it can be concluded that the BOT-SF seems to be a valid and reliable measure to assess motor proficiency in typically developing 4-7-year old Greeks. Further research is needed to investigate its usefulness in Greek children with motor delays. **References** Bruininks, R.H. & Bruininks, B.D. (2005). *Bruininks-Oseretsky test of motor proficiency* (2nd ed.). Minneapolis, MN: Pearson Assessment. Yun, J., & Ulrich, D. A. (2002). Estimating measurement validity: A tutorial. *Adapted Physical Activity Quarterly*, 19(1), 32-47.

## **FOOT CHARACTERISTICS IN NEPALESE CHILDREN AGED 4-16 YEARS**

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**Introduction** The foot status of children is influenced by many factors, including heredity and environment. It is assumed that the geographical conditions of Nepal, especially the predominantly hilly and mountainous environment, affects growth status and that the foot condition of children in particular is highly influenced by their walking in steeply sloping terrain. This study investigated foot sole parameters in a hilly area of Nepal. **Methods** The sample comprised 604 healthy children (278 boys and 326 girls) 4-16 years of age, who lived in a rural area near Kathmandu. Their height and weight were measured and their soles photographed in December, 2015. Sole photographs were taken using a two-dimensional foot scanner device (FootLook). Foot length and width, toe form, and planter arch condition were measured from the sole photographs. **Results and discussion** Mean height among the rural children aged 6-16 years ranged from



110.9 -160.1 cm for boys and, 105.9-151.3 cm for girls. This was smaller than the range among children from an urban area in Kathmandu, which was 114.6-161.9 cm for boys and, 113.3-152.6 cm for girls. Mean weight among the rural 6-16 year olds ranged from 20.0-42.7 kg for boys and was much smaller than the range among urban area children, which as 19.3-53.4 kg for boys. However, the ranged of 17.8-51.7 kg for rural girls was much greater than that of urban area girls, at 18.0-46.4 kg. Mean foot length and foot width show a steady increases from 4-14 years in boys, and also a gradual increase among girls of the same age group. However, mean foot length and foot width decreases among 14-15 year-old boys and girls. The mean width/length ratio increases from 6-14 years in girls. However, those increases fluctuate from 4-14 years in boys. There are significant increases from 14-15 years, and significant decreases from 15-16 in boys. Mean normal arch among the 7-12 years (92.4-91.4%) was much higher than the difference among Japanese children (71.5-79.3%). Nepalese children showed a low rate of flat arch (4.8%). However, mean normal arch among the 5-6 years (75.0-88.9%) were higher than the difference among Japanese children (73.3-78.2%). The shape of the foot is classified into three categories; Egyptian type was 98.0%, Greek type was 2.0% and Square type was 0%. These results suggest that Nepalese children have normal arches. Nepalese children usually wear school-shoes in daily life. However, it was observed that even if high school students they perform physical activities, like soccer and running, without wearing shoes. In addition, when going to school many Nepalese children must walk for more than 30 minutes along a steeply sloping road. It is assumed that such unshod activities and a long walk in the hills explains the lower prevalence of flat arch. Conclusion Nepalese children have a normal foot arch instead of a flat arch. Mean foot length and foot width increases from 4-14 years among boys and girls.

### RELIABILITY OF NEW AGILITY TEST, N CHALLENGE, FOR ELEMENTARY SCHOOL CHILDREN

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**Introduction:** Agility is one of the main physical fitness components, and is also considered the crucial component for success in many sports, such as tennis, basketball and soccer (Hachana et al., 2014). To improve agility, some types of agility and coordination drills and resistance training are used; however, these training are often less enjoyment, especially for children. The aims of this study were to develop an agility test with enjoyment for children, and to examine reliability of the test in elementary school children. **Methods:** We designed a new agility test which is set an N-shaped (7 m length; 5 m width) run course, which consists of 6-m straight sprint, right turn, 5 small hurdles (20-cm height), left turn, and 6-m zigzag run among 5 poles (1.2 m height; 1.2 m apart). The time to complete the all sections and each section were detected by phototube sensors, and were recorded by a personal computer. One-hundred thirty seven elementary school children (2nd and 3rd graders) performed the test twice. The children answered questionnaires for scoring enjoyment of the agility test. Reliability was assessed by Pearson's correlation between 1st and 2nd trials. **Results:** The time to complete the all sections were  $10.9 \pm 0.8$ ,  $11.6 \pm 0.8$ ,  $10.6 \pm 0.7$  and  $11.0 \pm 0.5$  sec in 2nd grade boys and girls, and 3rd grade boys and girls, respectively. Correlation coefficients between 1st trial and 2nd trial were 0.80, 0.80, 0.90, and 0.82 in 2nd grade boys and girls, and 3rd grade boys and girls, respectively (all  $p < 0.01$ ). All of children answered "I enjoyed strongly" or "I enjoyed" in 2nd graders and 63 children answered each of them in 3rd graders. However, only 3 children in 3rd graders answered "I didn't enjoy so much". **Discussion:** We developed an enjoyable agility test entitled "N Challenge" for children. By playing the agility test repeatedly, agility performance of children seems to improve and could lead to increase the amount of physical activity. **References:** Hachana Y, Chaabène H, Ben Rajeb G, et al. Validity and reliability of new agility test among elite and subelite under 14-soccer players. *PLoS One*. 9:e95773, 2014. Contact: morita.noriteru@i.hokkyodai.ac.jp

## Mini-Orals

### MO-PM32 Cardiovascular System

#### STATIC, ONTOGENETIC AND MULTILEVEL MODELING OF LEFT VENTRICULAR MASS IN ADOLESCENT BOYS: LONGITUDINAL EFFECTS OF AGE, BIOLOGICAL MATURATION, SIZE AND OBJECTIVELY MEASURED PHYSICAL ACTIVITY

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**Introduction** Left ventricular mass (LVM) is related to cardiovascular health (Gidding et al., 2013). LVM is generally normalized to determine appropriateness relative to body size (Foster et al., 2013). Accurate quantification is therefore essential to distinguish disease conditions from normal variants (Foster et al., 2013). The present study examined the contribution of body size, biological maturity status, physical activity (PA) and sedentary time to the development of LVM in healthy boys. **Methods** One hundred and ten boys (11.0-14.5 years at baseline) were assessed biannually for 2 years. Stature, body mass, and four skinfolds were measured. Lean body mass (LBM) was estimated. Current height expressed as a percentage of predicted mature height was used as an indicator of biological maturity status (Khamis & Roche, 1994). PA was measured using the Actigraph GT1M accelerometer. LVM was obtained from M-mode echocardiograms using two-dimensional images. **Results** At most age categories, inter-individual allometric coefficients for height did not exceed  $k=2.4$  while intra-individual coefficients showed wide variation ( $k=0.24-9.73$ ). The multilevel allometric model with the best statistical fit showed that a gain of 10 cm in height predicted 21 g of LVM when adiposity, LBM, age and biological maturity were simultaneously controlled. No associations were observed between PA variables and LVM. **Discussion** Results of static and ontogenetic allometric analyses were consistent with previous studies of youth showing that height, body mass and/or composition were independent determinants of LVM (Foster et al., 2013). Physical activity and sedentary time were not related to LVM. It is likely that more intense PA as in intensive training is needed to influence LVM over and beyond changes occurring with normal growth and development. In conclusion, results highlight the importance of individual differences in growth of body size dimensions and biological maturation in understanding the growth of LVM among male adolescents 11-16 years. **Acknowledgments** Portuguese Foundation for Science and Technology (SFRH/BPD/100470/2014; SFRH/BD/101083/2014) **References** Foster BJ, et al. (2013). *J Am Soc Echocardiogr*, 26:410-418. Gidding SS, et al. (2013). *Circ Cardiovasc Imaging*, 6:769-775. Khamis HJ, Roche AF (1994). *Pediatrics*, 94:504-507. Contact j.valente-dos-santos@hotmail.com

## OBESITY INCREASES PULMONARY VASCULAR RESISTANCE

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Background: Obesity, defined as a body mass index (BMI) > 30 kg/m<sup>2</sup>, is a chronic medical condition that can alter cardiac structure and function and is therefore an independent risk factor for cardiovascular disease and heart failure. However, little is known about the impact of overweight on the pulmonary circulation and aerobic exercise capacity (VO<sub>2</sub>max). Methods: Ten healthy obese subjects (39 ± 13 years, 167 ± 8 cm, 98 ± 10 kg, BMI: 35 ± 2 kg/m<sup>2</sup>) were matched for sex, age, and height to 10 control subjects (36 ± 9 years, 170 ± 5 cm, 65 ± 5 kg, BMI: 22 ± 1 kg/m<sup>2</sup>). Subjects performed a maximal incremental echocardiographic cycling exercise test in a semi-recumbent position. Workload was increased by 20W/2min and cardiac index (CI) and pulmonary arterial pressure (Pap) were measured at each exercise level. An incremental cardio-pulmonary exercise tests was performed on a cyclo-ergometer with measurements of gaz exchange. Workload was increased by 20-30W/min until exhaustion. Results: Obesity did not affect resting pulmonary hemodynamics. However, for a given CI, Pap increased to higher levels during exercise in obese subjects as compared to controls so that the mean Pap/CI slopes were increased with obesity (4.8 ± 1.4 mmHg/l/min/kg vs 4.8 ± 3.6 mmHg/l/min/kg, p<0.05). At maximal exercise, VO<sub>2</sub> (23 ± 8 ml/min/kg vs 46 ± 10 ml/min/kg, p<0.001), workload were decreased with obesity, while respiratory exchange ratio and heart rate remained unchanged. The inverse correlation between mPap/Q slope vs VO<sub>2</sub>max almost reached the level of significance (r=-0.37, p=0.054). Conclusion: Despite no impact of obesity on the pulmonary circulation at rest, obese subjects have an altered pulmonary vascular function at exercise. Understanding how this is related to a lower VO<sub>2</sub>max needs further research.

## FACTORS AFFECTING THE EFFECT OF HEALTH PROMOTION PROGRAMS ON BLOOD PRESSURE CONTROL

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Introduction Hypertension (HTN) is one of the common causes of premature death and morbidity (Ezzati et al., 2013). Community-based program is generally acceptable and feasible for elderly, but few study focused on metabolic health (Leite et al., 2015), especially on blood pressure control. In addition, most of the studies investigated the change of BP after intervention (Whelton et al., 2002) instead the responsiveness of BP control from the viewpoint of health outcome. The aim of this study was to identify the potential factors in responders and non-responders on BP control after 12 weeks community-based programs in elderly. Methods This was an exploratory study with a secondary analysis of community-based exercise intervention for health promotion. A total of 136 participants (74.13±5.9 years) were included. The baseline data were extracted as the potential factors, which included social demographic data, health related behavior data and cardiovascular (CV) risk. The outcome variable was the responders on BP control or not. The responder on BP was defined as BP in optimal level (SBP≤140mmHg and DBP≤90mmHg) or a significant BP reduction (SBP↓10mmHg or DBP↓5 mmHg) after 12-week intervention. Subjects who failed to achieve the above targets were defined as non-responders. Results The findings declared that 81.6% and 16.4% were BP-responders and BP-non-responders. The BP-responders showed lower SBP (132.94 ± 18.38 mmHg) and less proportion of HTN risk (37.8%) at baseline than non-responders (141.16 ± 16.37 mmHg, 64%, respectively). Active life style could elevate 4-fold in BP responder compared to the inactive elderly (OR[95%CI] = 4.071 [1.120-14.796]). Furthermore, some disparities were found among subjects with or without diagnosis of HTN. In subjects with HTN, higher educational level or more medication taken were likely to be BP responder. In subjects without HTN, those having clusters of abnormal metabolic markers (Hyperglycemia, Hyperlipidemia and elevated BP) or more medication taken had the tendency to be less response on BP control. Conclusion Active life style combined 12 weeks community-based program could elevate benefit to being BP responders in elderly. The health behavior related factors would be also needed to be concerned for health promotion program on BP control. Reference Ezzati M, Riboli E.(2013).N Engl J Med,369:954-64. Leite J C, Forte R,Vito G de, Boreham CA G,Gibney MJ,Brennan L,GibneyER. (2015).Arch GerontolGeriat, 60: 412–417. Whelton SP, Chin A,Xin X, He J. (2002). Ann Intern Med, 136:493-503. Corresponding Author's email: tmwk@ym.edu.tw Mei-Wun Tsai

## CARDIOVASCULAR PARAMETERS, LIPIDS AND GLUCOSE IMPROVED BY AN ACTIVE WORKSTATION.

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Introduction In recent years attempts were made to obtain a shift from passive sedentary workplaces to more active ones. These workstations had promising effects on health indicators. The aim of this study was to investigate the impact of a newly developed active workstation on cardiovascular parameters, blood values and physical activity (PA) at work. Methods In a cross-over study, 30 participants (18 female), aged 23- 57 years, completed one control week and three weeks of intervention within which they were provided with an active workstation (SAM) and were advised to use it at least for 10 minutes every hour during working hours. On one day in the control and the last intervention week, a venous blood sample was taken at fasting state, and participants were equipped with a heart rate monitor. Blood pressure (BP) was measured hourly during morning in control and intervention period. To measure PA, they received an accelerometer for one week in the control and two weeks in intervention period. A standardized meal was consumed in the control and intervention period and blood glucose was measured before (fasting) and each hour till five hours after the meal with a finger prick. HbA<sub>1c</sub>, total cholesterol, HDL, LDL and triglycerides were measured from the fasting venous blood samples. Results Both, mean bodyweight 75 (± 14.9) kg vs.74.2 (± 15.1) kg (p = 0.01), and mean resting systolic and diastolic BP (from 122.8 (± 10.9) to 120.3 (± 9.8) mmHg (p= 0.048) and from 93.4 (± 8.5) to 80.4 (± 8.1) mmHg (p< 0.001), respectively) decreased in intervention. Heart rate (HR) increased, from 76.5 (± 9.9) beats per minute (bpm) to 81.8 (± 10.2) bpm, in intervention (p < 0.001). Mean % of time spent in sedentary and light PA during working hours was stable with 86 (± 3.4) % vs. 85.9 (± 1.7) % and 7.4 (± 1.8) % vs. 7.1 (± 1.6) %, respectively, in control and intervention (both p> 0.05). No significant changes in blood glucose values, or in lipids and HbA<sub>1c</sub> were found (p> 0.05). Discussion Participants body weight decrease significantly, whereas HR increased significantly during intervention and thus correlates with findings in other studies investigating active workstations (Rovniak et al., Koren et al.). In addition a significant decrease in resting BP, both systolic and diastolic was found. Accelerometer data revealed no change in sedentary behavior or PA during working hours. Continuous glucose monitoring (CGM) might be more suitable to obtain precise data of blood glucose, because of more frequent measured points (Buckley et al.). Due to the short intervention period no significant changes in HbA<sub>1c</sub> or lipid values could be found. However, results with the SAM workstation are promising and further evaluation of the acceptability and effects of this device is warranted. References Rovniak LS, Denlinger L, Duveneck E, Sciamanna CN, Kong, L, Freivalds A, Ray CA. (2014). J Sci Med Sport, 17 (4), 376 – 380. Koren K, Pišot R, Šimunič B. (2016). Applied Ergonomics, 54, 83-89. Buckley JP, Mellor DD, Morris M, Joseph F. (2014). Occup Environ Med, 71, 109–111.

### AEROBIC HIGH-INTENSITY INTERVAL EXERCISE IN CARDIAC PATIENTS - TURN POINT-BASED REGULATION OF EXERCISE PRESCRIPTION AND THE ACUTE RESPONSE OF RISK MARKERS

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**Introduction** An adequate and individual exercise prescription is a critical factor for avoiding harmful side effects during intense exercise in patients (Tschakert & Hofmann 2013). Aim of this study was to investigate the acute response of cardiovascular and inflammatory risk markers as well as catecholamines induced by two different aerobic high-intensity interval exercise (HIE) protocols compared to moderate continuous exercise (CE) in cardiac patients by using a turn point-based methodological approach. **Methods** 8 patients undergoing phase III cardiac rehabilitation (7 with coronary heart disease, 1 with myocarditis; 7 males, 1 female; age: 63.0±9.4 years; height: 174.1±4.6 cm; weight: 83.6±8.7 kg; VO<sub>2</sub>: 21.6±7.6 ml/kg/min) performed a maximal symptom-limited incremental exercise test (IET) and three different exercise tests matched for mean load (P<sub>mean</sub>) and total duration (28 min): 1) short HIE (peak workload duration (t<sub>peak</sub>) = 20 s); 2) long HIE (t<sub>peak</sub> = 4 min); 3) CE (target workload (P<sub>target</sub>) equal to P<sub>mean</sub> of both HIE modes). The intensities during work (P<sub>peak</sub>) and recovery phases (P<sub>rec</sub>) for short HIE as well as the mean intensity (P<sub>mean</sub>, P<sub>target</sub>) for all tests were prescribed in relation to the maximum power output (P<sub>max</sub>) as well as to the first (LTP1) and second (LTP2) lactate turn point determined during IET: P<sub>peak</sub> = 100% P<sub>max</sub>; P<sub>mean</sub> = P<sub>target</sub> = 80% PLTP2; P<sub>rec</sub> = 90% PLTP1. Venous blood samples were taken before and after each test. Plasma was separated for subsequent analysis of cardiac biomarkers (high-sensitivity cardiac troponin T (hs-cTnT), N-terminal pro B-type natriuretic peptide (NT-proBNP), creatine phosphokinase MB (CK MB), and Lipoprotein-associated phospholipase A2 (Lp-PLA2)), and further health-related parameters. **Results** During short and long HIE and CE, the exercise-induced values for cardiovascular and inflammatory risk markers as well as catecholamines were not clinically relevant except for NT-proBNP, which was, however, already elevated at baseline in each test. Between the three test protocols, no significant differences in acute responses were found for any parameter (p>0.05). **Discussion** By using our methodological approach to interval exercise prescription, both short and long aerobic HIE were well tolerated and performed as safely as moderate CE by this study population. Further aerobic HIE studies are required particularly in cardiac patients with a lower functional capacity and patients with other chronic diseases. **References** Tschakert & Hofmann (2013). *Int J Sports Physiol Perf*, 8, 600-610.

### INTERNAL AND EXTERNAL CAROTID ARTERY BLOOD FLOW DURING RESISTANCE EXERCISE

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**Introduction** Resistance exercise induced-acute hypertension should affect cerebral blood flow (CBF) directly by causing cerebral hyperperfusion. However, Dickerman et al. (2000) reported that middle cerebral artery mean blood flow velocity was unchanged or even attenuated in elite power athletes during maximal weight-lifting. To what extent the arterial hypertension associated with heavy resistance influences the spatial distribution of blood flow to the intracranial arterial bed remains unknown. Our previous study (Sato et al., 2011) suggest that large increase in external carotid artery (ECA) blood flow affects intracranial CBF during dynamic exercise to prevent exercise-induced cerebral hyper-perfusion. The purpose of the present study was to examine the response of internal carotid artery (ICA) and ECA blood flow to resistance exercise. **Methods** Twelve healthy participants performed one-legged static knee extension exercise at 30 % maximal voluntary contraction for 2 min. Blood flow to the ICA and ECA were evaluated by duplex ultrasonography. **Results** ICA blood flow increased from baseline (P=0.001) before stabilizing at 60 s, while ECA blood flow progressively increased throughout exercise with the most marked changes observed between 60 and 120 s (P<0.001). ICA conductance significantly decreased by -14.4 ±13.8 % at the end of exercise (P<0.01) whereas in contrast, ECA blood flow (P<0.01), and conductance were shown to increase (P<0.05). **Discussion** The present findings demonstrated that resistance exercise was associated with vasodilation of the ECA that was accompanied by vasoconstriction of the ICA. We propose that the heterogeneity and reciprocal regulation of intracranial CBF reflects an adaptive neuroprotective mechanism that serves to protect the brain and associated vasculature against the structural damage associated with resistance exercise-induced hypertension. **References** Dickerman RD, McConathy WJ, Smith GH, East JW & Rudder L (2000). *Neurol Res*. 2000 Jun;22(4):337-40. Sato K, Ogo S, Hirasawa A, Oue A & Sadamoto T (2011). *J Physiol*. 2011 Jun 1;589(Pt 11):2847-56. Contact ogo@toyo.jp

### CARDIOVASCULAR DYSFUNCTION DURING THE MUSCLE METABOREFLEX ACTIVATION IN PATIENTS WITH DIASTOLIC HEART FAILURE

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**Introduction** Activation of the muscle metaboreflex leads to increase in arterial blood pressure. In normal subjects, this result is achieved by means of an increase in both systemic vascular resistance (SVR) and cardiac output (CO). In patients with chronic systolic heart failure an exaggerated vasoconstriction compensates for the reduced capacity to increase myocardial contractility and stroke volume (SV). This fact is however detrimental in the long term, as it may cause vasoconstriction in the working muscle, thereby impairing the capacity to exercise. To the best of our knowledge none has to date verified whether or not this phenomenon is present also in chronic diastolic heart failure (DHF). **Methods** Ten patients with DHF (5 females, age 34-79 yrs) were recruited. Diagnosis of DHF was based on history, signs, and symptoms consistent with DHF (ventricular ejection fraction >50%). Central hemodynamics during the metaboreflex obtained by the method of the post-exercise muscle ischemia were evaluated by means of impedance cardiography and echocardiography. Their response was compared to that of age matched control group (n= 12, 6 females, age 35-70 yrs). **Results** The main results were that the DHF group could not properly increase SV and CO in response to the muscle metaboreflex, whereas the CTL group did increase these parameters (-2.92±9.73 vs. 5.77±3.41 ml in the SV response and -225.5±787.6 vs. 549.2±454.9 ml\*1-1 in CO, for the DHF and the CTL group respectively, p<0.05 in both cases). Moreover, parameters related to diastolic function could not increase in the DHF group during the metaboreflex. For instance, end-diastolic volume decreased in the DHF group (-1.3±5.27 ml) while it increased in the CTL group during the metaboreflex activation (+6.17±10.06 ml, p<0.05 vs. DHF group). Yet, the DHF group reached the target blood pressure mainly by means of an exaggerated SVR increment as compared to the CTL group. **Discussion** This investigation provides evidence that diastolic function is important for normal hemodynamic adjustment during the metaboreflex and to avoid excessive vasoconstriction. **References** 1. Crisafulli et al. *Am J Physiol (Heart Circ Physiol)* 292: H2988-H2996, 2007. 2. Piepoli M and Crisafulli A. *Exp Physiol* 99: 609-615, 2014.

**TOTAL SERUM CHOLESTEROL IS RELATED TO TOTAL RED CELL VOLUME IN HEART FAILURE PATIENTS**

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**Introduction** Several studies have confirmed a positive association between serum cholesterol and hematocrit in healthy subjects. In the past, this relationship has been attributed to hematocrit acting as an indicator for a contracted plasma volume. In contrast to these observations, recent data highlighted that the erythrocyte membrane might, like high-density lipoprotein (HDL), act as a shuttle for cholesterol in the bloodstream and thus can contribute to reverse cholesterol transport. Both, total red cell mass, which is the amount of all erythrocytes in the body, and erythrocyte membrane cholesterol content, are affected by physical exercise. It can be speculated that hematological adaptation might constitute one mechanism by which physical exercise lowers serum cholesterol levels and hence cardiovascular risk. The relationship between red cell mass and serum cholesterol has, however, not been studied before. **Aim** of this study is to investigate whether a relationship between serum cholesterol and red cell mass can be observed. **Methods** For this study, data from 58 heart failure patients who participated in a research project of our department (DKRS Nr.) and for whom cholesterol data were available were analyzed. Red cell mass (RBV) was determined using the optimized CO rebreathing method. Relationship between cholesterol parameters (low density lipoprotein cholesterol (LDL-C), HDL-C, triglycerides, total serum cholesterol) and RBV was analyzed using rank based correlation and stepwise linear modeling ( $\alpha=0.05$ ). **Results** Correlation coefficients of RBV were  $r_{\text{RBV,Cholesterol}}=-0.31^*$ ,  $r_{\text{RBV,HDL-C}}=-0.26$ ,  $r_{\text{RBV,LDL-C}}=-0.19$  and  $r_{\text{RBV,TG}}=-0.19$ . Relation between RBV and serum cholesterol was confirmed in stepwise linear regression accounting for influence of age, body-mass-index, gender and statin therapy as well as plasma volume and hematocrit. **Conclusion** Serum cholesterol is significantly inversely correlated with RBV in the heart failure patients group. Cholesterol subfractions also show a trend towards an inverse association with RBV. These observations might point to a direct link between availability of erythrocytes and/or erythropoiesis and lower cholesterol levels. As RBV can significantly be increased by endurance exercise, our observation might thus point towards a cholesterol-lowering effect of exercise through increased erythropoiesis and consequently an elevated RBV.

**Mini-Orals****MO-PM24 Women & Osteoporosis****DELAYED MENARCHE AND MENSTRUAL STATUS IN FEMALE ATHLETES**

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**Introduction** Delayed menarche, in which a girl's first menstrual cycle comes late, has been suggested in female athletes. The proportion of body fat decreases with the effects of regular sports training around the age of menarche in female athletes, and it is thought that delayed menarche or amenorrhea occurs because body fat percentage does not reach 17–20%. In cases when menarche does not occur even though body fat mass has reached the critical period for the onset of menarche, it has been suggested that the delay in menarche may be due to physical and mental stress. Thus, for female athletes, the problem of delayed menarche or menstrual disorders becomes a big risk both in terms of the physical and mental aspects and the continuation of the sport. **Purpose** The aim of this study was to clarify the relationships with menstrual status or menstrual pain in individual female athletes. **Methods** A survey of general girls and female athletes (Korean girls from grades 1 to 11) was conducted in 2009 using longitudinal growth data on height and questionnaires. Birth date, age at menarche, menstruation status and menstruation pain were checked. Wavelet interpolation was applied to obtain the age at maximum peak velocity (MPV) of growth, which is an indicator of the level of maturity that is a reference point for delayed menarche. A numerical rating scale (NRS) was used to objectively measure the level of menstrual pain. **Results** In general girls (in a suburb of Busan), the age at MPV of height was 11.29 years and the age at menarche was 12.88 years. In female athletes, the age at MPV of height was 11.21 years and the age at menarche was 13.32 years. Compared with general girls, many female athletes were determined to have delayed menarche. Many female athletes also had high levels of pain. In addition, the menstrual cycle in female athletes showed greater variability than that in general girls. The results of determinations of delayed menarche by the sport in which female athletes participated suggested that many girls engaged in track and field, taekwondo, and judo had delayed menarche. **Discussion** Considering the weight restrictions in the weight classes for taekwondo and judo, it may be that delayed menarche occurs as a result of mental and physical stress from reducing body fat and forcing the body to stay under a certain weight. The above indicates that there may be cases when delayed menarche and subsequent menstrual disorders occur as a result of the effects of the physical and mental stress of rigorous sports training and reduced body fat from weight restrictions. **References** Fujii K, and Matsuura Y. (1999) Analysis of the growth velocity curve for height by the Wavelet Interpolation Method in children classified by maturity rate. *Am J Hum Biol*, 11, 13-30. Contact : b14705bb@aitech.ac.jp

**RELATIONSHIP BETWEEN MATERNAL AND PATERNAL PHYSICAL ACTIVITY DURING PREGNANCY**

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**Introduction:** Pregnancy is recognized as a unique time for behavior change, and the habits adopted during pregnancy can affect woman's health for the rest of her life. The physical activity recommendations for pregnant women and parturient are the same as those recommended for the general population, at least 150 minutes per week of moderate physical activity. A couple shares different environments and common experiences, which may result in similar options for the life of each, as the case of physical exercise together when the environment is conducive for this. **Objective:** To verify the relation between maternal and paternal physical activity during pregnancy; Analyze the change in maternal and paternal physical activity during the first to the second trimester; Verify a sociodemographic profile associated with active women. **Methods:** The study was applied to a sample of 40 couples, during the first and second trimester. Women physical activity was assessed by accelerometer and the Pregnancy Physical Activity Questionnaire (PPAQ). Physical activity of men was assessed through the International Physical Activity Questionnaire (IPAQ) - short version, in order to get the time spent in mod-



erate and vigorous physical activity weekly. Results: There was no significant correlation between the duration of physical activity of the mother and father ( $p > 0.05$ ). However, the first to the second trimester, there was a significant decrease in duration of maternal physical activity and a significant increase in duration of paternal physical activity ( $p < 0.05$ ). It was also found that sociodemographic characteristics and lifestyle habits do not significantly affect the duration of physical activity. Conclusion: The study suggests that there is no correlation between paternal and maternal physical activity during pregnancy, either a demographic profile associated with more active women. It was also concluded that physical activity decreases in women throughout pregnancy, unlike men, that physical activity increases.

#### **EFFECT OF A MULTIMODAL INTERVENTION PROGRAM DURING PREGNANCY ON MATERNAL BODY COMPOSITION AND MATERNAL BODY WEIGHT ONE YEAR POST PARTUM**

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#### **FACTORS INFLUENCING CARDIORESPIRATORY FITNESS IN POSTMENOPAUSAL WOMEN WITH PREHYPERTENSION IN RATCHABURI PROVINCE, THAILAND**

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Background: One of the most important components of physical fitness is cardiorespiratory fitness. Increasing cardiorespiratory fitness indicates increasing the capability of the heart and the cardiovascular system, which serves to supply oxygen and energy to body. Postmenopausal women are at risk for cardiovascular diseases (CVD) due to hormonal change. This cross sectional study therefore aimed to investigate factors influencing cardiorespiratory fitness in postmenopausal women with prehypertension. Method: Through purposive sampling, 84 postmenopausal women with prehypertension were recruited from Donsai Sub-district, Pakthor district, Ratchaburi Province. The data were collected by using the structured questionnaire with face-to-face interview. All of the participants were measured for cardiorespiratory fitness (estimated VO<sub>2</sub>max). Data were analyzed using descriptive and inferential statistic. Results: The results revealed that mean age of the sample was  $55.15 \pm 7$  years old, ranging from 44-69 years. Most of them were married (69%), obtained primary education (76.2%), worked as farmer (76.2%) and none farmers (23.8%). Approximately half of them did not exercise (42.9%). Cardiorespiratory fitness was associated with waist circumference ( $r = -0.646$ ,  $p = .000$ ), body mass index ( $r = -0.562$ ,  $p = .000$ ), heart rate ( $r = -0.589$ ,  $p = .000$ ), age ( $r = -0.298$ ,  $p = .008$ ), and occupation ( $r = -0.402$ ,  $p = .000$ ). There were no relationship between education, income, exercise habit and cardiorespiratory fitness. Conclusion : The results in this study suggest approaches for healthcare providers to develop programs promoting and monitoring cardiorespiratory fitness among postmenopausal women with prehypertension in order to enhance their health status. KEY WORDS: Cardiorespiratory fitness, Postmenopausal women, Prehypertension. American College of Sports Medicine. (2014). ACSM's Guidelines for Exercise Testing and Prescription (9 ed.). Philadelphia: Wolters Kluwer and Lippincott Williams&Wilkins. Garber, C. E., Blissmer, B., Deschenes, M. R., Franklin, B. A., Lamonte, M. J., Lee, I. M., . . . American College of Sports, M. (2011). American College of Sports Medicine position stand. Quantity and quality of exercise for developing and maintaining cardiorespiratory, musculoskeletal, and neuromotor fitness in apparently healthy adults: guidance for prescribing exercise. Med Sci Sports Exerc, 43(7), 1334-1359. doi: 10.1249/MSS.0b013e318213f6fb

#### **EFFECTS OF SHUTTLECOCK KICKING ON BMC AND BMD IN POSTMENOPAUSAL FEMALES**

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Introduction: BMC lose rapidly from the beginning of age of 50~60 years, about 1.5%~2.5% annually, BMD decreased rapidly from age of more than 45 years in Chinese postmenopausal females. Therefore, precautions should be taken postmenopausal females' OP to reduce the morbidity and better their life. Shuttlecock kicking (ti jian-zi) is a popular traditional sport for exercise and fitness in China, the purpose of this study is to explore the influence of shuttlecock kicking on BMC and BMD of Chinese postmenopausal females. Method: By randomized controlled study, the 39 participants (50-60 Years old) were be randomly divided into Group I of 20 females who kicking shuttlecock for 2 to 4 hours each time and 5 to 7 times each week, and Group II of 19 females who rarely exercise. After 12 months, observed the changes of the BMC and BMD of 10 parts: Head, T Spine, L Spine, L Ribs, R Ribs, Pelvis, both Arms, both Legs and the total body by dual-energy X-ray absorptiometry (DEXA). Statistics software of spss18.0 was used to calculate and the differences were compared

through the matching T examination. Results: After 12 months, BMC of the non-dominant leg and total body, BMD of Pelvis, both Legs and total body were significantly higher than before in Group I. There were different degrees of decline on BMC and BMD in Group II. BMC the non-dominant leg and total body, BMD of Pelvis, both Legs and total body were significantly in Group I were significantly higher than that in Group II. ( $P < 0.05$ ,  $P < 0.01$ , respectively) Discussion: Shuttlecock kicking is a whole body periodic exercise, mainly involving in movements of lower limbs. When the shuttlecock goes up and down, the body center of gravity shifts left and right, and the kicking leg swings back and forth or inside and outside. Repeated mechanical stimulation leads progenitor cell proliferation and differentiation of the lower limbs and pelvis. The body mass and leg muscle contraction of kicking shuttlecock produce stress load to bone which changes BMC and BMD. Conclusion: Shuttlecock kicking for postmenopausal females individuals leads a greater acquisition of BMC and BMD in total body, especially in the pelvis and legs. Perseverance Shuttlecock kicking in postmenopausal females has functions on the promotion of human body bone health, the prevention of osteoporosis, worth promoting as exercise prescription.

### RISK FACTORS OF THE FEMALE ATHLETE TRIAD AMONG UNIVERSITY STUDENTS

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**Introduction** The diagnosis of female athlete triad (FAT) requires the presence of eating disorder (ED), amenorrhea (AM), and osteoporosis (OP). The relevant literature is controversial about the frequency of FAT among athletes or non-athletes. Our purpose was to determine the prevalence of FAT's risk factors among female collegiate athletes and physically inactive university students to define which population is more vulnerable by FAT. **Methods** 58 collegiate athletes (AT) and 64 physically inactive (PI) university students participated in the study. We used the method of Torstveit and Sundgot-Borgen (2005) completed with bone densitometry to identify the risk factors of FAT. The risk factors of ED were low BMI, pathogenic weight-control methods (use of diet pills, hunger-repressive pills, laxatives, diuretics, or vomiting to reduce weight), self-reported eating disorder, results over the critical limits in 'Drive for Thinness' or 'Body Dissatisfaction' subscales of Eating Disorder Inventory (Garner, 1983). The risk factors of AM were self-reported menstrual dysfunction (primary amenorrhea, secondary amenorrhea, oligomenorrhea, or short luteal phase). The risk factors of OP were self-reported stress fracture and low bone mineral density (T-score  $< -1$ ). **Results** Any risk factor(s) of ED occurred at similar rate in both groups (AT: 32.76%, PI: 40.63%). There was no significant difference in the presence of any risk factor(s) of AM (AT: 56.9%, PI: 50.0%). Incidence of OP risk factor(s) was significantly more frequent in the PI group (AT: 22.41%, PI: 48.44%). The rates of participants with risk factors of ED and AM together (AT: 22.41%, PI: 21.88%) or ED and OP together (AT: 12.07%, PI: 17.19%) were similar. The common occurrence of AM and OP were more frequent in the PI group (AT: 10.34%, PI: 26.56%). A not significantly higher percentage of PI university students (84.37%) have one or more risk factor(s) of any component of FAT than ATs (75.86%), but no more than 10.94% of PIs – in comparison to ATs' 5.17% – has one or more risk factor(s) of all the three components of FAT. **Conclusion** Our results suggest that the risk factors of FAT are very prevalent in the observed population. The most frequent risk factors are the menstrual irregularities. The group of physically inactive university students are more vulnerable than collegiate athletes mainly in the aspect of osteoporosis and amenorrhea from the components of FAT. **References** Garner DM et al. (1983) *Int J Eat Disord*, 2, 15-34. Torstveit MK, Sundgot-Borgen J. (2005). *Med Sci Sports Exerc*, 37, 184-93. Contact: andor.h.molnar@gmail.com

### ACTIV4HER: PROCESS EVALUATION OF A PREVENTIVE WOMEN'S HEALTH PROGRAM FOCUSING ON PHYSICAL ACTIVITY AND HEALTHY EATING

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**Introduction:** The prevalence of chronic disease within Australia is of increasing concern, particularly within our ageing population. Preventive programs targeting unhealthy behaviours such as inactivity and unhealthy eating habits for young women are limited. Activ4her is an evidence-based program that aimed to create healthy lifestyle change within women who are at risk of developing cardiovascular and metabolic disease. It focuses primarily on physical activity and healthy eating and is underpinned by the Behaviour Change Wheel. The aim of the study was to evaluate the implementation of a multidisciplinary group-based healthy lifestyle intervention (MDG) compared to standard care with an Exercise Physiologist (EP). **Method:** The MDG program consisted of 16 female participants who attended eight weekly sessions. The EP program consisted of 15 participants who attended 5 individual sessions over 12 weeks with an Exercise Physiologist. In-depth interviews, surveys and physical measures were conducted immediately post-program and at 3 months follow-up as part of a thorough process evaluation of the program. **Discussion:** Completion rates for the programs were 94% and 87% for MDG and EP. Mean attendance rates were 80% (MDG) and 90% (EP). Thematic analyses revealed three key themes related to the group and multidisciplinary nature of the program; 'information provided' (amount, complexity and diversity), 'group dynamics' (social support, individualisation, and modelling and expectations) and 'intention to maintain' (opportunities for health, self-efficacy and maintaining motivation). **Conclusion:** Multidisciplinary, group-based interventions offer additional opportunities for women to learn more about their health and initiate self-determined motivation for healthy behaviours but pose additional considerations for health practitioners who must manage group dynamics, diverse client motivations, abilities and preferences. Contact: Nigel.Stepto@vu.edu.au

### CONFIRMATION FOR EVALUATION OF BONE MINERAL DENSITY BASE

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**Introduction :** The incidence of bone fracture in children has increased over more than three decades since 1970 in Japan. To examine this problem, detailed information on the body composition and bone density of Japanese children is necessary. In current bone density measurements dual energy X-ray absorptiometry (DXA) is used clinically as stable method, but DXA has problems in that it exposes subjects to radiation and measurements of children entail great risk. Therefore, to determine bone density simply and without radiation exposure application, application of ultrasound bone assessment values (stiffness values, OSI value) is reasonable. **Purpose :** Bone assessment values using stiffness values were applied to investigate the age-related changes in 3 to 5 year-old children. We sought to establish uniform measurements of bone density in early childhood by composing population data based on the cohort method, while also attempting to construct a bone density evaluation based on age-related changes and investigating validity of this evaluation. **Methods :** The subjects were 217 boy and 213 girl preschool children from 2010 to 2013. Population data were obtained with each preschool year. The analysis procedure consisted of bone density measurement of the right calcaneus using a bone density ultrasound machine (A-1000 Insight, Lunar). Precise chronological age was calculated from birthdate, and least squares approximation polynomials from first

to sixth order were applied to the bone density measurement items corresponding to that chronological age over a three-year span. A standard regression evaluation chart was constructed from the least squares approximation polynomial judged to be valid, and bone density was evaluated from a 5-step regression evaluation. Results : A one-way analysis of variance was performed for bone density indicator (stiffness, BUA, SOS) statistics in age-related changes of bone density in mixed cohort data, and the results showed significant differences ( $P<0.05$ ) in stiffness and SOS values for both boys and girls. Polynomial regression analysis for stiffness and SOS values was then applied, and significance was seen in the age-related changes in regression polynomials. Consequently, to construct a regression analysis chart for bone density, the best polynomial obtained with least squares approximation was seen to be a third order polynomial for boys and fourth order for girls. Thus, polynomial regression analysis charts with an appropriate order were obtained. Discussion : In an analysis of mixed cohort data, there is considerable significance in demonstrating age-related trends in the preschool years. Construction of bone density evaluation for preschool age based on these findings may provide useful information in terms of deriving health and fitness indicators for young children. These findings are suggestive for the tracking of bone density in adults.

## COMPARING THE MEASUREMENT RESULTS OF CALCANEAL QUANTITATIVE ULTRASOUND SYSTEM FROM TWO DEVICES

HUANG, Z.1, SUI, X.1, ZHU, Z.1, LI, Y.1, WANG, P.2

1:Guangzhou Sport University(Guangzhou,China),2:Tsinghua University(Beijing,China)

**Introduction** Osteoporosis is emerging as a worldwide problem and significantly associating with increasing bone fractures, which in turn negatively affect life expectancy. Dual X-ray absorptiometry (DXA) is currently considered the gold standard for measuring bone mineral density (BMD) and the diagnosis of osteoporosis(Martin, Campbell et al. 1999), but it is expensive and not an ideal choice for screening for bone mass alterations, particularly in resource-limited countries .So our research team designed a calcaneal quantitative ultrasound system (QUS) for predicting fractures and screening low BMD(Thomsen, Jepsen et al. 2015). This study aimed to compare QUS measurement results between ours and SONOST-2000(Steiner, Fernandes et al. 2008). **Methods** The volunteers consisted of 5 men and 24 women with a global mean age of  $55.2\pm 10.1$  years (range 29-65 years). Volunteers' ipsilateral calcaneals were measured by our QUS and SONOST-2000 , one after another. Both QUS are able to detect various bone mechanical properties and the trabecular structural orientation through the measurement of parameters represented by the speed of sound (SOS), broadband ultrasound attenuation (BUA, dB/MHz) and stiffness. Other parameters, such as bone quality index(BQI) T-Score, T-Radio, Z-Score, Z-Radio also were included. The association between the QUS parameters measurements was determined using the Pearson's correlation r coefficient. Simple regression analysis was used to test for trends among the different variables. **Results** According to WHO classification criteria, which identify a T-score values  $>-1$  SD as being normal, between  $-1$  SD and  $-2.5$  SD as indicating osteopenia, and  $\leq -2.5$  SD as indicating osteoporosis, the numbers of the samples being normal, osteopenia, osteoporosis are 19, 9, and 1 estimated by our device, while those by SONOST-2000 are 10, 14 and 5, with significant differences between the two instruments( $p=0.000$ , by Chi-Square analysis), also with significant differences in BUA,T-Radio and Z-Score( $P<0.05$ ) . The paired samples correlations on T-Score is 0.577,  $p=0.001$ . There were no significant differences in BQI, T-Score and Z-Radio( $P>0.05$ ). **Discussion** Our QUS is some different from that of SONOST-2000. Some improvement and veracity could be done for our instrument, maybe including the hardware and the software design. Especially, the software, developed by VisualC# and Matlab, should update the data evaluation standard and some calculation formula according to Chinese feature. **References** Martin, J. C., et al. (1999).J Clin Densitom 2(3): 265-273. Steiner, M. L., et al. (2008).Sao Paulo Med J 126(1): 23-28. Thomsen, K., et al. (2015). Osteoporosis International 26(5): 1459-1475. Contact 63649658@qq.com. This study was supported by the Funds National Key Technology Support Program (2012BAK21B04).

15:00 - 16:00

## Mini-Orals

### MO-PM25 Obesity

#### METABOLIC RISK FACTORS IN STATIN USERS WITH AND WITHOUT MYALGIA

MONBERG, T.J., MORVILLE, T., DOHLMANN, T.L., KUHLMANN, A.B., TORP, M.M., SAHL, R., HELGE, J.W., DELA, F.

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**Introduction** Early metabolic disturbances constitute the core components in the development of cardiovascular disease (CVD) and type 2 diabetes and a cluster of these disturbances are often referred to as the Metabolic Syndrome (MetS). Even though the pathogenesis is still unknown, several studies have suggested visceral adipose tissue (VAT) to be an important component of the MetS. In the primary prevention (PP) of CVD the beneficial effects of statins have been extensively debated. This debate is due partly to possible side effects of statins, the most common being myalgia. We hypothesize that statin users in PP are at higher metabolic risk, and that those experiencing myalgia have even more metabolic disturbances because of a reduced level of physical activity. Therefore the aim of this study is to compare the metabolic profiles of three groups (statin-myalgia, statin-non-myalgia, control). Moreover, the association between VAT and features of the MetS will be considered. **Methods** The study is cross-sectional and includes 50 subjects (age 50-70, BMI 27-35), divided into 2 groups; a control group (N=22) and a PP statin group (N=28). The latter is subdivided into two groups – one experiencing myalgia (N=11) and one without myalgia (N=17). The metabolic profile of each individual is measured including diagnostic risk factors for the MetS (blood pressure, fasting glucose, abdominal circumference, HDL and TG), HbA1c, VO2max and VAT estimated by DXA. The risk of having a CVD event within the next 10 years is calculated for each individual using standardized risk assessment tools. A oneway ANOVA or, in cases of unequal variance, a non-parametric test is used to compare groups. Results are mean $\pm$ SD. **Results** Controls have a significantly lower systolic blood pressure ( $120\pm 16$  vs.  $138\pm 16$  mmHg,  $p<0.01$ ) and a higher concentration of total cholesterol ( $5.6\pm 1.2$  vs.  $4.4\pm 0.6$  mmol/L,  $p<0.01$ ) and LDL cholesterol ( $p<0.01$ ) than Statin users. HbA1c, fasting glucose, HDL, triglyceride, VO2max, VAT, CVD risk and anthropometric measures are similar between all three groups. VAT is negatively correlated with HDL ( $p<0.01$ ,  $r=-0.48$ ) and positively correlated with CVD risk ( $p<0.05$ ,  $r=0.31$ ). **Discussion** This study shows that statin users in PP have another distribution of metabolic risk factors than

controls, including significantly higher systolic blood pressure and lower total and LDL cholesterol. Moreover the results suggest that statin induced myalgia is not associated with a less active lifestyle and thereby a higher metabolic risk. VAT seems to play a role in both lipid homeostasis and in overall CVD risk, but further statistics needs to be done to evaluate the interrelations of risk factors. Contact: vjl114@alumni.ku.dk

### SEGMENTAL FAT FREE MASS DID NOT INFLUENCE MUSCULAR STRENGTH IN OBESE AND NON-OBESE BOYS

LOPES, W.A.1, MORAES JUNIOR, F.B.2, SILVA, L.R.2, ARAÚJO, C.T.2, JESUS, I.C.2, COUTINHO, P.R.2, RADOMINSKI, R.B.2, LEITE, N.2

1: Universidade Estadual de Maringá - UEM (Paraná, Brazil), 2: Universidade Federal do Paraná - UFPR (Paraná, Brazil)

**Introduction** Muscular strength is recognized as an important component of health. In adults, lower levels of muscular strength have been associated with increased risk of mortality. In children and adolescents, it seems that elevated levels of muscular strength are inverse and positively related to metabolic risk and insulin resistance. However, the impact of obesity in muscular strength has been little investigated. Therefore, the aim of this study was to compare the absolute and relative muscular strength to body mass (BM), whole body fat free mass (FFM) and segmental FFM of upper and lower limbs among obese and non-obese boys. **Methods** Thirty-nine boys, aged 13-17 years-old, were divided into three groups: normal weight (n=11), overweight (n=14) and obese (n=14). BM, height and body mass index (BMI) were evaluated. Body composition was measured by x-ray absorptiometry dual energy (DXA). Maximal muscular strength of upper (leg press) and lower limbs (bench press) was estimated by one maximum repetition test (1RM). One-way ANOVA, Pearson's correlation coefficient and Multiple Linear Regression were used to compare and correlate muscular strength among and within the groups. **Results** Obese and overweight adolescents presented absolute muscular strength of upper ( $41.5 \pm 9.0$  and  $45.1 \pm 9.8$  vs  $41.6 \pm 11.0$ ,  $p=0.54$ ) and lower limbs ( $204.4 \pm 55.5$  and  $199.2 \pm 51.0$  vs  $192.7 \pm 40.2$ ,  $p=0.84$ ) similar to normal weight adolescent. Also, muscular strength of upper ( $2.2 \pm 0.2$  and  $2.3 \pm 0.3$  vs  $2.3 \pm 0.5$ ,  $p=0.71$ ) and lower limbs ( $13.0 \pm 2.5$  and  $12.1 \pm 1.7$  vs  $13.0 \pm 2.2$ ,  $p=0.44$ ) relative to segmental FFM were similar between groups. Linear regression showed that BMI explained 59% of the variation in the absolute muscle strength of lower limbs ( $\beta=0.59$ ,  $p<0.05$ ), FFM explained 84% of the variation in the absolute muscle strength of upper limbs ( $\beta=0.84$ ,  $p<0.01$ ) and 68% of lower limbs ( $\beta=0.68$ ;  $p<0.01$ ), while segmental FM was inversely associated with muscular strength of lower limbs ( $\beta=-0.53$ ,  $p<0.05$ ). **Discussion** Muscular strength levels of upper and lower limbs of obese and overweight boys were similar to those of normal weight boys. These findings are opposed to studies that found higher muscle strength of lower limbs in extremely obese adolescent boys (Abdelmoula et al., 2012) and obese children (Tsiros et al., 2013), but similar to the findings in overweight/obese adolescents girls (Lopes et al., 2013). The results of this study indicate that obesity does not affect adversely the generation of muscle strength in obese adolescent boys. **References** Abdelmoula A, Martin V, Bouchant A, Walrand S, Lavet C, Taillardat M, Maffiuletti NA, Duché P, Ratel S. (2012). Applied Physiology, Nutrition, and Metabolism, 37(2), 269-75. Lopes WA, Leite N, Silva LR, Moraes Junior FB, Consentino CLM, Araújo CT, Cavaglieri CR. (2013). Brazilian Journal of Physical Activity and Health, 18(6), 720-9. Tsiros DM, Coates AM, Howe PRC, Grimshaw PN, Walkley J, Shield A, Mallows R, Hills AP, Kagawa M, Shultz S, Buckley JD. (2013). European Journal of Applied Physiology, 113(6), 1415-22.

### RATING PERCEIVED EXERTION AND STRENGTH EXERCISES IN OVERWEIGHT AND OBESE SUBJECTS

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technical university of Madrid

**Introduction** Rating of Perceived Exertion (RPE) in resistance and combined circuits training has been previously studied (Miller et al., 2009; Skidmore et al., 2012), irrespective of body composition and gender. Squat and bench press has been included in many training routines, due to its low complexity and high energy expenditure (Vianna et al., 2011; Bocalini et al., 2012; Maté-Muñoz et al., 2014). Therefore, the aim of this study was to analyze the RPE in squat and bench press between overweight and obese women and men. **Methods** Forty-four men (S, n=20; SE, n=24) and forty-five women (S, n=23; SE, n=22), aged 18-50 years, performed tests of 15 repetitions maximum (15RM) for squat and bench press. Loads of 50% were individually calculated and the OMNI-RES Scale was immediately measured following each exercise during four weeks. Subjects were randomized into two training groups, strength (S) or combined (SE). Subjects of S group executed strength exercises, while the routine for the SE group consisted of a combination of aerobic exercises intercalated with strength exercises (Zapico et al., 2012). Training frequency was 3 times/week for both groups. Student t tests were performed to identify differences between gender, IMC classification and training groups in the RPE for squat and bench press. **Results** No differences were found between males and females or between S and SE for any of exercises ( $p>0.05$ ). Overweight individuals obtained greater score of RPE for bench press ( $W: 5.11 \pm 1.47$ ;  $O: 4.5 \pm 1.01$ ,  $p<0.05$ ). **Discussion** Studies show the relation between OMNI-RES Scale and Resistance Exercise (Vianna et al., 2011). We did not find studies demonstrating the difference between overweight and obese women and men regarding RPE. Our data does not show differences in RPE in squat and bench press between overweight and obese, and between female and male subjects. Although the differences were small, our results indicated greater RPE in bench press for overweight subjects, which could be related to a greater load in 15RM, and consequently a greater load in 50%. **References** Bocalini, D. et al. (2012). Clin Interv Aging, 7:551-556. Maté-Muñoz, JL. et al. (2014). J Sports Sci Med, 13(3):460-468. Miller, PC. et al. (2009). J Strength Cond Res, 23(2):366-372. Skidmore BL. et al. (2012) J Sports Sci Med, 11(4):660-668. Vianna, JM. et al. (2011) J Hum Kinet, 29A:75-82. Zapico, AG. et al. (2012). BMC public health 12:1100. Funding: DEP2008-06354-C04-01 Contact javierluru.lope@gmail.com

### WITHIN PARTICIPANT RELATIONSHIPS BETWEEN APPETITE SCORES, PEPTIDE YY IN OVERWEIGHT WOMEN BEFORE AND AFTER EXERCISE PROGRAMME

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**Background:** Exercise-induced weight loss was reported to modify peripheral hormones in a direction expected to enhance satiety and permit weight loss and/or maintenance. This suggestive causal relationship between exercise and appetite hormone alterations was not found in all studies. Thus, interactions between subjective appetite measures and hormonal appetite regulators require further investigation. **Objective:** To investigate the impact of a 4-week aerobic exercise programme applied to overweight women on subjective appetite measures, gastrointestinal appetite hormones and to establish whether within-participant relationships between appetite scores, peptide YY are modified by participation in exercise. **Design:** Study participants were eleven females of  $26 \pm 1.4$  years old with BMI of  $29.5 \pm 1.0$  kg/m<sup>2</sup>. Each participant underwent two 7-hour experimental trials; one before and another after a 4-week aerobic exercise programme



of weekly sessions of progressively increasing duration. During the 7-hour experimental trials blood samples were collected and appetite scores were measured before and after consumption of standardised breakfast and lunch. Commercially available ELISA kits were used to measure PYY concentrations. Results: The 4-week exercise programme had no impact on body weight (Before, 78.8±2.9kg; After, 78.0±3.1kg) and body fat percentage (Before, 37.8±1.3%; After, 37.2±1.2%) but significantly reduced the waist circumference (Before, 84.0±2.2 cm; After, 82.4±2.1cm,  $P<0.05$ ). Exercise programme did not have an impact on post-breakfast hunger (Before, 32±4mm; After, 33±4mm), post-breakfast satiety (Before, 59±3mm; After, 55±4mm), post-lunch hunger (Before, 24±3mm; After, 25±4mm), post-lunch satiety (Before, 68±5mm; After, 67±5mm), post-breakfast PYY concentration (Before, 94.1±12pg/ml; After, 78.3±9.2.9pg/ml) but significantly reduced the post-lunch concentration of PYY (Before, 102.0 ±18.6pg/ml; After, 86.4±17.1pg/ml,  $P<0.05$ ). Relationships between appetite score responses and PYY responses showed significant correlation during before and after the exercise intervention and these relationships were not modified by training status (Table 1). Table 1. Means (±SE), 95 CIs for the means of observed slopes and R2 values for within-subject relations between appetite scores and PYY before and after training programme Slope 95% CI R2 Before Satiety vs PYY  $0.92 \pm 0.18^* (0.52, 1.32)$   $0.37 \pm 0.07$  Hunger vs PYY  $-1.01 \pm 0.27^* (-1.71, -0.32)$   $0.37 \pm 0.07$  After Satiety vs PYY  $0.92 \pm 0.19^* (0.48, 1.35)$   $0.41 \pm 0.07$  Hunger vs PYY  $-0.81 \pm 0.27^* (-1.42, -0.20)$   $0.30 \pm 0.08$  \*Mean of the regression slopes significantly different from zero,  $P<0.05$  (Student's one sample t-test) Conclusion: Exercise programmes applied to overweight women result in changes in the peripheral hormones which would be expected to increase appetite. However, these hormonal changes do not modify subjective appetite and thus should not be considered to be responsible for the prevention of body weight loss commonly seen during exercise interventions.

## EFFECT OF HIGH INTENSITY INTERVAL TRAINING ON LEFT VENTRICULAR EJECTION FRACTION IN OBESE MEN

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EFFECT OF HIGH INTENSITY INTERVAL TRAINING ON LEFT VENTRICULAR EJECTION FRACTION IN OBESE MEN Obesity and overweight are epidemic and has substantially increased in recent years. Overweight and obesity are associated with the prevalence heart structural and functional impairments. Physical exercise improves diastolic function in obese/ overweight subjects and decrease end diastolic Left Ventricular Ejection Fraction (LVEF) in them( Kivisto et al., 2006) and reduced risk of cardiomyopathy in longer term (Schrauwen- Hinderling VB. et al., 2010). High intensity interval training (HIIT) is a proper exercise method to weight loss. Therefore the aim of this study was evaluation the effect of HIIT and caloric restriction as a predictor for heart function. Methods Participants included 24 healthy obese/ overweight males (280.229). EF was increased significantly only in DH group ( $P<0.02$ ). Discussion We demonstrated that due to 12 weeks of supervised HIIT, LVEF is improved in obese/ overweight male subjects. It seems that decreased cardiac lipid content with weight loss can improve heart function. On the other hand, increasing EF post training may be caused by improving contractibility of cardiac as a result of the elimination of cardiac ischemia, because increase of the pre-load improves the blood supply and decreases cardiac ischemia. The beneficial effect of training on systolic and diastolic function has been linked to alteration of  $Ca^{2+}$  regulatory system involved in excitation-contraction couple and relaxation process (Kemi et al., 2008) and thus decreased after load. Kivisto S., Perhonen M., Holmstrom M., Lauerma K.(2006). Med Sci Sports. 16:321-328. Schauwen-Hinderling VB., et al.(2010) J Clin Endocrinol Metab. 95(4): 1932-8. Kemi OJ., Ellingsen O., Smith GL., Wisloff U. (2008). Front Bioscience. 13: 356-68. \* lida\_moradi@hotmail.com

## RELATIONSHIP BETWEEN PHYSICAL SELF-DESCRIPTION AND ACTUAL HEALTH-RELATED FITNESS AMONG YOUNG QATARI WOMEN

KNEFFEL, ZS., GHAZI, W., ALREFAEI, J., ALQAWASSMI, D., MAJED, L.

*Qatar University*

INTRODUCTION Health-related fitness (HRF) explains the capacity to perform physical activities without tiring and include specific components that are objectively measured with standardized physical tests. The physical self-description (PSD) is a subjective judgment of the body and physical abilities that could diverge according for example to cultural backgrounds. Most studies on women's perception of their bodies and physical abilities have been done on western cultures, while limited exist data on Arab ones. The purpose of this study is to analyze the links between actual HRF and the estimated PSD among young Qatari women. METHODS 85 women (18-25 years) were recruited on campus to perform a standardized battery of HRF tests (ALPHA-FIT for adults, Suni et al., 2009). To estimate the physical self-concept the short version of Physical Self-Description Questionnaire (PSDQ) was used (Marsh et al., 2010). The collected data were imported to Statistica v.12 software and correlations were analyzed using Pearson coefficient. RESULTS 69.4% of the participants were classified as overweight (45.8%) or obese (23.6%). Significant correlations were found between: BMI on one hand and self-estimated appearance, body fat and global physical esteem on the other ( $r=-0.27$  and  $r=-0.29$ , respectively), between the 2km-walk performances on one hand and perceived endurance ( $r=0.4$ ) and global physical esteem ( $r=0.34$ ) on the other. Although, the jump-and-reach and modified push-up tests correlated significantly with the self-estimated strength ( $r=0.26$ ,  $r=0.31$ , respectively), this was not evidenced between the latter and the strength-related tests (handgrip,  $r=0.18$ ; dynamic sit-up,  $r=0.11$ ). Shoulder-neck mobility results were also significantly correlated to perceived flexibility ( $r=0.35$ ). The lowest fitness scores manifested in handgrip, modified push-up and 2km-walk tests. DISCUSSION Overweight and obesity are still primary issues among young Qatari female. The established correlations between BMI and estimated appearance scores indicated a rational image. However, in some strength related fitness scores (handgrip, dynamic sit-up) participants overestimated their abilities. The low performance in strength and endurance tests could be linked to the awareness concerning muscularity as well as participation in regular physical activity (Youssef et al., 2013). REFERENCES Suni J, Husu P, Rinne M. (2009). Tampere, Finland: Published by European Union DS, and the UKK Institute for Health Promotion Research. Marsh HW, Martin AJ, Jackson S. (2010). JSPE, 32, 438-482. Youssef RM, A-Shafie K, Al-Mukhaini M, Al-Balush H. (2013). Eastern Mediterranean Health Journal, 19, 759-68. Email: zs.kneffel@qu.edu.qa This study was made possible by UREP grant # UREP 17-044-3-011 from the Qatar national research fund (a member of Qatar foundation). The statements made herein are solely the responsibility of the authors.

## ANGLE FOR POSTURE ESTIMATION

VÄHÄ-YPYÄ, H., HUSU, P., SUNI, J., VASANKARI, T., SIEVÄNEN, H.

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Introduction Sedentary behavior (SB) is a risk factor for health, regardless of the level of concurrent physical activity (PA). Accurate measurement of SB would provide relevant data on total sedentary time and specific patterns in sedentariness. Waist-worn accelerometers are widely used to estimate habitual PA, but they are compromised by low accuracy in classifying the body posture into lying, sitting or

standing. The purpose of this study is to describe an accurate method for waist-worn triaxial accelerometers to classify posture. Classification is based on two facts: Earth's gravity vector is constant and the body walking posture while walking is upright. Methods Thirty healthy adults wore a waist-mounted triaxial accelerometer and underwent an individual array of lying, sitting, standing and walking tasks. The order and duration of these tasks was random. During walking, the accelerometer orientation in terms of gravity vector was taken as reference, and the angle for posture estimation (APE) was determined from the incident accelerometer orientation in relation to the reference vector. Results Receiver operator characteristic (ROC) curve yielded the optimal cut-point APE of 64.9° for lying and sitting and 11.4° for sitting and standing. Lying was perfectly (100%) separated from sitting while standing was separated from sitting with 94.4% sensitivity and 94.5% specificity. Discussion Upright walking provides a valid reference to determine the body posture spent lying, sitting and standing. The proposed analysis of the raw data obtained from waist-worn triaxial accelerometer provides more specific and detailed information about SB and standing.

## Mini-Orals

### MO-PM21 Physiology: Mixed Session

#### DAILY VARIATIONS IN RESTING METABOLIC RATE

VUCETIC, V., GRGIC, J., TOMIC, J., BRBOROVIC, H.

*University of Zagreb, Faculty of Kinesiology, Croatia; Sisters of Charity Hospital; University of Zagreb, School of Medicine, Andrija Štampar School of Public Health*

**INTRODUCTION** Resting metabolic rate (RMR) are indicators of the amount of calories a person needs during one day at rest. They provide information on the amount of calories burnt on basic body functions and also the amount of calories burned by food intake and physical activity. The purpose of this study was to determine possible daily variations in measured values of resting metabolic rate (RMR). **METHODS** Twenty male students of kinesiology (A: 24.3±3.3 years, H: 180.83±19.50 cm, W: 80.36±35.10 kg) were tested for RMR via COSMED QUARK CPET during one day, in the morning (8 am) in the midday (1 pm) and in the evening (5 pm). All measurements were conducted at the Sports Diagnostic center at the Faculty of Kinesiology, University of Zagreb. During the test the subject is lying without movement for 16 minutes and the RMR values are based on the last 10 minutes of the test. Statistical analysis was done using repeated measures ANOVA (Statistica for Windows 12.0), and statistical significance was set at  $p \leq 0.05$ . **RESULTS** The test results and comparison have shown statistically significant ( $F(1,19)=43.99$ ;  $p \leq 0.05$ ) differences between RMR results of the morning ( $2071.55 \pm 378.93$  kcal/day) compared to the midday ( $2623.50 \pm 658.92$  kcal/day) and evening data ( $2668.05 \pm 451.41$  kcal/day). The results of the morning RMR testing showed that morning values are much lower and closer to the values of basal metabolic rate (BMR) than to RMR. **DISCUSSION** Obtained results shown that the result of RMR can vary up to 22,36 %. Lower values of the morning testing are associated with the lower activity of the digestive system, because the subjects fasted from food. During sleep the calorie consumption is also lower due to the decreased activity of muscle cells, and central nervous system. **CONCLUSIONS** RMR results showed daily variability. For the most accurate results, spirometry should be done early in the morning. We strongly recommend following the outlined guidelines for RMR. If RMR testing on COSMED QUARK CPET system is used following the recommendation, this system is a very good and useful tool for measuring resting metabolic rate and ventilation parameters Do not insert authors here

#### CAN HEART RATE BE USED AS AN INDICATOR OF ENERGY DEMANDS DURING COMMUTER WALKING IN A METROPOLITAN AREA?

SCHANTZ, P., SALIER ERIKSSON, J., ROSDAHL, H.

*The research group for movement, health and environment*

**Introduction** Measuring the energetic demands of habitual commuter walking is essential to objectively relate to the impact that walking commuting can have on health. Hence, evaluating methods for such purpose is of great importance. Heart rate (HR) can possibly be used as long as the relationship between oxygen uptake (VO<sub>2</sub>) and HR is established in laboratory conditions and proven to be valid under field conditions. However, e.g. traffic, noise and exhaust fumes may introduce effects of e.g. stress that change the relationship in the field. Thus, the validity of the HR method needs to be scrutinized. **Methods** VO<sub>2</sub> and HR measurements during three submaximal exercise intensities on cycle ergometer were performed in the laboratory, as well as during normal commuting walking in the individuals' normal field setting in Greater Stockholm, Sweden. 20 habitual commuter pedestrians (10 males and 10 females) aged  $45 \pm 7$  yrs (mean  $\pm$  SD) participated and validated stationary and portable metabolic systems (Rosdahl et al. 2010; 2016; Salier-Eriksson et al. 2012), and HR monitors were used. A comparison of the VO<sub>2</sub> – HR relationship was made between the laboratory and field conditions. **Results and Discussion** Interpreting the heart rate levels during walking commuting from the VO<sub>2</sub> – HR relationship in the laboratory resulted in oxygen uptakes that were  $13.0 \pm 10.6$  % lower in males and  $10.5 \pm 11.5$  % lower in females than the correct VO<sub>2</sub> values. Thus, the study indicates that systematic differences between the laboratory and field conditions with respect to the VO<sub>2</sub> – HR relationship are present in metropolitan conditions. The reason for these differences remains to be elucidated. **References** Rosdahl, H., Gullstrand, L., Salier Eriksson, J., Johansson, P. & Schantz, P. 2010. Evaluation of the Oxycon Mobile metabolic system against the Douglas bag method. *Eur J Appl Physiol* 109 (2):159-71. Rosdahl, H., Salier Eriksson, J. & Schantz, P. 2016. Validation of data collected with mobile metabolic measurement systems over time during active commuting. *Proceedings of the 21st Annual Congress of The European College of Sport Sciences*, Vienna, Austria, 6-8 July (Abstract). Salier Eriksson, J., Rosdahl, H. & Schantz, P. 2012. Validity of the Oxycon Mobile metabolic system under field measuring conditions. *Eur J Appl Physiol*, 112 (1): 345-355.

#### COMPARISON OF BODY FAT ASSESSMENT METHODS ON FIELD IN ELITE JUNIOR ROWERS

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**Introduction** There is a large variety of body fat measurements, which differ in validity and reliability, especially for athletes. It is necessary to find a method that quantifies body fat most accurately and that is feasible for field testing. The purpose of this study was to compare

three methods of body fat estimation in rowers of the German National Junior Rowing Team (8 females, 8 males): skinfold-thickness (SKF), near-infrared interactance (NIR) and ultrasound (US) measurement of subcutaneous adipose tissue (SAT). Methods The examiners were certified by the International Society for the Advancement of Kinanthropometry (ISAK) and Association of Applied Sciences in Medicine and Sports (ASMS). SKF and NRI measurements were taken at three sites and are reported as total body fat percentage (BF%). US measurements were taken at 8 sites and are reported as a sum of SAT (mm) with a distinction made between SUMExcl (without embedded structures) and SUMIncl (including embedded tissues) (10/15 MHz linear transducer L12-3 US, Phillips CX50, Amsterdam, NL). Results Mean BF% via SKF was  $10.9 \pm 1.9\%$  and  $11.7 \pm 2.9\%$  via NIR. Mean SAT thickness was  $46.6 \pm 12.1\text{mm}$  (SUMIncl), respectively  $42.5 \pm 11.4\text{mm}$  (SUMExcl). A comparison of the three body fat assessment measurements showed significant correlations between US and SKF (SUMIncl:  $p < 0.001$ ,  $r^2 = 0.86$ ; SUMExcl:  $p < 0.001$ ,  $r^2 = 0.86$ ) and between US and NIR (SUMIncl:  $p < 0.01$ ,  $r^2 = 0.38$ ; SUMExcl:  $p < 0.01$ ,  $r^2 = 0.40$ ). There were also significant correlations between SKF and NIR ( $p < 0.001$ ,  $r^2 = 0.56$ ). Furthermore, a Bland-Altman-analysis showed a 95% agreement between the SKF and NRI method. Discussion Body fat assessment in field testing can be performed by using any of these three methods. US allows the quantification of pure SAT, and the protocol for fat patterning by Müller et al. (2016) permits reliable and valid results. Currently there are no reference data and/or a formula for estimating US-BF (%), and further research is required. The SKF method cannot quantify pure SAT, and NIR has lower accuracy compared to US and SKF. The method of choice depends on the skills of the examiner, number of athletes and available time. For highly accurate SAT measurements, US could be a gold standard once reference data is established. References Müller W., Lohman T., Stewart A., Maughan R., Meyer N., Sardinha L., Kirihehennedige N., Reguant-Closa A., Risoul-Salas V., Sundgot-Borgen J., Ahammer H., Anderhuber F., Fürhapter-Rieger A., Kainz, P., Materna W., Pils U., Pirstinger W., Ackland T. (2016). *Br J Sports Med*, 50 (1), 45-54. Contact anne.kelso@uni-ulm.de; trajer.emese@gmail.com

### ASSOCIATIONS BETWEEN NECK CIRCUMFERENCE AND ADIPOCYTOKINES AMONG ADOLESCENTS

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Introduction Neck circumference (NC) was recently indicated as a useful parameter for predicting cardiovascular diseases (CVD). Adipocytokines may play a key role in the development of CVD. The purpose of this study was to examine the associations between NC and adipocytokines in adolescents. Methods A cross-sectional, school-based study was conducted on 529 Portuguese adolescents (267 girls) aged 12-18 years-old. Anthropometry, plasma biomarkers (adiponectin and leptin), cardiorespiratory fitness, socioeconomic status, diet and pubertal stage were obtained from each participant. Results NC was significantly and positively correlated with leptin and negatively correlated with adiponectin, after controlling for age, sex, pubertal stage, cardiorespiratory fitness, socioeconomic status and diet ( $p < 0.001$ ). Linear regression analyses showed that NC was positively associated with leptin ( $\beta = 3.722$ ,  $p < 0.001$ ), whereas it was significantly and inversely associated with adiponectin ( $\beta = -1.326$ ,  $p < 0.001$ ), after adjusting for the aforementioned confounders. Discussion The main findings of this study suggest that NC, regardless of other potential confounders, predicts status of pre-inflammatory process; therefore, this anthropometric measure can be useful as an additional predictor of cardiovascular and inflammatory risk in adolescents. NC, as an index of upper-body obesity, has already been found to be a simple and practical screening method that can be used to identify CVD risk factors, such as obesity and metabolic syndrome (Laakso et al, 2002; Onat et al, 2009). Conclusions The use of NC as a screening tool for CVD risk factors should be considered. Since the onset of chronic disease risk factors starts in early childhood, it is important to assess the risk predictors in order that effective preventive strategies targeting those at risk start as early as possible. References Laakso M, Matilainen V, Keinänen-Kiukaanniemi S. 2002. Association of neck circumference with insulin resistance-related factors. *International journal of obesity and related metabolic disorders : journal of the International Association for the Study of Obesity* 26(6):873-875. Onat A, Hergenc G, Yuksel H, Can G, Ayhan E, Kaya Z, Dursunoglu D. 2009. Neck circumference as a measure of central obesity: associations with metabolic syndrome and obstructive sleep apnea syndrome beyond waist circumference. *Clinical nutrition* 28(1):46-51.

### THE EFFECT OF FUCOXANTHINOL ON LIPOLYTIC ACTIVITY IN 3T3-L1 ADIPOCYTES

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Introduction Fucoxanthin (FX) is a carotenoid found in edible seaweed such as Undariapinnatifida. Fucoxanthin suppressed weight gain of white adipose tissue in diabetic/obese KK-Ay mice (Maeda et al, 2007). Furthermore, FX and its metabolite fucoxanthinol (FXOH) inhibited the differentiation of 3T3-L1 through the down-regulation of PPAR $\gamma$  protein expression (Maeda et al, 2006). However, the effect of FXOH on the cellular mechanisms responsible for lipolysis in mature adipocytes is unknown. The aim of this study was to investigate the effect of FXOH on lipolytic activity and lipolysis-related protein expression in mature adipocytes. Furthermore, we investigated the responsiveness of FXOH-treated cells to catecholamine stimulation. Materials and methods After 8 days of differentiation, mature 3T3-L1 adipocytes were treated with 2.5 $\mu\text{M}$ , 5 $\mu\text{M}$  or 10 $\mu\text{M}$  FXOH for 72 hours. During the treatment, aliquots of the medium were collected and biochemically analyzed for glycerol and fatty acid (FA) contents. Triacylglycerol (TAG) content was also biochemically measured. The expressions of lipid-associated proteins such as fatty acid synthase (FAS), perilipin1, adipose tissue triglyceride lipase (ATGL), comparative gene indennification-58 (CGI-58), acetyl-CoA carboxylase (ACC), AMP-activated protein kinase (AMPK) and hormone-sensitive lipase (HSL) were analyzed by Western blotting. After the 72 hours of FXOH treatment, lipolytic activity by catecholamine stimulation was also analyzed biochemically. Results Intercellular lipid accumulation (TAG content) was significantly decreased by FXOH treatment as compared to control in a dose-dependent manner ( $P < 0.01$ ). FXOH treatment significantly increased lipolytic activities as estimated by glycerol and fatty acid release compared with control in a dose-dependent manner ( $P < 0.01$ ). On the contrary to our expectation, however, the expressions of lipolysis-associated proteins such as ATGL, HSL, perilipin1 and CGI-58 were significantly lower in FXOH as compared to control ( $p < 0.01$ ). On the other hand, FXOH enhanced AMPK and ACC phosphorylation ( $P < 0.05$ ). Furthermore, the expression of lipogenesis-associated protein (e.g., FAS) was lower in FXOH treated cells than in control ( $P < 0.01$ ). In line with the expressions of lipolysis-associated proteins, FXOH treatment significantly decreased lipolytic activity in response to catecholamine stimulation compared with control. Conclusion These results suggest that FXOH activates basal, but not catecholamine stimulated-lipolytic activity, and inhibits the lipogenesis in 3T3-L1 adipocytes. The mechanisms underlying this effect of FXOH might involve suppression of fatty acid synthesis by decreased expression of FAS as well as augmented phosphorylation of AMPK and ACC.

## THE RELIABILITY OF THE EXTRA LOAD INDEX AS A MEASURE OF RELATIVE LOAD CARRIAGE ECONOMY

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**Introduction** The aim of this study was to measure the reliability of the Extra Load Index (ELI) (Lloyd et al, 2010) as a method of assessing relative load carriage economy. The ELI is calculated as  $\text{mLO2L} \cdot \text{kg} \cdot \text{min}^{-1} / \text{mLO2U} \cdot \text{kg} \cdot \text{min}^{-1}$ , where mLO2L refers to loaded oxygen consumption for the combined mass of the individual and external load and mLO2U refers to oxygen consumption for unloaded walking. This accounts for the energy cost of unloaded walking and thus measures the change in economy associated with load carriage. An ELI value of 1 indicates that the additional energy cost is proportional to the mass of the external load. Values <1 or >1 indicate a relatively lower or higher energy cost respectively. The ELI is independent of the magnitude of external load, walking speed and body composition (Lloyd et al., 2010). Methods 17 apparently healthy volunteers (12 male, 5 female; age  $27 \pm 10$  years; stature  $177 \pm 8.7$  cm; mass  $77.5 \pm 13.9$  kg) performed walking trials at  $3 \text{ km} \cdot \text{h}^{-1}$ ,  $6 \text{ km} \cdot \text{h}^{-1}$  and a self selected pace (SS). Trial conditions were completed in a randomised order, separated by at least 48 hours and repeated identically 7 days later. Trials involved 4x4 minute periods of walking, each separated by 5 minutes of rest. The initial stage was performed unloaded, followed in a randomised order, by a second unloaded period and loaded walking with backpacks of 7kg and 20kg. Reliability of the ELI was assessed using a repeated measures ANOVA, limits of agreement (LoA: mean of the differences  $\pm 1.96$  SD; Bland and Altman, 1986) and coefficients of variation (CV). Results ELI values did not differ significantly between trials for any of the speeds (main effect speed,  $p = 0.46$ ) with either of the additional loads (main effect load,  $p = 0.297$ ). At  $3 \text{ km} \cdot \text{h}^{-1}$ , the LoA were  $-0.01 \pm 0.11$  for 7kg and  $0.00 \pm 0.10$  for 20kg, with a CV of 4.17% for 7kg and 2.74% for 20kg. At SS, the LoA was  $0.00 \pm 0.05$  for 7kg and  $0.03 \pm 0.09$  for 20kg with a CV of 1.75% for 7kg and 3.42% for 20kg. At  $6 \text{ km} \cdot \text{h}^{-1}$ , the LoA was  $-0.02 \pm 0.09$  for 7kg and  $0.00 \pm 0.07$  for 20kg, with a CV of 3.51% for 7kg and 2.51% for 20kg. Discussion The ELI demonstrated good reliability at different walking speeds with both a light and heavy load. The systematic bias was small in all conditions and the largest LoA was within  $\pm 0.11$ . The CV was also small in all conditions (highest magnitude of 4.17%). Therefore, the ELI appears to be a reliable measure of relative load carriage economy. It provides a dimensionless index that can be easily interpreted by developers and manufacturers as well as researchers. We conclude the ELI represents a useful tool for comparing the relative economy of different load carriage systems. References Bland JM, Altman DG. (1986) *Lancet*, 1, 307-310 Lloyd R, Hind K, Parr B, Davies S, Cooke C. (2010) *Ergonomics*, 53 (12), 1500-1504. s.hudson@leedstrinity.ac.uk

## PICKING GOODS ASSISTED BY HEAD-MOUNTED AUGMENTED REALITY SYSTEMS IN WAREHOUSES

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**PICKING GOODS ASSISTED BY HEAD-MOUNTED AUGMENTED REALITY SYSTEMS IN WAREHOUSES** **Introduction** Picking operations are subject to continuous improvements, as more goods must be loaded on even smaller spaces. As the diversity of products increases, the number of single orders decreases requiring supportive systems for the workers, in order to optimize the working process (Schwerdtfeger et al. 2011). Aim of the study was to compare an optical see-through (OST) prototype vision picking system (VS) with an augmented reality approach, to a conventional voice-controlled system (VC) during a typical order picking activity in terms of physiological impacts on the workers. Methods 20 male subjects ( $29.9 \pm 4.5$  yrs) performed a cycle ergometry to determine performance (first lactate turn point, LTP1). Heart rate (HR) and number of steps were obtained for a 10 hour work shift. Gas exchange measures were performed during representative phases of work (Wultsch et al. 2012). Bipolar surface electro-myography (sEMG) recordings were performed every 150 minutes for the right neck muscles and forearm muscles. The volunteers worked for two days each with a different system in a randomized order. Results Maximal power output (Pmax) and maximal oxygen consumption (VO2max) was  $236.4 \pm 26.6$  W and  $2.975 \pm 0.375$  l.min<sup>-1</sup>. Shift HR (HR10h) ( $106.6 \pm 12.6$  bpm;  $59.7 \pm 5.9$  % HRmax) and oxygen consumption during work ( $1.178 \pm 0.189$  l.min<sup>-1</sup>;  $39.9 \pm 3.3$  % VO2max) in VS was significantly different to VC HR10h ( $99.7 \pm 9.6$  bpm;  $55.9 \pm 5.7$  % HRmax) and VO2 ( $1.011 \pm 0.139$  l.min<sup>-1</sup>;  $33.5 \pm 5.5$  % VO2max). Subjects handled significantly more goods with VC ( $1142 \pm 222$  goods,  $7767.2$  kg) and walked significant more steps ( $10448 \pm 3014$  steps) compared to VS ( $1066 \pm 199$  goods,  $7529.2$  kg;  $9477 \pm 2254$  steps). No significant correlation between pieces of goods and HR10h, VO2 10h, HRmax 10h as well as energy expenditure during the working time (EEW) were found for both systems. Significant changes of the sEMG amplitude were found only for the neck muscles for both systems. Discussion The subjects picked up fewer goods with a significantly higher physiological strain using a new prototype vision system. A higher degree of attention with the vision system, a shorter training phase and a higher weight of the device may explain these differences. Nevertheless, new systems like the HMDs should reduce strain with the same output and therefore development should focus on the weight of systems in order to minimize the risk of neck pain. References Schwerdtfeger B, Reif R, Günthner W, Klinker G. (2011). *Virtual Reality*, 15, 2-3. Wultsch G, Rinnerhofer S, Tschakert G, Hofmann P. (2012). *Scand J Work Environ Health*, 38(4), 370-379. Contact [peter.hofmann@uni-graz.at]

## EFFECTS OF THE DIFFERENT WEIGHT-LOSS PATTERN ON BODY COMPOSITION AND PERFORMANCE IN COLLEGIATE WRESTLERS

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Most athletes participating in sports with specific weight categories compete in a class 5-10% below their habitual weight(1). It remains common to lose weight by a combination of dietary restriction, exercise, and sweating for 4-5 days prior to competition. The purpose of this study was to examine the effects of the different pattern of weight-loss on body composition and performance. Experimental period consisted of three phases: pre weight-loss, weight-loss and repletion. Evaluation was conducted before(Pre) and at the end of weight-loss (Post) and 14-15h repletion (Recovery). Study 1 is an observational study for six collegiate male wrestlers preparing for competition. In Study 2, the subjects were divided into a moderate weight-loss group(n=6) and a severe weight-loss group(n=6). They were asked to lose 6%/9% of their body weight during 56h/125h through self-determined ways. Measurements were body weight(BW), body composition, urine specific gravity(USG) and dietary intake (daily energy intake and the proportion of carbohydrates, proteins and fats). Vertical jump and wingate test were also examined in Study 2. In Study 1, BW decreased by  $4.8 \pm 0.5$  % in Post and reached Pre-value in Recovery ( $p < 0.05$ ). Although lean body weight(LBW) showed similar change( $p < 0.05$ ), no difference was observed in percent body fat. In Study 2 BW of both groups decreased in Post ( $6.0 \pm 0.1$  % for the moderate group vs.  $8.8 \pm 0.2$  % for the severe group),but it did not reach Pre-value in Recovery ( $p < 0.05$ ). Although reduced percent body fat by weight-loss reached Pre-value in Recovery( $p < 0.05$ ), LBW did not recover fully in



both groups ( $p < 0.05$ ). USG increased in Post and sustained higher value above Pre in Recovery in both groups ( $p < 0.05$ ). Energy intake significantly decreased in weight-loss and increased above pre weight-loss value in repletion ( $p < 0.05$ ). The carbohydrate proportion increased, but the fat proportion decreased in repletion compared with pre weight-loss ( $p < 0.05$ ). Although the exercise performances were impaired in Recovery compared with Pre ( $p < 0.05$ ), the blood lactate change by wingate test was not affected by weight-loss. No group differences were observed in dietary intake and performance. Weight loss over 6% was accompanied with decreased LBW with dehydration, which might impair performance. However, no effects of the weight-loss patterns were observed. 1) Brownell KD, Steen SN, Wilmore JH. Weight regulation practices in athletes: analysis of metabolic and health effects. *Med Sci Sports Exerc.* 19(6):546-56, 1987

## FAMILY FUNCTION AND LIFESTYLE IN UNIVERSITY STUDENTS

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**Introduction** Develop healthy programs in universities is very important, which are involved not only students but also the entire administrative and teaching personnel to prevent physical inactivity, obesity and poor eating habits among others. The aim of this study was to compare family function and lifestyle in the university population among medical students, nursing, engineering, administrative and teachers. **Methods** The study included a total of 220 participants, the sampling was per cluster and the sample consisted of 54 medical students, 36 nursing, 67 in engineering, 38 administrative and 25 teachers members Surcolombiana University. The study logistics complied with the Declaration of Helsinki. APGAR was the instrument to measure family function. APGAR shows how the family perceives the performance family level globally. FANTASTIC instrument was used to measure lifestyle, it have internal consistency and construct validity criteria on Spanish version. It is recommended that the questionnaire be used in primary healthcare and epidemiological studies. Bivariate analyses with chi square and ANOVA analysis of variance of a factor. The SPSS for Windows (version 16.0) was used for statistical analyses. All  $p$  values  $\leq 0.05$  were regarded as statistically significant. **Results** The general characteristic of the study were 220 participant; mean age of 27,  $23 \pm 14.4$  years. By applying the analysis of variance of a factor only significant difference between family function (APGAR) of nursing students versus administrative with a value  $p = 0.04$  were found. As for the comparison of the other groups no significant differences were found. With regard to lifestyle (FANTASTIC) No statistically significant differences were found among nursing students, engineering, medicine, administration and teachers **Discussion** The lifestyle of the University population evaluated (USCO) is homogeneous and does not differ by academic program (nursing, medicine and engineering) or by the activity they perform (Student Administrative Staff). With regard to family function, only the results differ between administrative and nursing students. **References** Pan American Health Organization. Evaluation of health promotion: principles and perspectives. Washington D.C. OPS; 2007. Pan American Health Organization. Ottawa Charter for Health Promotion (legal regulation on the internet). Ottawa, Canada: OPS; 1986 (cited 2011 August 23). Available in: <http://www.paho.org/spanish/hpp/ottawachartersp.pdf>. Velez Ramirez R, Agredo A. Reliability and validity of the 'FANTASTICO' instrument to measure lifestyle in Colombian adults. *Revista Salud Publica.* 2012; 14 (2): 226-237. Francisco Gomez, Ponce E. A new approach to the interpretation of Family Apgar (Spanish version). Mexico: Aten Fam; 2010 (cited 2014 July 9); 17 (4): 102-106 Available at: <http://www.medigraphic.com/pdfs/atefam/af-2010/af104f.pdf>. Contact Lisímaco Vallejo Cuéllar [lisvac@gmail.com](mailto:lisvac@gmail.com)

## THE EXTRA-TIME PERIOD OF SOCCER: IMPLICATIONS FOR PHYSIOLOGY AND PERFORMANCE

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**Introduction** Although soccer matches typically last 90 min, when scores are tied at the end of normal time an extra-time (ET) period consisting of two 15 min periods may be required in certain knockout competitions. The demands of 90 min of soccer-specific exercise are well known, however the responses to ET are relatively understudied. This is surprising as 35% of matches in the knockout phase of FIFA World Cup competitions between 1986 and 2014 required ET and indices of physical and skill performance are negatively impacted during ET (Harper et al., 2014; Russell et al., 2015). We aimed to examine the performance and metabolic responses to 120 min of soccer-specific exercise; with a particular focus on the responses elicited during ET. **Methods** Twenty two university standard soccer players completed 120 min of simulated soccer match-play which required following a prescribed intermittent exercise pattern and the completion of soccer dribble testing and 15 m sprints. Participants performed countermovement jumps (CMJ), 20 m sprints and a shooting test (to assess speed and precision) at pre-exercise, 45 min, pre-second half, 90 min and 120 min. Venous blood was taken throughout exercise to measure glucose, lactate, epinephrine, interleukin-6 (IL-6), glycerol and non-esterified fatty acid (NEFA) concentrations. **Results** Data shown as mean  $\pm$  SD. Repeated measures ANOVA highlighted that exercise significantly influenced all variables ( $p < 0.05$ ). Sprint velocities (15 m and 20 m) and shooting speed reduced at 120 min compared to 90 min ( $-5.7 \pm 4.8\%$ ,  $-4.2 \pm 6.8\%$ , and  $-4.6 \pm 8.1\%$ , respectively; all  $p < 0.05$ ). Compared to 90 min, blood glucose concentrations were lower at 120 min ( $-0.7 \pm 0.8$  mmol.l<sup>-1</sup>  $p < 0.05$ ) and plasma epinephrine ( $+1835.8 \pm 1840.0$  pmol.l<sup>-1</sup>), IL-6 ( $+4.8 \pm 4.01$  pg.ml<sup>-1</sup>), glycerol ( $+114 \pm 101$  umol.l<sup>-1</sup>) and NEFA ( $+0.5 \pm 0.6$  mmol.l<sup>-1</sup>) concentrations were elevated (all  $p < 0.05$ ). However, shooting precision, lactate concentrations, and CMJ height remained unchanged in ET ( $p > 0.05$ ). **Conclusion** The ET period elicited perturbations in metabolic and performance responses compared to those observed at 90 min. Depressed blood glucose concentrations with concomitant increases in NEFA and glycerol concentrations indicates increased fat oxidation during ET. Elevated epinephrine and IL-6 concentrations suggest a taxing of muscle and liver glycogen in ET. Decrements in sprinting and shooting velocities are putatively associated with shifts in substrate utilisation. Practitioners working with players who may be exposed to ET should be cognisant of these deleterious effects. Investigations on the efficacy of interventions that seek to attenuate decrements are warranted. **References** Harper LD et al. (2014) PLoS ONE 9(10) Russell et al. (2015) J Sport Sci 33(20) Contact [liam.harper@unn.ac.uk](mailto:liam.harper@unn.ac.uk)

## Mini-Orals

### MO-BN07 Motion Analysis 2

#### CONTRIBUTION OF BODY SEGMENTS TO AERODYNAMIC FORCES DURING TAKEOFF IN SKI JUMPING

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**Introduction** In the series of movement involved in the ski jumping technique, the takeoff motion is considered to be the most important phase to determine the performance (Schwameder, 2008, Virravirta et al., 2009). Since ski jumpers are required to change their posture from the crouching posture to the flight posture within an extremely short period of time, the aerodynamic force acted upon a ski jumper changes dynamically (Yamamoto et al., 2015). The aim of this study was to investigate the contribution of each body segment to the aerodynamic force during the motion. **Methods** Three dimensional surface model of a ski jumper was obtained by 3-D laser scanning of an active ski jumper, and divided the model into 15 body segments with joint mobility. Two sets of motion data were generated using the video analysis of ski jumper's takeoff motion (world-class jumper A and less-experienced junior jumper B). The CFD method adopted for this study was based on Large-Eddy Simulation. The incoming velocity was set to 23.23 m/s. The aerodynamic force, pressure distribution on the model's surface and contribution of each body segment to the aerodynamic force were calculated and then were compared between the two jumpers. **Results** Regarding the lift force, although jumper A's lift force was less in the in-run posture, it became greater than that of jumper B at the end of the movement. Lift forces acted upon Jumper A and B at the posture right before the takeoff were 62.1N and 57.6N, respectively. The body segment which was the most contributive for the lift force was a trunk (A: 63.8%, B: 56.8%). The second contributive segments were the arms (A: 31.5%, B: 32.5%). The drag force acting upon jumper A was weaker than that acting upon jumper B through the whole movement. Those were 60.7N for A and 94.7N for B at the posture right before the takeoff. However, the trunk segment had a great influence to drag as well as lift (A: 40.1%, B: 60.1%), and the contribution of the arms was relatively low (A: 4.0%, B: 9.4%). **Discussion** As for the lift, the total contribution of the trunk and the arms segments reached approximately 90%, and it was suggested that trunk movement was important aerodynamically. The contribution of the trunk segment to drag was also high, but the relatively low contribution of the arms segments was an interesting finding. These results suggested that the movements of the arms would have an influence in increasing lift and restraining drag. **References** Schwameder, H. (2008). *Sports Biomechanics*, 7(1), 114-136. Virravirta, M. et al. (2009). *J. Biomech.*, 42(8), 1095-1101. Yamamoto, K. and Tsubokura, M. (2015), *Science and Skiing VI*, 536-542. Contact [kyamamoto@hokusho-u.ac.jp](mailto:kyamamoto@hokusho-u.ac.jp)

#### SLED TOWING: A KINEMATIC ANALYSIS TO DETERMINE THE OPTIMAL TRAINING LOAD

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**Introduction** Sled towing is a popular method for sprint training, frequently used to improve performance in the acceleration phase. The kinematics of both unloaded sprinting and sprinting when towing a sled with different loads were compared, at maximum sprinting velocity. The aim of this study was to establish which load maximize athletes' mechanical power without inducing detrimental technical changes. **Methods** Thirteen athletes (mean BM=67.88±5.93 kg) performed 5 trials at maximum speed over a 20 m distance: unloaded, +15, +20, +30 and +40% of BM. The following parameters were measured: contact and flight times (CT, FT), step length (SL), velocity, acceleration and hip, knee and ankle angles, by using a 3D body motion system (Vicon MXSystem, UK, 100Hz) in the first 5m, and two cameras (Elixim Casio, 100 Hz) over the remaining distance. All videos were further analysed with SIMI motion software. The leg and vertical stiffness (kleg, kvert) were calculated according to Morin et al. (2005). Mechanical power (P) was calculated according to Samozino et al. (2015). **Results** CT, kleg and kvert increased whereas SL and FT decreased when sled load increased. Knee and ankle angles decreased while hip angle increased, with increasing load, both at touch down and at take off. Significant changes in these angles were observed at +30% and +40% compared to the initial no load condition (no differences were observed at +15% and +20%). Mechanical power reached its maximum between +15% and +20%. **Discussion** Many studies have demonstrated that resisted sprint training may influence sprint technique (e.g. Cronin et al. 2008). In the present study we found that sled towing affects sprint kinematics during the acceleration phase: indeed, significant differences do exist at different loads on spatio-temporal parameters and lower limb angles. By considering all variables, the +20% condition represents the optimal overload for specific sprint training since at this load the subjects reach their highest power without causing significant angular changes. **References** Cronin J, Keir Hansen K, Kawamori N, Peter Mcnair P. (2008). *Sports Biom*, 7:2, 160-172. Morin JB, Dalleau G, Kyröläinen H, Jeannin T, Belli A. (2005). *J Appl Biomech*, 21, 167- 170 Samozino P, Rabita G, Dorel S, Slawinski J, Peyrot N, Saez de Villarreal E, Morin JB. (2015). *Scand J Med Sci Sports*, Advance online publication: doi: 10.1111/sms.12490 Contact [andrea.monte92@hotmail.com](mailto:andrea.monte92@hotmail.com)

#### INTRA-INDIVIDUAL DIFFERENCE IN SPATIOTEMPORAL VARIABLES DURING MAXIMAL SPRINTING

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**INTRA-INDIVIDUAL DIFFERENCE IN SPATIOTEMPORAL VARIABLES DURING MAXIMAL SPRINTING** **Introduction** Accelerated sprinting ability is of great importance for athletes in many sports. Spatiotemporal variables could provide useful information of characteristics in sprinting. Although a previous study that investigated the relationship among spatiotemporal variables during sprinting employed the inter-individual approach (Nagahara et al. 2014), an investigation of intra-individual difference in spatiotemporal variables during sprinting is limited. Thus, the purpose of this study was to clarify on a step-to-step basis the intra-individual difference in spatiotemporal variables during the acceleration phase of maximal sprinting. **Methods** Fifteen male sprinters ran 60-m with maximal effort for at least three times, during which ground reaction force was recorded with 54 force platforms. Spatiotemporal variables through 50 m were computed from the ground reaction force data, and the changes in variables during acceleration phase were approximated with 4th order polynomial equation. A t-test was used to examine the difference in variables between the best and the worst trials. **Results** The best and worst 60 m sprint times were 7.18 ± 0.17 s and 7.29 ± 0.15 s (P < .001). The running speed of the best trial was significantly higher than the worst trial from the 3rd to 22nd step. While there was no significant difference in step length at all steps, step frequency of the best trial was signifi-

cantly higher than that of the worst trial from the 2nd to 22nd step. The support time of the best trial was significantly shorter than that of the worst trial from the 2nd to 6th and from the 8th to 22nd step, although there was no significant difference in the flight time. Discussion The main result showed that intra-individual basis better accelerated sprinting was achieved by higher step frequency through shorter support time. The higher step frequency in the best trial is in line with the study of Hunter et al. (2004). Increase in constant running speed from nearly maximal to maximal is achieved by increase in step frequency, and this increment in step frequency is attributed to greater acceleration of hip and knee joints during swing, driven by hip muscles. Thus, trying to stimulate these hip muscles is possibly being a conditioning solution to accomplish one's best performance in a day. That said, it should be taken into account that the attempt to increase one of step length or frequency maybe result in impairment of a sprint performance, i.e. running speed. Accordingly, further investigation examining the effect of the intervention within a single day is suggested. Reference Nagahara R, Naito H, Morin J.B, Zushi K (2014). *Int J Sports Med*, 35, 755-761. Hunter JP, Marshall RN, McNair PJ (2004). *Med Sci Sports Exerc*, 36, 261-271. Contact nagahara.r@gmail.com

## KINEMATIC PARAMETERS OF FIRST AND FOURTH HURDLE CLEARANCES IN FEMALE SHORT HURDLE RACE

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1: ASU (Maykop, Russia), 2: KC (Krasnogorsk, Russia), 3: KSUF CST (Krasnodar, Russia) Introduction Top female hurdlers run from the start to the third hurdle with marked acceleration and achieve highest speed at the fourth hurdle or later (Hucklekemes, 1990). This suggests that the techniques of the hurdle clearance during acceleration and in the top speed phase may differ. However, most of the studies have focused on the parameters of clearance in the phase of high speed (Francis et al., 2004 et al.). Therefore, the aim of this study was to compare kinematic characteristics of the clearance of the first and the forth hurdles. Methods Five female hurdlers (age 19.8±4.1, height 1.72±0.06 m, weight 62.0±5.8 kg, 100 m hurdles personal best 14.39±0.88 s) took part in the study. Each participant performed one trial of maximal speed running in five-hurdle race using starting blocks. Videotaping was done with two high speed camcorders (240 Hz) placed perpendicular to the run direction, about 20 m away from the first and the forth hurdles. 2D video analysis was carried out with the help of SkillSpector software. Paired sample t-test was used to examine statistical differences of data. Results Horizontal velocity (HV) of center of gravity (CG) at takeoff before and at touchdown after the first hurdle were significantly smaller than similar parameters at the fourth hurdle ( $p=0.041$  and  $0.034$ ). It was also found that the vertical velocity (VV) of CG at takeoff ( $1.84\pm0.33$  and  $1.40\pm0.21$  m/s,  $p=0.012$ ), the takeoff angle of CG ( $15.6\pm3.6$  and  $11.6\pm2.7^\circ$ ,  $p=0.007$ ) and the flight time ( $0.336\pm0.028$  and  $0.327\pm0.031$  s,  $p=0.032$ ) were significantly larger at the first hurdle clearance. The takeoff distance ( $1.68\pm0.11$  and  $1.90\pm0.09$  m,  $p=0.001$ ), the takeoff CG height ( $1.05\pm0.04$  and  $1.07\pm0.04$  m,  $p=0.023$ ) and the stride length ( $2.86\pm0.18$  and  $3.04\pm0.15$  m,  $p=0.025$ ) were significantly smaller at the first hurdle clearance. Discussion Thus, hurdlers tend to perform the first hurdle clearance from shorter distance, with a larger takeoff VV and takeoff angle. However, CG maximal height at the first and the forth hurdle clearances is simply possible due to the lower position of CG at the first hurdle takeoff. Faster HV at the forth hurdle clearance allows runners to decrease their flight time and increase the stride length due to takeoff distance. The study results can be used in technical training of hurdlers. References Hucklekemes, J (1990). Model technique analysis sheets for the hurdles. Part VI: The Women's 100 metres Hurdles. *New Stud Athlet*, 4, 33-58. Francis, J, Finch, A, Ariel, G (2004). Kinematic alterations in women's 100 m hurdle technique over current 84 cm hurdle and proposed 91 cm hurdle heights. *Proceedings of 22 International Symposium on Biomechanics in Sports*. Ottawa, Canada, 237-240.

## RELATIONSHIP BETWEEN ISOKINETIC KNEE STRENGTH AND FLIGHT DISTANCE AT DIFFERENT START TECHNIQUES IN EXPERIENCED SWIMMERS

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Introduction Lower body strength is one of the most important determinants of start performance (McBride et al., 2009). It directly affects the ability to exert force on block during push-off phase which affects the take of velocity and flight distance (Slawson et al., 2013). The aim of this research is to examine the effect of maximal isokinetic knee strength on flight distance for grab, track and kick start techniques. Methods 17 experienced swimmers (Age; 16.84±1.68 year, Body mass; 72.16±7.16 kg, Height; 179.95±5.80 cm. BMI; 22.28±1.91) participated in this study. Start performance was recorded with two digital video cameras to determine flight distance. Isokinetic peak torque was assessed for the knee extensors and flexors at 60 degree/s and at 180 degree/s (Biodex System 4 Dynamometer). Peak torque value of the best repetition were used for each angular velocities. One way analysis of variance (ANOVA) and Pearson correlation analysis was used to assess the relationship between isokinetic strength variables of the knee and flight distance for three start techniques. Results There was no relation between flight distance and knee flexion-extension peak torques at 60 degree/s for both front and rear legs in all three starting techniques ( $p>0.05$ ). However at 180 degree/s, flight distance was related with knee extension peak torques ( $p<0.05$ ) for front leg in grab start ( $r=0.539^*$ ,  $p=0.016$ ), track start ( $r=0.489$ ,  $p=0.046$ ) and kick start ( $r=0.663^{**}$ ,  $p=0.004$ ). Moreover at 180 degree/s positive relationship was found for rear leg in kick start technique between knee extension peak torques and flight distance ( $r=0.506^*$ ,  $p=0.032$ ). There was no relationship at rear leg in grab and track start techniques ( $p>0.05$ ). Same as 60 degree/s, knee flexion peak torques were not related with flight distance at 180 degree/s in all three techniques. Discussion Our results showed that at 180 degree/s isokinetic knee extension strength was positively correlated with flight distance at front leg for all start techniques. Previous studies have also reported significant correlation between the contractile properties of leg extensor muscles and start performance (Đurovic et al., 2015). Differently from grab and track start techniques, at 180 degree/s positive correlation was found at rear leg between knee extension strength and flight distance in kick start technique. In kick start position swimmer's back leg is positioned on an incline plate. Therefore, the horizontal component of ground reaction force on the kick plate during push off is bigger, compared to other techniques. It is reported that bigger horizontal force in kick start leads to higher horizontal velocity, thereby longer flight distance (Honda et al., 2011; García-Ramos et al., 2015). This could mean that the contribution of rear leg extensors to the start performance is more significant at kick start. Contact goktug.sanli@marmara.edu.tr

### STROKE VARIABLES OF JUNIOR PADDLERS IN 200-M SPRINT KAYAKING

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**Introduction** Sprint kayak is competed over 200-m, 500-m, and 1000-m distance. In theoretically, kayak velocity ( $V_{kayak}$ ) is a product of stroke rate (SR) and displacement per stroke (DPS). However, previous study has not been reported these classical variables of junior paddlers. Therefore, the purpose of this study was to clarify the relationship between the  $V_{kayak}$  and stroke variables in the junior paddlers of the 200-m sprint kayaking. **Methods** We analyzed 52 junior male paddlers (Race time:  $43.177 \pm 2.044$ sec). Also, subjects were divided into Good ( $n = 12$ , Race time:  $40.486 \pm 1.154$ sec) and Poor ( $n = 15$ , Race time:  $45.583 \pm 1.116$ sec) groups according to race time. The race movies were collected at the Japan Canoe Sprint Junior Championship in 2015 in Fujikawaguchiko-machi using three video cameras. During the competition, three parts of durations; 0-25m (Initial part), 100-125m (Middle part), and 175m-200m (Finish part) were selected for the analysis such as  $V_{kayak}$ . In each part, consecutive 6 stroke time was determined for the calculation of the SR. DPS was calculated by dividing the  $V_{kayak}$  at the SR. Pearson's correlation coefficients were used to examine the relationships between  $V_{kayak}$ , SR, and DPS in all subjects. Further, the two-way repeated ANOVA was performed to examine the effect of different groups and sections on  $V_{kayak}$ , SR, and DPS. A Bonferroni post hoc multiple comparison test was performed if a significant main effect was observed. In each statistical analysis, the level of significance was set to be  $p < 0.05$ . **Results and Discussion** A significant positive correlations were found between  $V_{kayak}$  and SR (Initial part:  $r = 0.401$ ,  $p < 0.01$ , Middle part:  $r = 0.733$ ,  $p < 0.001$ , Finish part:  $r = 0.535$ ,  $p < 0.001$ ). In addition, a significant positive correlation was found between  $V_{kayak}$  and DPS only at the Initial part ( $r = 0.382$ ,  $p < 0.001$ ). These results of the presents study agrees with past findings that SR was significantly related to kayak velocity in adult paddler due to the decrease water phase time [McDonnell et al. 2013].  $V_{kayak}$  and SR of initial, middle, and finish was significantly higher in the good groups ( $p < 0.01$ ,  $p < 0.01$ ), however, DPS was did not differ between two groups. According to a previous study, SR of international adult paddlers was higher than in the national paddlers (Brown et al. 2011). Thus, these results suggest that the kayak performance time differences between good and poor paddlers can be maintain attributes to SR difference. **Conclusions** Key factor to improve the performance in the 200-m sprint kayaking should increase the stroke rate without loss of the displacement per stroke. **Reference** McDonnell L. K., Hume P. A., Nolte V. (2013). *Sports Biomech*, 1-16. Brown M. B., Lauder M., Dyson R. (2011). *Int J Perform Anal Sport*, 171-183. Contact {tomoyahira-no@outlook.jp}

### THE INFLUENCE OF DRAG IN THE EXTERNAL MECHANICAL WORK OF CROSS-COUNTRY SKIING

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**Introduction** Classical cross-country skiing (CSS) can be performed using three main techniques: diagonal stride (DS), double poling (DP), and double poling with kick (DK). In CSS, the mechanical external work ( $W_{ext}$ ) was recently estimated by Pellegrini et al. (2014) in skiers while they roller skied on a treadmill at 14 km·h<sup>-1</sup> (and a 2° slope) and found to be: 0.87, 0.70 and 0.79 J·m<sup>-1</sup>·kg<sup>-1</sup> for DS, DP and DK, respectively. In that paper, external work was calculated based on the kinetic and potential energy changes of CoM at each stride and by taking into account the work done to overcome frictional forces; however, in that study, the effects of air resistance (drag) on  $W_{ext}$  was not investigated. The aim of this study was to estimate air resistance (at this slope and speed and in these three techniques) based on intra-cyclic measures of frontal area (as recently proposed by Gatta et al. 2015 in swimming). **Methods** Four cross-country skiers (3M/1F) were asked to roller ski at 14 km·h<sup>-1</sup> (and a 2° slope) on a treadmill (H/P, Saturn 300/100r, Cosmos, Germany) using DS, DP and DK techniques. All trials were video-recorded with a camera (Elixim Casio, 100 Hz) positioned behind the skier. The ImageJ software was utilized to calculate frontal area (A) in five "positions" during the cycle (DS = left propulsive phase; rolling phase; right propulsive phase; rolling phase; left propulsive phase; DP = pole contact; pole propulsion; propulsive phase; rolling phase; pole contact; DK = pole contact and propulsion; left propulsive phase; rolling phase; right propulsive phase; pole contact). Drag force was calculated by means of the pressure drag equation:  $F_d = \frac{1}{2} \cdot A \cdot C_d \cdot \rho \cdot v^2$ ; where  $C_d = 1$ ,  $\rho = 1.18$  and  $A$  = average frontal area. **Results** Average frontal area was  $0.930 \pm 0.056$ ,  $0.987 \pm 0.139$  and  $0.928 \pm 0.134$  m<sup>2</sup> in DS, DP and DK, respectively. The intra-cyclic variations in  $A$  were  $6.0 \pm 3.8$ ,  $12.5 \pm 6.5$  and  $6.7 \pm 1.7$  % in DS, DP and DK.  $F_d$  was  $7.46 \pm 0.45$ ,  $7.93 \pm 1.11$  and  $7.45 \pm 1.07$  N in DS, DP and DK, respectively. **Discussion** This is the first study (to our knowledge) that attempts to estimate drag resistance in CCS based on measured values of frontal area. The larger intra-cyclic variations were observed in DP (12.5%) whereas small differences were observed in the other two techniques (6-7%). In % of total external work ( $W_{ext} + F_d$ ) air resistance was of about 9-14%, in all techniques. This indicates that  $F_d$  could not be neglected when external mechanical work is calculated in this form of locomotion. **References** Gatta G., Cortesi M., Fantozzi S., Zamparo P. (2015). *Hum. Mov. Sci.*, 39, 41-54. Pellegrini B., Zoppirolli C., Bortolan L., Zamparo P., Schena F. (2014). *J. Exp. Biol.* 217 (21), 3910-3918.

## Mini-Orals

### MO-PM38 Training & Testing: HIIT

#### HALF-TIME RE-WARM UP WITH REPEATED BOUTS OF EXERCISE IMPROVES SUBSEQUENT INTERMITTENT EXERCISE PERFORMANCE IN FOOTBALL REFEREES

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**Introduction** The previous review suggested that an active continuous half-time re-warm up is effective for attenuating the reduction of physical performance (Yiannis, 2014). In addition, the review suggested that more research is needed to investigate the effect of different frequencies of exercise during the half-time on subsequent physical performance (Yiannis, 2014). Moreover, there was no literature to investigate the effects of the re-warm up on blood metabolites including creatine kinase (CK), a marker of muscle damage. Therefore, the purpose of the present study was to examine the effects of a re-warm up with repeated bouts of running exercise (RWR) during the half-time period on subsequent intermittent exercise performance and blood metabolites. **Methods** Ten male referees ( $22 \pm 1$  years,  $173.6 \pm 5.8$  cm and  $67.2 \pm 6.4$  kg) were required to complete two trials (i.e., Control (seated rest) and RWR) administered in a randomised counterbalanced order. The two trials consisted of the Loughborough Intermittent Shuttle Test (LIST), half-time and Yo-Yo Intermittent Recovery



Test level 1 (Yo-Yo test) periods. In the half-time period, participants either rested on the chair (Control) or RWR for 15 min. The RWR protocol consisted of repeating 2.15 min of a passive recovery, followed by 2.15 min of running at 70% of HRmax for 13 min. The re-warm up started 1 min after the start of the half-time period and ended 1 min before the start of the Yo-Yo test period. Yo-Yo test performance, plasma glucose, serum fatty acids (FFA), serum triglyceride (TG), blood lactate (BLa), plasma CK, the rating of perceived exertion (RPE), mean heart rate (HR) and maximal heart rate (HRmax) were analysed. Results For the distance covered during the Yo-Yo test, the RWR trial was higher than the control trial ( $3094.6 \pm 102.9$  vs  $2904.4 \pm 133.1$  m,  $p < 0.05$ ). Circulating concentrations of glucose, FFA, TG, BLa and CK did not differ between the RWR and control trials. RPE during the half-time period, but not after Yo-Yo test period, was higher than the control trial. Mean HR and HRmax during Yo-Yo test did not differ between the RWR and control trials. Discussion The present findings indicate that RWR improves subsequent intermittent exercise performance and do not affect blood metabolites response (i.e., circulating concentrations of glucose, FFA, TG and BLa). These findings suggested that energy substrates may not be a factor to improve subsequent intermittent exercise performance at least in our study. Moreover, the present study showed that RWR do not affect concentrations of CK. References Yiannis M. (2014). *Intl j Sport Std* 4: 1317-1321.

## EFFECT OF HIGH INTENSITY TRAINING AND ISOINERTIAL TRAINING ON MUSCLE FUNCTIONS IN OLDER ADULTS

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Introduction Maximal muscle strength is a strong predictor of functional skills and ability to maintain independent living in elderly. Muscle contraction properties has been shown to decline to a greater extent than muscle strength with aging and it has been considered the main responsible of the observed decline in functional status (Izquierdo et al., 1999). Endurance high intensity interval training (HIT), by involving large muscle groups, and eccentric strength exercise (IRT), by producing high mechanical loads, could be used in elderly to improve muscle function and quality of life (Milanović et al., 2015). Therefore, the aim of this study was to examine the changes in muscle properties in elderly after 8 wk of HIT and IRT. Methods 12 moderately active older adults (age:  $69.4 \pm 4.3$  yy; BMI:  $22.9 \pm 2.7$  kg/m<sup>2</sup>;  $\dot{V}O_{2max}$ :  $29.5 \pm 4.1$  mL/kg/min) have completed 8 wk of: i) HIT, 7 two-minute cycling repetitions at 90% of  $\dot{V}O_{2max}$ , 3 times/wk, and, after 4 months, ii) IRT performed with an isoinertial leg press (YoYo TechnologyAB) comprised 4x7 maximal concentric-eccentric knee extensions, 3 times/wk. Maximum voluntary contraction (MVC) was measured using a cell load in a custom-made setup (90° knee flexion). Electrically evoked muscle single twitch was superimposed onto MVC: neuromuscular activation (NA) was calculated as the ratio between the amplitudes of the superimposed and resting twitches. Muscle volume of the quadriceps (Qvol) was obtained by MRI scans. Results MVC at 90° knee flexion, increase significantly only after IRT ( $P < 0.01$ ). Both training modalities affected significantly NA ( $P < 0.05$ ): +12.4% after HIT and +14.2 after IRT. Similarly, Qvol increase by 5.1% ( $P < 0.05$ ) after HIT intervention and by 4.9% ( $P < 0.05$ ) after IRT. Discussion Our results confirm the feasibility and effectiveness of HIT and IRT to improve muscle qualities: 8 wk of specific training are able to modify muscle mass, MVC and neuromuscular activation in elderly subjects. This stresses the importance of using effective approaches such as exercise treatment with high loads and high intensities in the prevention of disuse in elderly individuals who are concurrently exposed to the deleterious effects of aging on muscle contractile function and mass (Behrens et al., 2016). We can therefore speculate that the two proposed training modalities may be helpful in improving functional status and prevent frailty in elderly subjects. References Izquierdo M, Aguado X, Gonzalez R, Lopez JL, Hakkinen K. (1999). *Eur J Appl Physiol Occup Physiol*, 79, 260-7. Milanović Z, Sporiš G, Weston M. (2015). *Sports Med*, 45(10), 1469-81. Behrens M, Brown N, Bollinger R, Bubeck D, Mau-Moeller A, Weippert M, Zschorlich V, Bruhn S, Alt W. (2016). *Appl Physiol Nutr Metab*, 41(1), 110-3.

## EFFECTS OF DIFFERENT RECOVERYS IN HIGH-INTENSITY INTERVAL TRAINING: METABOLIC AND PERFORMANCE RESPONSES.

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Abstract The aim of this study was to investigate the acute responses of high-intensity interval training (HIT) with different times and types of recoverys in metabolic and performance parameters. Eight physically active subjects ( $28.0 \pm 3.7$  years,  $75.0 \pm 10.5$  kg,  $174.1$  cm  $\pm 3.7$ ,  $49.5 \pm 5.9$  mL/kg·1min<sup>-1</sup>) underwent four protocols in randomized HIT  $\dot{V}O_{2max}$  separated by short passive recovery (PC-2min); long passive recovery (PL-8min); short active recovery (AC-2min) and long passive recovery (AL-8min). Were evaluated for each pause: performance of maximum effort, time limit (Tlim); and the removal of lactate during and after of exercise. ANOVA (1-way) with repeated measures correction factor was applied to compare the metabolic and performance parameters. Significant changes were found in performance between the two active PL and pauses ( $P < 0.01$ ), and between the PC x AL ( $P < 0.05$ ). Significant changes were found between PC Tlim x AC ( $P < 0.05$ ), AL x PC ( $P < 0.05$ ), PL x AC ( $P < 0.01$ ) and PL x AL ( $P < 0.01$ ), respectively. No significant changes were found in blood lactate during exercise in comparing any recovery's ( $P > 0.05$ ). We conclude that the use of recovery PL promotes advantage over active, it allows improvement or maintenance of performance over the maximal efforts, greater Tlim and distance travelled. Contact Email: charles\_ricardo@hotmail.com

## EFFECTS OF HIGH INTENSITY INTERVAL TRAINING ON BALANCE ABILITY AND RECOVERY TIME IN YOUNG ATHLETES

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Introduction Specifically, high intensive interval training (HIIT) may induce fatigue, which is a natural physiological response. Fatigue decreases dynamic balance ability and subsequently may negatively affect technical performance such as passing, shooting and dribbling. These technical abilities are an important component of soccer players. Therefore the aim of this study was to investigate the effects of HIIT on single leg balance ability (SLBA) and alert time for return to the origin value in young athletes. Methods Twenty one soccer players (12 males, 9 females, age =  $21.76 \pm 3.09$  years; wt =  $64.5 \pm 9.8$  kg; ht =  $169.4 \pm 7.18$  cm) with no history of lower extremity injury participated in this study. The Biodex SD balance system was used to determined to non-dominant athletic single-leg stability (ASLS). Monark cycle ergometer was used for high intensity anaerobic exercises. Each subject performed four maximal effort cycling on a electronically braked cycle ergometer against a resistance equivalent to 0.075kg/kg body mass for 30 seconds with a three-minute rest intervals. Subjects were verbally encouraged to continue pedalling as fast as possible throughout the each test. After four maximal cycling, subsequently subjects performed ASLS test and then repeated same test with a five-minute passive rest period for 4 times. Results The result of this study has indicated that, HIIT negatively effects SLBA. Furthermore SLBA turn to the baseline status after 5 minutes passive recovery

duration. Discussion The main finding was that HIIT had negative significant impact on SLBA. The finding of this study has similarities with result of previous studies (Toshimitsu et al 2011; Wilkins et al. 2004). However balance recovery time in our study was faster than previous studies (Toshimitsu et al 2011, Susco et al. 2004), these differences may be explained by the better dynamic balance on the dominant leg of soccer players (Rosario et al. 2011). References Toshimitsu I, Rebecca A.H, Ben R., Marc S.F., Recovery of time on limits of stability from functional fatigue in division II. J Strength and Conditioning Research 25:7 (2011) Wilkins JC, Valovich McLeod TC, Perrin DH. Performance on the balance error scoring system decreases after fatigue. J Athl Training 39: 156-161 (2004) Susco TM, Gansneder BM, Shultz SJ. Balance recovers within 20 minutes after exertion as measured by the balance error scoring system. J Athl Training 39:241-246. (2004) Rosario Barone, Filippo Macaluso, Marcello Traina, Vicenza Leonardi. Soccer Players have a better standing balance in nondominant one-leg stance Open Access J. Sports Medicine 2 1-6 (2011). Contact oguler@ankara.edu.tr

### **INFLUENCE OF HIGH INTENSITY INTERVAL TRAINING UNDER HYPOXIC COMPARED TO NORMOXIC CONDITIONS ON POWER OUTPUT DURING A SET OF TIME TRIALS**

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Introduction: In sports like cross country sprint events where athletes perform three to five time trials separated by 20 min breaks, the ability to regenerate is one key factor for athletes to compete successfully. The enhancing effect of high intensity interval training under hypoxic (HIITH) compared to normoxic conditions on repeated sprint ability was shown by Faiss et al (1). The question raised, whether HIIT under hypoxic conditions may even lead to superior results on repeated time trial ability. Methods: 10 endurance trained athletes were randomly divided into a hypoxic (HG FIO<sub>2</sub> 15%) and normoxic (NG FIO<sub>2</sub> 19.7%) group. They were blinded to the training conditions. Ahead (pre PT) and after (post PT) the training period performance tests were conducted on a cycle ergometer. Tests included a ramp test followed by three time trials (TT) of four min separated by a break of 20 min. HIIT consisted of two sessions per week for three weeks. Sessions included 10 min of low intensity cycling followed by n=12 (for the first four sessions) and n=14 (for the last two bouts) 15-sec all-out sprints interjected by a break of 45 sec. Power output (PO), heart rate (HR) and lactate concentration (LC) were measured. Results: There was an increase for PO in post PT compared to pre PT for both groups detected. No significant differences were found for any of the analyzed parameters between HG and NG. 30% of the athletes estimated the conditions in which they trained wrong. Conclusion: Six training sessions of HIITH didn't lead to superior results compared to the same training regime under normoxia concerning power output, lactate blood concentration, and heart rate during a set of time trials. As we expected higher effects of hypoxic compared to normoxic training we hypothesize that hypoxic training load (two sessions per week for three weeks with a total hypoxic exposure time of 256 min), the delayed time of post PT (ten days after the last training session instead of five days according to Voigt et al (2)) may have influenced PO development during the TT. References: 1 Faiss R, et al., Significant molecular and systemic adaptations after repeated sprint training in hypoxia. 2013 PLoS One 2 Vogt M et al Is hypoxia good for muscles and exercise performance? 2010 Prog. Cardiovasc Dis.

### **SPRINT INTERVAL TRAINING INVOLVING EITHER THE ARMS OR LEGS ELEVATES WORK EFFICIENCY AND ANAEROBIC CAPACITY IN THE CASE OF THE ARMS ONLY**

ZINNER, C.1,2, MORALES-ALAMO, D.3, LARSEN, F.J.4, SCHIFFER, T.A.5, BOUSHEL, R.6, ØRTENBLAD, N.2,7, CALBET, J.A.3, HOLMBERG, H.C.2,6,8

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3: IUIBS and Dep. of Physical Education, University of Las Palmas de Gran Canaria, Spain 4: Swedish School of Sport and Health Sciences, Stockholm, Sweden 5: Department of Physiology and Pharmacology, Karolinska Institute, Stockholm, Sweden 6: School of Kinesiology, University of British Columbia, Vancouver, BC, Canada 7: Institute of Sports Science and Clinical Biomechanics, University of Southern Denmark, Odense, Denmark 8: School of Sport Sciences, UiT Arctic University of Norway, Tromsø, Norway Introduction Sprint interval training (SIT) in the form of cycling by previously untrained adults improves efficiency as well as anaerobic capacity in as little as two weeks. The present study was designed to characterize and compare the effects of SIT that engages both the arms and legs on the efficiency and anaerobic performance of the limbs. Methods Sixteen healthy, untrained men ( $23.9 \pm 3.7$  yrs;  $183.8 \pm 6.8$  cm;  $80.3 \pm 14.1$  kg (means  $\pm$  SD)) performed six sessions of 4-6 30-sec all-out sprints with the legs, then arms (or vice versa) separated by a 1-h recovery over an 11-day period. A 4-min submaximal work economy and anaerobic capacity tests (2 30-sec Wingate tests with 4 min of recovery between) were carried out and muscle biopsies (from the m. vastus lateralis and m. triceps brachii) taken before and after the training period. Results Prior to the training period, the gross efficiency of the legs was higher than that of the arms ( $P < 0.05$ ) and training enhanced this parameter for the arms ( $\sim 9\%$ ,  $P < 0.05$ ), but not the legs. The accumulated VO<sub>2</sub> during the Wingate tests was higher for the legs than arms ( $P < 0.05$ ) and was greater in both sets of limbs following training ( $P < 0.05$ ), with more pronounced improvement in the arms (52 vs. 6%,  $P < 0.001$ ). The O<sub>2</sub> deficit was unaffected by leg cycling, but fell 17% ( $P < 0.001$ ) as a consequence of arm cycling, an effect observed even after taking lean mass into account and in connection with both the 1st and 2nd Wingate tests. Relative to the mean power and lean mass, this O<sub>2</sub> deficit was 4-5 fold greater for arm than leg cycling ( $P < 0.001$ ). When the data for the arms and legs were combined, the proportion of MHC I correlated positively with both the accumulated VO<sub>2</sub> during the Wingate tests ( $r = 0.57$ ,  $P < 0.001$ ) and gross efficiency ( $r = 0.60$ ,  $P < 0.01$ ), while O<sub>2</sub> deficit showed a positive relationship to MHC II ( $r = 0.28$ ,  $P = 0.04$ ). Discussion The arms have higher anaerobic capacity, as reflected by the greater O<sub>2</sub> deficit per kg of lean mass. SIT involving either arm or leg cycling for 11 days increased the accumulated VO<sub>2</sub> in both cases, but enhanced gross efficiency only in the case of the arms. The improvement in performance in both extremities was mostly explained by improvements in aerobic energy system. These findings indicate differences in limb responsiveness to SIT. Contact Christoph.zinner@uni-wuerzburg.de

### **THE EFFECTS OF INTERMITTENT HEAVY RESISTANCE TRAINING IN HYPOXIA ON DYNAMIC AND STATIC STRENGTH AND ACID-BASE PARAMETERS**

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Introduction: Intermittent hypoxic resistance training (IHRT) might lead to increase the number of metabolic products and the release of anabolic hormones compared to training under normoxia. This might lead to an increase in protein biosynthesis and, subsequently, strength. The aim of this study was to analyze the effects of a praxis-oriented multi-joint strength training program with a barbell in nor-

mobaric hypoxia compared to the same training protocol in normoxia. Methods: 23 male sport students (23.7±2.9 y, 183.0±7.0 cm, 78.1±7.1 kg) were randomly assigned into a hypoxia (HG, FiO<sub>2</sub>=14%) and normoxia (NG, FiO<sub>2</sub>=21%) training group, with a training period of 9 weeks (65 min/session, 2 times/wk) including squat (SQ), bench press (BP), dead lift (DL) and bent over row (BR) exercises, in a single blinded manner. Maximal voluntary contraction for 5 s and 30 s (MVC5, MVC30) was tested in SQ and BP, and 1RM of SQ, BP, DL and BR were tested prior to and after the intervention, respectively. 4 weeks after completion of the study, 9 participants were randomly selected to perform 2 additional training sessions in a single blinded manner at 14% and 21% FiO<sub>2</sub>, respectively, to determine acute effects on blood lactate concentration and acid-base parameters. Results: Both training groups improved 1RM in SQ (HG: Δ21.9±9.5 kg, NG: Δ21.6±13.9 kg, p≤0.001), BP (HG: Δ3.1±4.5 kg, NG: Δ4.8±7.2 kg, p≤0.01), DL (HG: Δ21.3±15.2 kg, NG: Δ35.5±21.7 kg, p≤0.001), BR (HG: Δ13.7±7.3 kg, NG: Δ20.8±10.8 kg, p≤0.001), MVC (BPMVC5= HG: Δ175.2±201.7 N, NG: Δ40.4±128.0 N, p≤0.01; SQMVC30= HG: Δ130.2±245.8 N, NG: Δ166.0±303.1 N, p≤0.05; BPMVC30= HG: Δ157.2±76.4 N, NG: Δ66.6±139.1 N, p≤0.001), without any difference in any strength gain between groups (p>0.05). pO<sub>2</sub> and sO<sub>2</sub> decreased significantly during training in HG but not in NG, while decline in pH, pCO<sub>2</sub>, and cHCO<sub>3</sub><sup>-</sup>, and increase in blood lactate concentration did not differ between HG and NG. Discussion: The hypoxic multi-joint strength training protocol improved dynamic and static strength to the same amount as the same training regime under normoxia. The more pronounced decline in pO<sub>2</sub> and sO<sub>2</sub> under hypoxia indicated that hypoxia was effective, but comparable values of pH, pCO<sub>2</sub>, cHCO<sub>3</sub><sup>-</sup>, and blood lactate clearly showed that some physiologic adaptation mechanisms like vasodilatation<sup>2</sup> were able to counter-measure tissue hypoxia under these conditions. In order to induce an additional metabolic stressor, hypoxic strength training should be performed under an even lower normobaric oxygen concentration than 14%. References: 1Scott BR, Slattery KM, Dascombe BJ. (2014). *Med Hypotheses*, 84, 145-149. 2Marshall JM. (2015). *Exp Physiol*, 100(12), 1400-1411. Contact: marius.kirmse@rub.de

## Mini-Orals

### MO-PM29 Health Promotion & Environment

#### OPEN PUBLIC SPACE AND STRUCTURES OF PHYSICAL ACTIVITY ON NEIGHBOURHOOD ENVIRONMENT AND DAILY PHYSICAL ACTIVITY AMONG BRAZILIAN ADOLESCENTS

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Introduction Combining the offer of public open spaces and the structures of physical activity (PA) on adequate neighborhoods environment may facilitate daily PA among adolescents and has been recognized an important strategy to promote PA (McCormack et al., 2010). The aim of this study was to identify associations between (1) existence of public spaces; (2) characteristics of structures for PA on public spaces; and (3) quality of the structures of public spaces with levels of daily PA among Brazilian adolescents. Methods This was a cross-sectional study comprised a school-based random sample of 176 adolescents (71 boys) recruited from 10 public schools from a city in Southern Brazil. Levels of daily PA was determined through average daily steps measured by a pedometer during three days. Adolescent's addresses were geocoded and public open spaces and structures for PA were assessed through direct observation using the Physical Activity Resource Assessment. A 500 meters linear radius from each adolescent household centroid was considered to determine individual buffers. The distance from each house to the closest public open space was calculated considering the street network connection. Structural equation modeling was used to verify the associations between variables of open space with levels of daily PA. Results The levels of daily PA of adolescents were approximately 11.590 steps per day. Only 47.2% of students have public spaces in the buffer. Existence of public spaces (β: 1899.03; p: 0.007), structures for PA (β: 2833.85; p: 0.03) and distance from the residence to the public space (β: -27.66; p: 0.001) showed association with levels of daily PA. Discussion There are just a few numbers of studies in Brazil aimed to understand the relationship between open public space and PA in adolescents (Reis et al., 2009; Lima et al., 2013). Our data analysed the relationship between daily PA and public open space by direct observation in a school-based random sample. The quality of PA structures in open public spaces did not showed association with levels of daily PA among adolescents. Nevertheless, our data showed the importance of an open public space near house with structures for PA to improving levels of daily PA and highlighted the importance of public strategies in Brazilian adolescents. References Lima A, Fermino R, Oliveira M, Rodriguez Añez C, Reis R. (2013). *Cad Saúde Publica*, 29 (8), 1507-1521. Reis R, Hino A, Florindo A, Añez C, Domingues M. (2009). *Jour of Phys Acti and Heal*, 19, 503-509. McCormack, G. R., Rock, M., Toohy, A. M., & Hignell, D. (2010). *Health & place*, 16(4), 712-726.

#### DEVELOPMENT A OF SELF-ADJUSTING RESISTANCE BY ROTATING SPEED TO PHYSICAL FITNESS EQUIPMENTS FOR ELDERLY IN NEIGHBORHOOD PARKS

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The project combines continuously variable resistance mechanism, friendly environmental requirements and needs of senior citizens to develop the physical fitness recumbent cycle in neighborhood parks. The major mechanism consists of centrifugal rollers, drive pully, driven pully, and rubber belt. The position of rubber belt in the drive and driven pully changes as pedaling speed varies. The process is mechanically controlled by the centrifugal force produced centrifugal rollers. No sensors and electricity is applied in this design. When centrifugal force is larger than the spring torque set up in the drive pully, driven pully will start to have axial displacement pushed by centrifugal rollers. This leads to the continuous variation of resistance transmission, and has effective muscle training. Further, active aging can be achieved by this physical fitness recumbent cycle. Since the gradually coming of the aging society, making elderly enjoy life through healthy promotion becomes more and more important. This project develops and establishes elderly physical fitness recumbent cycle in the neighborhood, where is easily accessed by the elderly in their daily life. Through exercises, bone and muscle system can be strengthened. Demands of the elderly based on different healthy condition can be provided by this continuously variable resistance mechanism. Meanwhile, the physical functions of elderly can be improved, and the cost of medical care will be reduced. Finally, high quality and longevity of life can be pursued through aging in place and active aging.

## EFFECTS OF OUTDOOR ACTIVITIES ON ONE'S SENSE OF SPIRITUALITY.

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**Introduction** Many studies have shown that human's health and spirituality have close relations. Moreover, our previous study revealed that there would be certain relations between the habits of daily exercise and the tendency of spirituality. It was also shown that daily exercise might strengthen one's tendency of spirituality. On the other hand, several studies mentioned that staying in the natural field could enhance one's sense of spirituality. Therefore, in this study the hypothesis that outdoor activities in the natural field can strengthen one's tendency of spirituality more than competitive sports was proposed. The purpose of this study was to examine this hypothesis. **Methods** The subjects of the study consisted of 120 male and 22 female university students. They were divided into two groups: the natural field group (NFG n=49) and the competitive sports group (CSG n=93). The NFG consisted of students who belong to outdoor activity groups like a climbing club. And the CSG was made up of students who belong to competitive sports clubs like baseball or tennis clubs. The tendency toward spirituality was measured using The Japanese Youth Spirituality Rating Scale (JYS) and The Purpose In Life Test (PIL). The tendency toward spirituality was then compared between these two groups. **Results** The NFG showed higher scores of JYS than those of the CSG. However, there was no significant difference in PIL. There was no significant difference in the results between male and female. This might mean that the NFG has higher tendency of spirituality than the CSG. **Discussion** Our previous study suggested that there was a relationship between habits of daily exercise and the tendency of spirituality. In this study, it was examined what kind of activities could more efficiently enhance one's tendency of spirituality. As a result, it was revealed that outdoor activities could enhance one's tendency of spirituality more efficiently than ordinary competitive sports. Further investigation is demanded to clear what kind of mechanisms lead to this result.

## THE RELATIONSHIP BETWEEN PHYSICAL DISCOMFORT AND COMPELLED WALKING IN JAPANESE CITY MARATHON RACES

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**Introduction** Many city marathoners wish to continue running until the finish line, which they often do by walking after 30 km during a marathon race. The factors influencing this phenomenon include running strategy and training volume (Mori et al. 2014, 2015). Moreover, it is known that this phenomenon may be accounted for by physical difficulties encountered during running, such as muscle and joint discomfort. However, it is unclear whether they relate to city marathoners becoming compelled to walk. The purpose of this study was to determine the relationship of physical discomfort and compelled walking for both men and women separately in Japanese city marathon races. **Methods** This study was undertaken at four popular city marathons held in Japan. A total of 1,410 runners (Men: n=1134, Women: n=276; Mean age,  $38 \pm 12$  years; Height,  $169 \pm 7$  cm; Weight,  $61 \pm 9$  kg; Finish time,  $4:18 \pm 1:18$ ; Monthly running distance,  $154 \pm 118$  km/month) who completed each race were surveyed. The survey questionnaire included queries on the finish time, age, body characteristics, training volume (monthly running distance), total number of marathon races participated in, whether the respondents were compelled to walk (i.e. did not drop out), and if discomfort was encountered during running. The reasons for compelled walking included muscle soreness (calf, anterior thigh and posterior thigh), joint discomfort (knee, low back, foot), as well as blister and foot soreness from wearing shoes during the race. **Results** Runners who were compelled to walk accounted for 46% and 52% of men and women respondents, respectively. Runners who were physically hindered accounted for 65% and 76% of men and women respondents, respectively as well. A higher percentage of female runners experienced joint discomfort (knee, low back, foot) compared to men. Calf soreness, anterior and posterior thigh soreness, knee, low back and foot joint discomfort were strong factors in relation to compelled walking for male runners. Calf soreness, anterior and posterior thigh soreness were significant factors in relation to compelled walking for female runners. **Discussion** Although muscle soreness (i.e. calf, anterior thigh and posterior thigh) was related to compelled walking during marathon races, joint discomfort (i.e. knee, low back, foot) was found to be a significant factor in relation to compelled walking for male runners only. Joint discomfort (in particular, the knee joint) is predominately affected by larger Q-angles. Anatomically, females have wider pelvic girdles, which can result in larger Q-angles compared to men. In fact, in the current study, a higher percentage of female runners experienced joint discomfort relative to their male counterparts. Therefore, regardless of whether female runners were compelled to walk, the majority experienced joint discomfort, which may therefore not have been a strong factor in relation to compelled walking. **Reference** Mori H., Yamamoto M. (2014). ECSS books of abstracts, 593-594. Mori H., Nabekura Y., Yamamoto M. (2015). ECSS books of abstracts, 158.

## RESEARCH ON PROMOTION OF WINTER SPORT PARTICIPATION IN CHINA

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**Research on Promotion of Winter Sport Participation in China** **Introduction** In 2015, Beijing won the bid to host the 2022 Winter Olympics united with Zhangjiakou, which leads to massive surge of winter sport participants in China. Currently, Chinese Olympic Committee is implementing the "Encouraging 300 Million People to Participate in Winter Sport" program. Winter sport in China enjoys a long history but its base is relatively weak and the participants are limited to people from northern China. In order to achieve the target of bringing 300 million Chinese to winter sport, some further measures need to be adopted. **Methods** This paper tries to summarize and analyze the status quo of winter sport participation in China. On this basis, a few suggestions for further enhancing the participation level of winter sport in China have been proposed. The methods of literature research, expert interviews and comparative analysis are applied in this paper. **Results** Firstly, the southern and western regions in China should be attached more importance. The northeast region is the traditional base for winter sport in China. However, following the rapid economic and social development of the country, more and more people from the southern China especially the middle class are becoming skiing enthusiasts. Secondly, the construction of ice and snow infrastructure should be accelerated. The organizing committee has promised a frugal plan, with a total budget of slightly over 3 billion US dollars, split between games operation and infrastructure construction. 20 years ago, there were no more than 20 ski facilities in China, but now the number has exceeded 500. Thirdly, all aspects of social sectors should be admitted and guided to invest in the construction of winter sport facilities and operation of winter sport events. Fourthly, the role of various levels of winter sport associations should be given full play. **Discussion** With careful system design and appropriate promoting measures, we believe that the 2022 Winter Olympics will boost participation and involvement in winter sport across China. The fast development of winter sport may also change the



lifestyle of millions of Chinese and help them live a healthier and more enjoyable life. References Liu Xiaojian. (2015) Study on present situation and development strategy of mass participation in winter ice-sports in Beijing. Capital sport university, Beijing. Liu Guoyong, Yang Hua. (2015) Blue Book of Sport for All. Social Sciences Academic Press, Beijing. The State Council of China. (2011) National Fitness Program (2011-2015).

### DEVELOPMENT OF AN ALTERNATIVE SOLAR COLLECTOR USING PET BOTTLES FOR DRESSING ROOMS WATER HEATING OF THE OLYMPIC CENTRE AT UNB

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**Introduction** In sports facilities, water is very important both for sports training and for the maintenance of athletes' personal hygiene. Seeking an alternative and clean energy source, this project aims to use PET (polyethylene terephthalate) bottles as alternative solar collectors utilizing the principle of heat transfer, in order to heat the water of the facilities to better serve their users. **Methods** The model consists of a system with collector grid composed of interconnected pipes and recycled absorption plates, both wrapped in PET bottles; this is aimed by driving the water to the storage container. As water moves through the pipes, the sun light heats the water in the grid that flows through it to the top of the tank, thus creating a convection current. Data collection will be based on periodic measurement, by using specific thermometers, of the incoming and outcome temperatures of the fluid collector grids, together with the water storage container and the environment temperature. It will be measured the time required to acquire the average temperature of the fluid mass in the heat tank, through a digital precision chronometer. **Results** It is expected that the prototype, with a daily intense sunlight of 6 to 8 hours, can achieve an average temperature of the water column in the tank about 45 degrees Celsius. With this result the solar collector using PET bottles can be used as an alternative way to heat water in sports venues. In our case, the prototype will be used in the dressing rooms for shower heating. **Discussion** Heating water with an alternative solar collector using PET bottles can be a cheaper and environment friendly solution for sports facilities and sports venues, depending on the climate conditions. We expected an energy consumption economy of 35% in our showers heating system. The system can also be used for swimming pools with bigger solar grids. **References** CAMILA, R.; DENISE, T.; ROCHA, P. G. Cenários para a Matriz Elétrica 2050. In: Plataforma Cenários Energéticos – PCE Brasil 2050. 1, 2015, Brasília. Algumas conclusões e desafios para uma matriz energética sustentável até 2050, Distrito Federal, APEX Brasil. p. 49 (Publicação digitalizada). PINTO, C. F. Em busca de uma arquitetura sustentável: o uso de fontes alternativas de energia. São Carlos: Escola de Engenharia de São Carlos, 12 de setembro de 2009. (Dissertação de Mestrado em Arquitetura, urbanismo e tecnologia). SANTOS, N. R. G. DOS. Projeto, Construção e Análise de Desempenho de Coletores Solares Alternativos Utilizando Garrafas PET. Natal: Universidade Federal do Rio Grande do Norte, março de 2007. (Programa de pós-graduação em Engenharia Mecânica). Contact leonardo3367@hotmail.com

## Mini-Orals

### MO-BN05 Biomechanical Testing

#### EFFECTS OF COMBINED BALANCE AND STRENGTHENING EXERCISES ON POSTACTIVATION POTENTIATION AND PERFORMANCE IN FEMALE YOUTH ATHLETES

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**Introduction** It is well-known that different conditioning activities can improve muscle contractile properties possibly inducing acute enhancements in proxies of athletic performance (Sale, 2002). Furthermore, balance training appears to have facilitating effects on subsequent strengthening exercises (Bruhn et al., 2006). Thus, the purpose of the present study was to examine the acute effects of a combined conditioning activity (i.e., balance and strength [B+S]) vs. a single conditioning activity (i.e., strength only [S]) on twitch contractile properties, maximal voluntary strength, and jump performance in youth athletes. **Methods** Female elite youth soccer players (N=12, age: 14-15 yrs) were tested for electrically-evoked isometric twitches and maximal voluntary contraction (MVC) torque of the plantar flexor muscles. In addition, they completed countermovement jumps (CMJ) and drop jumps (DJ) in randomized order before and after two conditioning activities (B+S, S) and a resting control period. S included 3 series of 8-10 dynamic leg extensions at 80% of the one repetition maximum whereas B+S comprised 3 series of 40s double-leg stances on a balance board prior to leg extensions (same as S). Twitch peak torque, twitch rate of torque development, MVC torque, CMJ and DJ height as well as DJ contact time were assessed. **Results** Repeated measures ANOVA indicated significant effects of conditioning activities on twitch contractile properties ( $p < .05$ ,  $d = 1.1$ ) and performance outputs ( $p < .05$ ,  $1.1 \leq d \leq 1.2$ ). Post-hoc tests revealed that postactivation potentiation was larger by trend for twitch peak torque ( $p = .07$ ,  $d = 1.8$ ) and significantly larger for twitch rate of torque development ( $p < .05$ ,  $d = 2.4$ ) following S (33 and 55%) but not B+S (25 and 45%) when compared to control (21 and 42%). In contrast, CMJ height was significantly higher (3%,  $p < .01$ ,  $d = 1.9$ ) and DJ contact time was significantly shorter (10%,  $p < .01$ ,  $d = 2.0$ ) following B+S but not S compared to control. **Discussion** This study revealed acute improvements in twitch contractile properties following S and significant increases in jump performance following B+S only. Thus, it appears that postactivation potentiation effects in the triceps surae do not directly translate to improved jump performance in female youth soccer players. Muscle contractile properties appear to be affected by type and/or volume of the conditioning activities. Thus, it can be speculated that gains in jump performance following B+S are related to neuromuscular changes (e.g., intermuscular coordination) rather than improved contractile properties. **References** Sale DG (2002). Exerc Sports Sci Rev, 30, 138-143. Bruhn S, Kullmann, N, Gollhofer, A (2006). Int J Sports Med, 27, 401-406. Contact prieske@uni-potsdam.de

## BIOLOGICAL VARIATION AND DEVICE ERROR IN VERTICAL JUMP HEIGHT WITH TWO TYPES OF MEASUREMENT SYSTEM

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**Introduction** Vertical-jump tests are used to evaluate lower-body power of athletes and non-athletes. The aim of this study was to compare two methodologies for such tests: the popular and convenient jump mat, and a criterion method, motion capture by video analysis. **Methods** Thirty-one young adult males (15 rowers and 19 non-athletes) alternated four countermovement jumps (CMJ) with four standing jumps (SJ). Jump height was measured with a commercially available jump mat and simultaneously by video. The modifying effects of foot length on the two measures of jump height were estimated with a mixed model, which also allowed separate estimation of errors arising from the subject and from the device. Effects were evaluated using standardization and non-clinical magnitude-based inference. **Results** Countermovement jump height was  $34.4 \pm 6.2$  cm and  $47.8 \pm 6.8$  cm for the jump mat and video respectively (mean  $\pm$  SD). Foot length had a clearly positive small effect on jump height for the video compared with the jump mat ( $1.8 \pm 0.6$  cm per 3 cm of foot length for CMJ, mean  $\pm 90\%$  confidence limits; similar effect for SJ). Adjustment to zero foot length removed most of the difference in jump height between the methods, although the remaining difference was unclear. Within-subject variability for CMJ and SJ were both 1.5 cm (SD, 90% confidence limits  $\pm 0.2$  cm). Device errors with jump mat and video were similar for CMJ (SD 0.7 and 0.8 cm respectively), but less with the jump mat for SJ (SD 0.2 and 0.8 cm respectively). **Discussion** The substantial difference between jump height with the jump mat and video can be explained by the effect of foot length on the way flight time is recorded on the jump mat. Both methods contributed a similar substantial amount of error for countermovement jumps, but surprisingly, the jump mat had less error for standing jumps. We conclude that a jump mat provides trustworthy measurements for monitoring changes in jump height.

## VALIDATION OF THE MICROSOFT KINECT™ FOR EVALUATING KNEE JOINT ANGLE IN SQUAT EXERCISE

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**Introduction** Microsoft Kinect™ (MK) is a markerless, cheap and suitable technology that could be used to replace more complex video analysis instruments (Bonnechère et al., 2014). Due to high price and poor transportability of marker-based system, MK can be a useful instrument for sport scientists to analyse athletes' movement. Thus, the aim of this study was to investigate the concurrent validity of the MK compared to a low cost video analysis software such as Kinovea (Ki) in the measure of knee joint angles (KJA) during a slow squat motion. **Methods** Thirty-seven males took part in this study ( $28.29 \pm 13.56$  yrs,  $75.05 \pm 8.92$  kg, and  $180.37 \pm 8.21$  cm). Participants were asked to perform three repetitions of squat exercises at three different KJA (i.e., quarter squat (QS), half squat (HS), and full squat (FS)). The KJA was measured during the three squat exercises by MK using LabVIEW (National Instrument, USA) and Ki (V0.8.15). In order to detect differences and interaction among squat exercises and between MK and Ki, two-way ANOVA RM corrected for Greenhouse-Geisser adjustment was performed. The magnitude of the difference was evaluated by partial eta squared (part  $\eta^2$ ). Pearson Correlation Coefficient (r) was computed to evaluate the relationship between MK and Ki in each squat exercise. The agreement of the two methods was assessed using a modified Bland-Altman analysis (B-A) corrected for repeated measurements. The systematic bias (mean absolute difference, calculated as Ki-KN) and limits of agreement [LOA (1.96 SD of the bias)] were calculated. **Results** The two-way ANOVA RM showed significant interaction among KJA in the squat exercises and between MK and Ki ( $F(1.541,55.528)=16.053$ ,  $p<0.001$ , part  $\eta^2=0.308$ ). A significant correlation between MK and Ki was found in each squat exercise (QS:  $r=0.742$ ,  $p<0.001$ ; HS:  $r=0.714$ ,  $p<0.001$ ; FS:  $r=0.832$ ,  $p<0.001$ ). A systematic bias of  $28.24$  [ $8.04 - 48.45$ ] degrees was detected by B-A. **Discussion** While the MK ability to track a human figure is acceptable for videogame, MK measurement accuracy is not acceptable for athletes' analysis (Pfister et al., 2014). The systematic bias found between KJA may be explained by different anatomical landmarks estimated by MK (i.e., anterior superior iliac crest) and used in Ki (i.e., greater trochanters) as affirmed by Schmitz et al. (2015) that compare the MK to a marker-based system. **References** Bonnechère B, Jansen B, Salvia P, Bouzahouene H, Omelina L, Moiseev F, ... Van Sint Jan S. (2014). Gait Posture, 39(1), 593–598. Pfister A, West AM, Bronner S, Noah JA. (2014). J Med Eng Technol, 38(5), 274–280. Schmitz A, Ye M, Boggess G, Shapiro R, Yang R, Noehren B. (2015). Gait Posture, 41(2), 694–698.

## THE EVALUATION OF AUTOMATICALLY DETECTED ELECTROMYOGRAPHIC THRESHOLDS

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1: UG (Graz, Austria), 2: AU (Aarhus, Denmark) **Introduction** Electromyographic thresholds (EMGT) can provide individual muscle-specific feedback during incremental tests non-invasively. However, the determination of thresholds depends on signal processing methods [1] and often includes active as well as passive phases of movements, which might bias results. Therefore, the aim of this study was to compare visually and mathematically detected EMGT calculated from active movement phases only. **Methods** Seven trained triathletes performed an incremental test on a cycle-ergometer. The respiratory compensation point (RCP) was determined using the VE versus VCO2 relationship [2]. EMG signal was measured continuously (3000 Hz) from vastus lat. (VL) and rectus fem. (RF) of both legs. In a computer-aided, semi-automatic step the activity intervals were registered manually and were used to assess the noise level. In a second step, the data were segmented into signal and pure-noise parts, followed by stabilizing the noise-signal-indicator [3]. Subsequently, several EMG parameters (integrated RMS, maxRMS, mean frequency) were calculated and time courses analyzed by 2 blinded peers to detect thresholds visually (EMGTv). Furthermore, EMG parameters were automatically fitted by minimizing the overall mean square error of three regression lines. A break between the second and third line was interpreted as the EMG threshold (EMGTa). Comparison of the methods was conducted by a repeated measures ANOVA and Pearson's correlation coefficients. **Results** Although several parameters showed a similar behavior, the integrated RMS appeared to be the most consistent signal to detect EMGT visually (EMGTv:100%). No significant difference was found between EMGTv, EMGTa and RCP ( $p>0.05$ ) for both RF, and left VL. EMGTv and EMGTa did not differ significantly for right VL, but both were significantly different from RCP ( $p<0.05$ ). Medium to high correlations were found between EMG thresholds and RCP ( $r=0.62-0.98$ ). **Discussion** The main outcome of this study was that muscular thresholds could be detected visually and automatically from the integrated RMS of active phases of the EMG signal in RF and VL during incremental tests. Comparisons to ventilatory thresholds revealed better agreement in RF than in VL. This could be explained by heterogeneity in muscle recruitment during incremental tests [4]. **References** [1]Camata, TV, Lacerda, TR, Altamirani, LR, Bortolotti, H, Fontes, EB, Dantas, JL, Moraes, AC. (2009). Electro-myography Clin Neur, 49(6), 305–310. [2]Beaver, WL, Wasserman, K, Whipp, BJ. (1986). J Appl Physiol, 60(6), 2020–2027. [3]Cressie, N, Serra, J.

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## AN OBSERVATIONAL STUDY OF STROKE SYNCHRONISATION IN CREW-BOAT SPRINT KAYAKING

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**Introduction** The four-seater K4 is the largest crew-boat in Olympic sprint kayaking. Four paddlers work in unison to propel their boat over distances of 200-, 500- or 1000-m in the shortest time. The role of stroke synchronisation in successful crew-boat performance has been debated; some think that perfect synchronisation is essential (e.g. Wing and Woodburn, 1995), while others think a slight asynchronicity in the blade movement is important (de Brouwer et al., 2013). The aim of this study was to identify the extent of stroke synchronisation for a K4 200-m crew. **Methods** High-speed (120 Hz) video of a men's K4 200-m crew from a national team was recorded from the sagittal view during a selection timetrial. Video analysis was performed to identify the stroke positions (catch, immersion, extraction and release) of each paddler in the K4, based on McDonnell and colleagues' model (2012). An offset variable, defined as the timing difference between a paddler compared to the first-seat paddler, was obtained for each paddler. The offset was interpreted as either negative, zero, or positive e.g. a negative offset occurs when the back paddler catches before the 1st seat paddler. For all offset variables, mean and 95% CI was calculated. **Results** The performance timing was 31.87 s. A total of 41 strokes (excluding the first 3 acceleration strokes) were analysed. The mean absolute offset was 90 [79, 100] ms. At the specific stroke positions, the values were: catch 89 [79, 94] ms, immersion 71 [65, 78] ms, extraction 104 [90, 119] ms and release 96 [86, 107] ms. By paddler position, the offsets were: 2nd seat 39 [34, 45] ms, 3rd seat 4 [-1, 9] ms and 4th seat 16 [8, 24] ms. **Discussion** The results show a tendency for positive-offset synchronisation patterns for the crew, where the 2nd, 3rd, and 4th seat paddlers are slower than the 1st seat paddler. The crew was more synchronised at the immersion position, and least synchronised at the release position. This adds a new perspective to the crew-boat stroke synchronisation theories, that perhaps it is important to be synchronised at one part of the stroke but slightly asynchronised at the other positions. Interestingly, it was the 2nd seat paddler that was most out-of-sync to the 1st seat paddler despite being the closest and having the best view to follow the 1st seat paddler's movements. This highlights the need for future studies to uncover the mechanisms of how synchronisation is achieved. Besides Olympic sprint kayaking, such information would also be useful for other similar sports with crew-boat racing like rowing and dragon boat racing. **References** de Brouwer AH, de Poel HJ, Hofmijster MJ (2013). PLoS One, 8, e54996. McDonnell LK, Hume PA, Nolte V (2012). Sports Biom, 11(4), 507-523. Wing AM, Woodburn C (1995). J Sports Sci, 13(3), 187-197. Contact cheryltsh@gmail.com

## KNEE MUSCLE TENDON COMPLEX FORCES RATIO DURING SQUATTING

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**Introduction** Squatting is one of the most frequently used exercise for strength development. Involvement of different knee muscles in force/torque participation depending on movement pattern and knee angle is point of interest of sport scientists and coaches. Two phenomena influence on the knee muscle tension during squatting: knee angle (lengthening and shortening of the vastus medialis (VM) and vastus lateralis (VL) and muscles contraction. Using MC sensor (TMG-BMC Ltd.) for muscle and tendon tension measurement we try to find relationship between knee torque and VM and VL and knee torque and tension in patellar tendon. The MC sensor [1, 2] is a wearable ( $m < 1.5$  g) sensor that measures muscle and tendon tension/force. The aim of our study was to find angle dependent relationship between directly measured muscle tension on vastus lateralis, vastus medialis and knee torque during controlled squatting as well as relationship between directly measured patellar tendon and knee torque. **Methods** Thirteen international level athletes (eight male and five female, age 20-31) were measured during squatting. Tension forces of VM, VL and patellar tendon were measured with the MC sensor with 1 kHz sampling rate. Athlete's movements were captured with accelerometer for knee angle detection. To standardize motion as much as possible, the Smith machine was used. **Results** We calculated knee torque divided by each muscle tension – knee torque divided by MC(VL), knee torque divided by MC(VL) and knee torque divided by summation of MC (VM) and MC (VL). The maximum of ratio between torque and MC (VL) was when the movement was upward – at the angle 20 degrees. The maximum of torque divided by MC (VL) was at 20 degrees also, but when the movement was downward. The ratio between patellar tendon tension and knee torque was linear. The coefficient of determination ( $R^2$ ) was 0.98. **Discussion** The basic idea was to try to determine the tension of individual muscles and tendons at different knee torque during defined squatting movement. We found very different tension relationship comparing tension of VL and VM with knee torque and patellar tendon tension- especially comparing eccentric and concentric part of muscle contraction (down and up phase of squatting). The peak of the quotient between knee torque and VM or VL tension have different knee angle dependencies as well. Additional research on knee muscle/tendon mechanics will be necessary for understanding load distribution during different squatting movement. **References** [1] S. Đorđević et al, Sensors 2011, 11(10):9411-25. doi: 10.3390/s111009411 [2] S. Đorđević et al, Sensors 2014, 14(9):17848-17863. doi: 10.3390/s140917848 Contact srdjandj@tmg.si

## OFFICIAL MATCH BALL DIFFERENCES: WHAT PLAYERS RECOGNIZE

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**Introduction** Football equipment has increasingly become a subject of scientific research. While official match balls (OMB) are evaluated intensely through mechanical testing, less new findings consider the actual football players' perception. This comparative benchmark study investigated subjective player perception of three OMBs by examining ratings of specific ball criteria and its correlation with playing surfaces and player positions. **Methods** Three certified FIFA match balls (Nike Ordem 2 Hi-Vis, adidas torfabrik & Derbystar Brilliant APS) have been tested. Prior to testing, crucial ball criteria were identified through guideline-based interviews with eight experienced players. Consecutively, 82 players ( $23.4 \pm 3.0$  years; 3rd - 5th German league) took part in the core study. Balls were tested in randomized order. Participants performed a supervised, standardized test trial and three respective team training sessions. Perception was quantified by completing a questionnaire, which aimed at player-ball interface and general influence factors, likewise. Ranking was conducted according to a 10-point Likert scale. Reproducibility of test design was assessed through repeated measures. **Results** The preceding interview yielded 8 major characteristics such as flight behavior, energy transmission and grip. Players perceived significant differences between the balls for energy return, grip, design, roundness, visibility and size. Intra class correlation coefficient of repeated measures confirmed excellent reproducibility ( $r > 0.9$ ). The players' position correlated with most perception criteria. No statistical evidence was

found between natural and artificial ground conditions concerning overall ball ratings. Discussion Identified perception criteria confirmed and expanded findings by Roberts et al. (2009). While mechanical tests can explain the interrelationships of e.g. panel number and ball aerodynamics (Asai and Seo, 2013), these test fail to quantify the desirability of ball characteristics (i.e. grip and flight behavior) in relation to players' position. In this study, participants were able to differentiate between individual characteristics of OMBs. Thus, this work presents a reliable approach to quantify players' perceptions. It is suggested that the quantification of subjective player perception can highly contribute to the understanding and evaluation of specific design criteria and the process of development. References Asai T, Seo K (2013). SpringerPlus, 2(171), 1-5. Roberts J, Neilson P, Harland A, Jones R (2009). Science and Football 6, 24-28. Routledge, New York. Contact stu89375@mail.uni-kiel.de

## ACCURACY OF NINE ACTIVITY TRACKERS FOR THE MEASUREMENT OF STEPS, ENERGY EXPENDITURE AND DISTANCE

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**Introduction** In the last ten years there was an increasing development of wearables and activity trackers. Besides the use by the general population for activity tracking, wearables might also be beneficial for (elite) athletes to monitor their training load and their physical activity during leisure time. Currently, the training load even in elite sports is often not determined or only assessed by the measurement of heart rate or by asking the perceived physical strain after training sessions (Düking et al. 2016). Physical activity during leisure time is usually not determined. For the general use, but especially for the use in elite sports, these activity trackers need to measure accurate and valid. Especially for elite athletes accuracy needs to be given for a broad spectrum of velocities or even fast changes in velocities. Therefore, the aim was to evaluate the validity of eleven activity trackers for measuring step counts, energy expenditure and distance under laboratory conditions with different constant and varying velocities. **Method** Twenty healthy sport students (10 men, 10 women; mean age:  $25.2 \pm 2.7$  years; height:  $175.3 \pm 9.4$  cm; weight:  $70.6 \pm 13.3$  kg) performed a running protocol consisting of four 5 min stages of different constant velocities (4.3; 7.2; 10.1; 13.0 km/h-1) and a 10 min period of intermittent velocity while wearing nine different activity trackers (Beurer AS 80, Fitbit Charge, Fitbit Charge HR, Garmin Vivoactive, Garmin Vivofit, Garmin Vivosmart, Polar Loop, Sensewear Bodymedia, Withings Puls Ox). Energy expenditure, steps and distance were evaluated by comparing each activity tracker with a reference method (indirect calorimetry, Optogait system, treadmill). **Results** Steps differed significantly for the Sensewear, Polar and Beurer for all velocities, and for the Fitbit Charge for 4.3 and 13.0 km/h and for Withings for 13.0 km/h and the intermittent protocol. All trackers showed significantly different distances at 4.3 km/h, 7.2 km/h and 10.1 km/h. At 13.0 km/h only Withings and for the intermittent protocol Garmin Vivofit showed good agreement. Although not for every single velocity the Garmin devices (-Viofit, -Vivosmart, -Vivoactive) and the Fitbit charge showed the best agreements. **Conclusion** Of all three determined parameters, the number of steps is the most valid measure over all velocities. Three devices measured steps accurately over all velocities. Furthermore, only three devices showed an accurate measure of energy expenditure in 3 of 5 velocities. The measurement of distance is inaccurate for all devices over all velocities. Due to these limitations, activity trackers cannot be used for the quantification of training load in elite sports. References Düking P et al. (2016). Front Physiol Contact: Y.Kilian@dshs-koeln.de

## Mini-Orals

### MO-BN08 Balance & Posture

#### THE LEVEL OF BODY BALANCE IN A HANDSTAND AND THE EFFECTIVENESS OF SPORTS TRAINING IN GYMNASTICS

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**Introduction** The aim of the study was to determine the level of maintaining body balance in a handstand among gymnasts at the stage of directed and championship training and to prove a relationship with the sports result, taking into account the difficulty and the quality of exercises. **Methods** The study involved boys aged 11-12 years systematically training gymnastics ( $n = 20$ ) and 12 experienced gymnasts aged 18-26 years with an accomplished international class ( $n = 12$ ). The study was conducted prior to the apparatus trial, on the day preceding competition in an official sports tournament. The 10-sec measurements of the body balance in a handstand was performed on an AccuGait force plate. The assessment of the effectiveness of sports training was made on the basis of judges' scores protocols from official sports competitions. **Results** An analysis of the tests showed significant differences in the level of maintaining the body balance in a handstand. The largest one was reported in mean values of Area 95, whose field in experienced athletes was less than half the size ( $8.16 \pm 8.06$  cm<sup>2</sup>) of the younger group ( $19.81 \pm 8.74$  cm<sup>2</sup>). In both groups, Area 95 showed to be significantly ( $p < 0.05$ ) correlated with sport results, although younger group had higher correlation with the quality ( $r = -0.538$ ) while the adults with the difficulty ( $r = -0.755$ ) of the exercises. Discussion In contrast with other authors' analyses, the present research on body balance in a inverted stance has shown significant differences between experienced and inexperienced gymnasts (Vuillerme et al., 2001; Asseman et al., 2005; Gautier et al., 2009). Attention is also drawn to much higher results of body balance in the medio-lateral axis rather than the antero-posterior one in both groups. This data may confirm the importance of the mobility of wrist and shoulder joints in the sagittal plane in a strategy to maintain body balance in a handstand (Kerwin et al., 2001). **Conclusion** Analysis of correlations of body balance in a handstand with the level of sports preparation has helped demonstrate that the level of this skill specific to artistic gymnastics improves throughout sport experience and has great significance in developing elite athletes. References Asseman F, Gahery Y. (2005). Neuroscience Letters, 375, 134-137. Gautier G, Marin L, Leroy D, Thouvarecq R. (2009). Human Movement Science, 28, 129-140. Kerwin DG, Trewartha G. (2001). Medicine and Science in Sports and Exercise, 33, 1182-1188. Vuillerme N, Teasdale N, Nougier V. (2001). Neurosciences Letters. 28, 311(2), 73-76. Contact andrzejkochanowicz@o2.pl



## ADJUSTED CUSHION SHOE CAN CORRECT FOOT POSTURE BUT NOT ALTER POSTURAL CONTROL OF UPRIGHT STANDING IN PEOPLE WITH FLEXIBLE FLATFOOT

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Clinically, flat foot is characteristic of lower medial longitudinal arch and heel pronated, which consists of flexible and congenital flat foot. Adjusted cushion shoe can provide an additional support for medial arch with inserted plates to improve the alignment of bone structure in medial side of the foot. We hypothesized that this intervention may significantly improve the alignment of foot to improve postural control of upright standing in recreational athletes with flexible flatfoot. A total of 24 subjects (12 with flexible flat foot and 12 health controls with age- and gender-match) were participated in this study based on the inclusion and exclusion criteria. A motion analysis system and forceplate was used to collect forceplate data during upright quiet standing. The findings have shown that significant improvement in the alignment of foot bone at all plates inserted on the medial side. However, no significant change was found in the variables of center of pressure (CoP) trajectory, indicating no increase in postural control in people with flexible flat foot with adjusted cushion shoe. Changes in foot posture with foot orthotics (for example, adjusted cushion shoe) may not immediately lead to improved postural control of quiet upright standing in people with flexible flatfoot.

## EYE MOVEMENTS AFFECT POSTURAL CONTROL IN YOUNG AND OLDER FEMALES

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**Introduction:** Eye movements have been shown to affect postural control in young adults (Laurens et al., 2010). However, this has received little attention in older individuals, which is surprising given the prevalence of eye movements in everyday life, the link to postural control, and the high incidence of falls in the elderly. Here we assessed the effects of eye movements on postural control in young and older females. **Methods:** 12 young (mean  $\pm$  SD: 26.1 $\pm$ 4.9 years) and 12 older (72.8 $\pm$ 6.9 years) females without visual, vestibular or balance deficits, were presented with 10 visual scenes containing combinations of a) stimuli to initiate stationary gaze fixations, smooth pursuits and saccadic eye movements, and b) absent, fixed and oscillating large-field visual backgrounds to diminish or generate retinal flow. Postural sway and gaze errors were simultaneously assessed with a force platform (AMTI AccuPower) and eye tracking equipment (Tobii Glasses 2), and compared within scenes and between age groups. Hedges gav effect sizes were calculated for significant differences. **Results:** Within scene comparisons showed fixed backgrounds and stationary gaze fixations attenuated postural sway ( $p < 0.001$ , gav=0.96, 27.18%;  $p = 0.032$ , gav=0.40, 12.75%, respectively). In contrast, smooth pursuits and oscillating backgrounds increased postural sway ( $p < 0.001$ , gav=0.95, 30.36%;  $p < 0.001$ , gav=1.46, 48.20%, respectively). There were no differences regarding saccades. Between age group comparisons showed no differences in postural sway or gaze errors in any visual condition. **Discussion:** The stabilising effect of the fixed visual stimuli show how retinal flow and extraocular factors guide postural adjustments (Guerraz and Bronstein, 2008). The destabilising effect of oscillating backgrounds and smooth pursuits may be related to challenging conditions for sensing body shifts from retinal flow, and more complex extraocular signals, respectively. Because extraocular factors are used for postural control, discerning the contribution of retinal and extraocular components in elders at high fall risk might be an important step in understanding postural stabilisation strategies and developing fall prevention interventions. Moreover, since smooth pursuits increased postural sway, stability whilst tracking moving targets may also be affected during locomotion, which could place older individuals, typically less able to correct postural disturbances, at a greater risk of falls. However, the present results suggest declines in posture and gaze control, during quiet stance, may not be a direct consequence of healthy ageing. **References:** Guerraz M, and Bronstein A. (2008). *Neurophysiol Clin*, 38, 391–398. Laurens J, Awai L, Bockisch C, Hegemann S, van Hedel H, and Dietz V. (2010). *Gait & Posture*, 31, 37–41. Contact: Neil.thomas@cumbria.ac.uk

## THE EFFECT OF FORWARD-BENT POSTURE OF UPPER BODY IN ACCELERATION PHASE ON 100M SPRINT PERFORMANCE

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**Introduction** The technique called forward-bent posture is used in the acceleration phase of the 100m sprint running. The performance was influenced because of maintaining forward-bent posture of different distances (Ito, 2010). In this study, there were two purposes. First, to determine whether subjects can carry out accelerating with longer and shorter distance. Second, to reveal the influence of the running velocity (RV), the stride length (SL) and the stride frequency (SF) from the point of view of motion and electromyogram (EMG) of the lower extremities. **Methods** Nine collegiate sprinters run 100m sprint by using three patterns of acceleration patterns. First acceleration pattern was the usual method of raising forward-bent posture which was used in the daily training. Second and third acceleration pattern was the longer and shorter method than the usual method of raising forward-bent posture, respectively. The forward angle of every 10m in 0-40m interval were calculated. Subsequently, six collegiate sprinters run 100m sprint by using three types of acceleration patterns. RV, SL and SF were calculated. In addition, the hip, knee and ankle joints angle of 0-40m interval and EMG of gluteus maximus, rectus femoris, biceps femoris and gastrocnemius of 0-100m interval were measured. **Results** It was thought that subjects could carry out accelerating by longer and shorter. In the RV of 0-100m, the value of the longer raising method was significantly higher than that of the shorter raising one. In the SL of 0-30m, 0-40m, 0-50m, 0-60m, 0-70m and 0-90m, the value of the longer raising method was significantly higher than that of the shorter one. **Discussion** It was estimated that what the knee and ankle angle increased was caused to the reduction of the force to kick the ground because of the kick the ground with a higher center of gravity in the contact phase (Iwai, 1997). In the angle of the knee and ankle joints at the 15m and the 35m points in this phase, the value of the shorter raising method was significantly higher than the other two methods. This was likely to be shorter the stride during running. It was reported that there were the changes, and no changes in relation to muscle activity with the different joint angle of the lower limb (Ema, 2010). By comparing this, the differences in running velocity could not be explained from the amount of muscle discharge of lower limb. However, in this study, the ratio of each muscle activity might be changed among three different methods during accelerating. **References** Ito H, Ito A. (2010). Shizuoka University Faculty of Education research report, 41, 229-236. Iwai M, Ichikawa H, Ito A. (1997). 13th Society of Biomechanics tournament editorial committee body movement of Biomechanics, 173-177. Ema R, Wakahara T, Kanehisa H, Yanai T, Kawakami Y. (2010). *Sport Sciences*, 7, 109-118.

## THE EFFECT OF START POSTURE AND STEPPING RATE ON THE PULLING PERFORMANCE OF INDOOR TUG OF WAR

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**Introduction** Maintaining a high, steady pulling force while stepping backward is an important technique in indoor tug of war. Literature shows that a low start posture for stepping backward produces a higher pulling force (Guo, 2001). Furthermore, step rate and step size also play important roles in producing high pulling force (Lin, 2000). However, there has been little information about the performance variability of the backward stepping technique in indoor tug of war research. The purpose of the study was to examine the effect of starting posture and the stepping rate on the overall pulling performance of backward stepping in indoor tug of war. Methods 8 elite high school male indoor tug of war athletes volunteered for the study. The MLP-300 (Transducer Techniques) load cell, BIOPAC MP150, and AcqKnowledge 3.9 data processing systems were used for collecting force data, and a JVC camera and the Kwon3D 3.1 system were used for capturing kinematics of left shoulder, hip, knee, and ankle. All the participants performed 3 (low, middle, high posture) x 3 (2 Hz, 1 Hz, 0.5 Hz step rate) trials of pulling with stepping backward. Each trial took 30s, and 3min rests between trials. 2 way repeated measure ANOVAs were performed on the means and SDs of peak pulling force (PPF), step duration, and step length. Results Both main effects were significant on PPF. PPF increased from the high starting posture to the low one, and the 2 Hz rate had the lowest PPF. For the variability of the PPF within a trial, the low starting posture was also higher than the other 2 postures. There was a significant effect of the stepping rate for the step duration, which was a direct consequence from the experimental manipulation. In addition, the significant interaction effect between the starting posture and the stepping rate showed that under the high start posture, the variability of the step duration increased along the decreasing stepping rate, and the high start posture had a higher variability of the step duration than the low posture only at the low stepping rate condition. Discussion The findings of the study, the low starting posture had the highest PPF and the high stepping rate produced low PPF, were consistent with the literature. However, the high variability of the PPF observed in the low starting posture has not been previously reported. Moreover, the analysis of the variability of the step duration indicated that the low step rate tends to have increased variability. The variable step duration may disrupt the in-sync rhythm of the backward step in the team, and the variable PPF may provide an opportunity for the opponent to attack. We suggest that the low starting posture along with the medium (1 Hz) step rate may be the optimal combination for executing backward steps; however, additional training should be focused on reducing the peak force variability when taking the low posture. References Guo K-S. (2001). Unpublished master thesis, NTNU, Taipei, Taiwan Lin L-C. (2000). Unpublished master thesis, NTNU, Taipei, Taiwan

## BIOMECHANICAL ANALYSIS OF A WEARABLE SUPPORT DEVICE FOR OVERHEAD WORK

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**Introduction** There is a broad agreement that e.g. in aircraft assembly overhead work with forceful movements is one risk factor for musculoskeletal disorders (MSD) of the upper extremity (Rhode, 2015). At the HSU two wearable support devices were engineered specifically to support overhead work. The aim of this study is to assess the systems effects on reducing exposure on movement-involved muscles for the upper extremity and the lower back while working. Methods 24 participants completed an overhead task using a power drill (load 1,5kg) without (baseline) and with the two exoskeletons A and B. 3D motion-analysis (Vicon) examined full body movements. EMG signals were obtained from eight muscles (e.g. biceps brachii, trapezius, deltoid). Statistical analysis for curve data of the shoulder angles was performed using confidence bands for the difference between the means based on the bootstrap method (Duhamel et al. 2004) using matlab. Repeated measures ANOVAs using SPSS were used to examine the differences in EMG parameters and elevation angle of the shoulder girdle. Results Both exoskeletons decreased muscle activity significantly. For exoskeleton A: biceps 1,6%MVC\*sec (F=14.2; p<.001;  $\eta^2=.381$ ), forearm extensors 8,6%MVC\*sec (F=12.4; p<.001;  $\eta^2=.350$ ) and infraspinatus 9,7%MVC\*sec (F=5.5; p=.037;  $\eta^2=.152$ ), for exoskeleton B: trapezius 12%MVC\*sec (F=4.1; p=.022;  $\eta^2=.153$ ), deltoid 6,3%MVC\*sec (F=20.7; p<.001;  $\eta^2=.474$ ) and triceps 3,8%MVC\*sec (F=5.8; p=.006;  $\eta^2=.202$ ). No significant differences were found for lower back muscle. Both exoskeletons (A/B) showed significant differences for shoulder mobility compared to baseline for the following parameters: abduction: 0-18%/0-15% and 82-100%/85-100%, internal rotation 0-10%/0-5% and 91-100%/96-100%, flexion 0-13% and 79-100% for A and 14-26% of the movement cycle for B. Exoskeleton B showed an increased elevation angle of the shoulder girdle of 4,9° (F=5.9; p=.005;  $\eta^2=.204$ ). Conclusion Although both support systems restrict shoulder mobility, positive effects of reducing muscle activity were found for overhead work. Especially system B relieved muscles close to the shoulder joint. Therefore, we conclude that wearing the support systems can minimize risk factors for MSD. However, with regard to multifactorial pathways of MSD additional parameters e.g. EMG frequency analysis of muscle fatigue or additional body segments should be further examined. Moreover, ongoing evaluation and adaptations of the systems for the practical use are necessary. Reference Rhode, B. A. (2015). *MOJ Orthopedics & Rheumatology*, 3(4), 4–11 Duhamel, A., Bourriez, J. L., Devos, P., Krystkowiak, P., Destée, A., Derambure, P., Defebvre, L. (2004). *Gait & Posture*, 20 (2), 204–212. Contact Christine Berger: lbergerc@hsu-hh.de]

## UPPER BODY ACCELERATIONS DURING GAIT TERMINATION IN YOUNG AND OLDER WOMEN

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**INTRODUCTION** Transitory tasks, such as gait termination, involve interactions between neural and biomechanical factors that can challenge postural stability and head stabilisation patterns in older adults (Tirosh et al., 2005). The aim of the study was to compare upper body patterns of acceleration during planned gait termination at different speeds between young and older women. **METHODS** Ten young and 10 older women were asked to carry out three gait termination trials at slow, comfortable and fast speed. A stereophotogrammetric system (VICON, UK) was used to measure whole body 3D kinematics. RMS of head, trunk and pelvis acceleration were calculated in antero-posterior (AP), medio-lateral (ML) and vertical (VT) directions. AP and ML RMS were normalised by VT RMS to remove the influence of gait speed. Transmission of acceleration was expressed as a percentage difference in RMS from lower to upper body segments (Mazzà et al., 2008). Differences between groups were tested using independent t-test and Mann-Whitney U test ( $\alpha=0.05$ ). **RESULTS** Older women walked slower at each speed and approached the stopping position with lower AP and ML RMS than young women. After removing the influence of gait speed, however, older women showed higher AP and ML normalised RMS than young women. During the last step, pelvis-to-trunk attenuation of RMS accelerations was lower in older compared to young women along AP direction (-2% and 14% at slow speed, 0% and 10% at comfortable speed, respectively; p<0.05) and ML direction (0% and 38% at com-

fortable speed, 0% and 41% at fast speed, respectively;  $p < 0.05$ ). No significant between-group differences were observed in trunk-to-head attenuation coefficients. **DISCUSSION** Older women adopted the so called "slowness strategy" likely to improve their stability and reduce the risk of falling. However, when the influence of gait speed was removed, older women showed higher accelerations of upper body segments, which reflect a greater instability with respect to young women. The lower attenuation of acceleration from pelvis to trunk may be ascribed to the fact that: i) older women do not have to reduce acceleration as young women; ii) trunk rigidity in older women reduces their ability of attenuating these accelerations. Therefore, trunk appears to play a major role in the head stabilisation process, which should be taken into account in designing training interventions aimed at preventing falls in older individuals. **REFERENCES** Mazzà C, Iosa M, Pecoraro F, Cappozzo A (2008). *J Neuroeng Rehabil*, 5, 30. Tirosh O, Sparrow WA (2005). *Gait Posture*, 21, 279-288 **CONTACT** Lorenzo Rum. E-mail: l.rum@uniroma4.it

## Mini-Orals

### MO-PM17 Fatigue

#### SIDE-TO-SIDE DIFFERENCES IN KNEE EXTENSOR STRENGTH AND FATIGUE

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**Introduction** Differential loading patterns during sports training may exacerbate strength imbalances between the lower limbs that may predispose to lower extremity injuries (Rosene et al. 2010). The aim of the present study was to compare maximal power and isometric strength tests in determination of asymmetry in knee extensors; secondly, to study whether the strength differences can be explained by muscle size or neural activity; and third, to study the effects of acute loading on knee extensors strength balance. **Methods** Team sport athletes (men,  $n=11$ , women,  $n=4$ ;  $24 \pm 2$  yrs.) volunteers for the study. Subjects had no history of lower extremity injuries during the past two years. The maximal power (POW) of knee extensors was determined unilaterally by pneumatic loading device (Hur 3350, Hur Ltd., Finland). Maximal isometric torque (ISO) was measured by dynamometer. EMG activity of m.vastus lateralis (VL) was determined during the strength tests. Thickness of VL was determined by ultrasound. Strength tests were performed before and after acute loading protocol of a 10 repetition maximum set in Hur device followed by approximately 5 min circuit exercise of bench stepping, lunge squats, and vertical jumps. **Results** Side-to-side knee extensor strength differences did not correlate between POW and ISO tests, and laterality were not related to EMG activity or muscle size. The loading led to decreases bilaterally in POW ( $-5 \pm 20$  %, ns.) and ISO ( $-19 \pm 9$  %,  $p < 0.001$ ). Acute loading decreased difference between stronger and weaker limb from  $8.7 \pm 7.7$  % to  $0.8 \pm 14.2$  % ( $p < 0.05$ ) in POW but similar change was not observed in ISO. The loading-induced changes in EMG activity were not associated with changes in muscle strength. **Discussion** Athlete's performance detriments (Hart et al. 2014) and risks for lower extremity injuries (Keeley et al. 2011) can be evaluated by testing of strength imbalance between the lower limbs. However, determination of side difference in knee extensor strength depends on the analyzing method. In the present study, the POW and ISO showed divergent results in 6 out of 15 subjects. Neither EMG activity during the muscle actions nor muscle size of knee extensors explained the present strength differences by side. Fatiguing loading induced decreases strength more in stronger compared to weaker limb in POW but not in ISO. Changes in symmetry of limb strength by fatigue may ultimately decrease athlete's efficiency in sport activities. The present findings suggest that maximal power tests in fatiguing conditions could be promising diagnostic tool in determination of functional asymmetry in the lower limb strength. **References** Hart NH et al. (2014) *J Sports Sci Med*. 13:157-65. Keeley DW et al. (2011) *J Strength Cond Res*.25:1632-7. Rosene JM et al. (2001) *J Athl Train*. 36:378-83. **Contact** juha.ahainen@jyu.fi

#### FATIGUE LEVEL DURING HANDGRIP TEST: COMPARISON BETWEEN YOUNG JUDO ATHLETES AND NON ATHLETES.

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**Introduction:** The training of young judo athletes involves a lot of intermittent maximal and submaximal isometric handgrip actions, mainly while fighting. However, it is still unclear if this process could generate significant outcomes on strength in adolescents. Therefore, the aim of this study was to analyse the level of fatigue in young judo athletes and untrained young people on a handgrip test. **Methods:** 40 judo athletes [JA] (13.5 years old  $\pm 1.13$ ) and 40 untrained young people [UN] 13,5 years old  $\pm 1,15$ ) weight, height and maturational status (Mirwald, 2002) were evaluated. The individuals performed, in both hands, a handgrip strength test consisting of 10 all-out repetitions in 10 seconds with 20 seconds of rest between the repetitions. A digital manual dynamometer was used to assess the mean and the peak of handgrip strength of each repetition. The fatigue index [(maximum - minimum) \*100/maximum] was used for mean and peak values to determine percentage of loss in strength during the test. The normality of data was assessed by Shapiro-Wilk test, and, after this, all variables were compared between the groups using T student test. The effect size (cohen's d) for the fatigue index of mean and peak was calculated. A p-value less than 0,05 was adopted as criteria of statistical significance. **Results:** JA and UN presented no differences in weight, height and maturational status. The mean of training age in JA was 5.42 years. The fatigue index mean values in the dominant hand were JA:  $33.2 \pm 6.8$  % and UN:  $38.3 \pm 8.7$  % ( $p: 0.004$ ; ES: 0.65) while the values in the non-dominant hand were JA:  $35.3 \pm 7.61$  % and UN:  $38.3 \pm 8.3$  % ( $p: 0.09$ ; ES: 0.38). For the peak values of strength, the fatigue index was JA:  $31.6 \pm 7.44$  % and UN:  $34.8 \pm 8.7$  % ( $p: 0.08$ ; ES: 0.38) for the dominant hand, and JA:  $34.5 \pm 8.3$  % and UN:  $35.1 \pm 7.1$  % ( $p: 0.76$ ; ES: 0.06) in the non-dominant hand. **Discussion:** Despite the equality in the decreasing peak values indicate that both groups could have had same capacity to reach similar values in all repetitions, the significant difference in the mean values showed that JA group had a greater capacity to sustain the isometric contractions at a higher level of strength in comparison to the UN, at least in the dominant hand. Dias et al. (2012) reported similar result in judo athletes when compared with sedentary adult men, indicating that the greatest strength endurance can emerge since the beginning of adolescence and persists until adult age, when judo is practiced. **References** Mirwald, R. L., Baxter-Jones, A. D., Bailey, D. A., & Beunen, G. P. (2002). *Medicine and science in sports and exercise*, 34(4), 689-694. Dias, J. A., Wentz, M., Kulkamp, W., Mattos, D., Goethel, M., & Júnior, N. B. (2012). *Science & Sports*, 27(3), e9-e14.

## EFFECTS OF TRUNK FATIGUE ON DOUBLE POLING PERFORMANCE AND PACING STRATEGY IN JUNIOR CROSS-COUNTRY SKIERS

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**Introduction:** The trunk plays a crucial role in the power production during double poling (Hegge et al., 2015), one of the main sub-techniques in classical cross-country skiing. While intense whole-body exercise has been shown to result in general fatigue and reduced performance, the effect of fatigue in more isolated components of the relevant muscle chains is less understood. Therefore, the aim of this study was to investigate acute effects of a fatigued trunk on double poling performance and pacing strategy in junior cross-country skiers. **Methods:** 16 well-trained male junior cross-country skiers completed two identical pre- and post-tests on separate days in a randomized, controlled cross-over design. In between pre- and post-test, either a 25-min fatiguing exercise sequence targeting the core musculature (FAT) or a 25-min resting control condition (CON) were applied. Performance tests consisted of a maximal isometric trunk strength tests (flexion and extension; IsoMed 2000 backmodule; D&R Ferstl, Hernau, Germany), followed by a 3-min self-paced double poling test (SkiErg; Concept2, Morrisville, VT, USA). Power output, cycle characteristics and cardiorespiratory variables were continuously measured during the double poling test. **Results:** Isometric peak torque during trunk flexion (-63%) and extension (-11%) decreased in FAT (both  $p < 0.001$ ) and was unchanged in CON ( $p = 0.39$  and  $p = 0.42$ ). Trunk fatigue led to a 13% decrease in mean power output (mean pre-post change: -32 (95% CI -41, -23) W;  $p < 0.001$ ), whereas power did not change in CON (+2%;  $p = 0.21$ ). Cycle rate decreased by 10% in FAT (-0.11 (-0.14, -0.08) Hz;  $p = 0.001$ ) and by 5% in CON (-0.06 (-0.09, -0.02) Hz;  $p = 0.005$ ). Peak heart rate did not differ between FAT and CON (-1%;  $p = 0.10$  and +1%;  $p < 0.001$ ). Peak oxygen uptake decreased by 4% in FAT ( $p = 0.004$ ) and increased by 3% in CON ( $p = 0.027$ ). Peak ventilation decreased by 7% in FAT ( $p < 0.001$ ) and did not differ in CON (0%;  $p = 0.59$ ). Pacing analysis showed the greatest power reduction during the first 60 s in FAT (-64 W;  $p < 0.001$ ), with less reductions in the second 60 s (-31 W;  $p < 0.001$ ) and no difference in the third 60 s (-3 W;  $p = 0.524$ ). **Discussion:** Acute fatigue of core muscles in junior cross-country skiers resulted in substantial decreases in power output and altered pacing profiles during double poling. The accompanied reduction in respiratory capacity after fatigue indicates a close tie between trunk control, respiration and performance in double poling. **References:** Hegge, A. M., Bucher, E., Ettema, G., Faude, O., Holmberg, H. C., & Sandbakk, O. (2015). *Eur J Appl Physiol*, 116(2), 291-300. Contact: elias.bucher@unibas.ch

## EFFECTS OF ACTIVE RECOVERY AFTER INTENSIVE TRAINING ON PERFORMANCE AND MARKERS OF FATIGUE IN ELITE GERMAN WEIGHTLIFTERS

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**Introduction** The aim of the present study was to investigate the effect of a repeated use of active recovery (ACT) compared with passive recovery (PAS) during a two-day heavy weightlifting training block with two training sessions per day on sport-specific performance and selected markers of fatigue. **Methods** Eight competitive male ( $n=7$ ) and female ( $n=1$ ) German weightlifters from the Olympic national team participated in this study. In a crossover design, separated by a two-week wash-out period, the subjects performed either supervised ACT (submaximal rowing ergometer exercise; 1 Watt per kg body mass) or PAS (resting in a seated position) for 15 minutes after each training session. Sport-specific performance comprising maximal barbell velocity during the clean pull (CP) at 85% (CP85), 90% (CP90) and 95% (CP95) of the maximum load, as well as markers of fatigue including jump performance (countermovement jump, CMJ), skeletal muscle contractile properties (maximal displacement of the muscle belly, Dm; muscle contraction velocity, V90) using tensiomyography, muscle damage (serum creatine kinase activity, CK), muscle soreness (delayed onset muscle soreness, DOMS), and perceived overall stress and overall recovery levels (short recovery stress scale, SRSS) were measured one day before (Pre) and one day after (Post) completing the training programs. **Results** There were neither significant recovery type x time interactions nor meaningful differences in pre-post changes between ACT and PAS in all analyzed variables. However, the training block induced small decreases between Pre and Post over all relative intensities in CP (CP85, ACT: Effect size (ES)=-0.20, PAS: ES=-0.50; CP90, ACT: ES=-0.29, PAS: ES=-0.35; CP95, ACT: ES=-0.41, PAS: ES=-0.20;  $P>0.05$ ). There were trivial pre-post changes in CMJ as well as in Dm and V90 in both interventions ( $ES\leq 0.20$ ;  $P>0.05$ ). Large to very large increases between Pre and Post could be found in CK (ACT: ES=2.11, PAS: ES=1.41;  $P=0.001$ ) and DOMS (ACT: ES=1.65, PAS: ES=2.33;  $P=0.052$ ) as well as moderate to large effects in perceived overall stress (ACT: ES=1.35, PAS: ES=1.01;  $P>0.05$ ) and overall recovery levels (ACT: ES=-1.35, PAS: ES=-1.33;  $P>0.05$ ). **Discussion** The repeated use of individualized ACT seems not to promote recovery more effectively than PAS. However, ACT has also no detrimental effect on the recovery process compared with PAS. Therefore, the use of ACT should be considered at the individual level in the applied field.

## DIFFERENCES OF ACUTE PHYSIOLOGICAL RESPONSES BETWEEN TWO HIGH-INTENSITY INTERVAL EXERCISE MODES IN ENDURANCE AND SPRINT TYPE ATHLETES

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**INTRODUCTION** A number of variables prescribe high-intensity interval exercise (HIIE) but the principle of individuality has to be respected also. Regarding HIIE, the effect of training mode has received limited scientific interest so far. Therefore, the aim was to compare the acute cardiorespiratory and metabolic response to short and long HIIE in endurance and sprint trained athletes. **METHODS** Sixteen highly-trained males (8 endurance (E) and 8 sprint (S) athletes, age  $22.5\pm 3.0$  years,  $VO_{2max}$ : E:  $66.2\pm 5.0$  ml.kg<sup>-1</sup>.min<sup>-1</sup>; S:  $56.8\pm 5.0$  ml.kg<sup>-1</sup>.min<sup>-1</sup>) volunteered in this study. The participants firstly performed a maximal incremental treadmill test. Then they performed a short (30s) and a long HIIE (180s), matched to one constant load exercise (CE) (50 % of  $V\dot{V}O_{2max}$ ; total duration 32 min). Long and short intervals were identical for work/relief ratio (1:1) as well as for the relative work ( $V\dot{V}O_{2max} = 100$  %) and relief intensity (passive). Ventilatory parameters, heart rate (HR) and lactate (La) were monitored during the exercise. A magnitude based inferences were employed within the statistical analysis (Batterham & Hopkins, 2005). **RESULTS** The HR and  $V\dot{V}O_2$  peaks during the long HIIE clearly crossed the second ventilatory threshold (VT) while this peak cardiorespiratory response remained at the level of the first VT during the short HIIE. The differences between E and S athletes in mean HR response (bpm or % HRmax) were unclear in all trials. Endurance athletes performed the exercise interventions with moderately (CE) or largely (both HIIE modes) higher mean  $V\dot{V}O_2$ . These differences were unclear or trivial when  $V\dot{V}O_2$  was expressed as a function of  $V\dot{V}O_{2max}$ . Moderately lower RER values were found in endurance athletes. The E vs. S differences in mean La were unclear (both HIIE modes) or nearly perfect in CE, with higher values in sprint athletes. **DISCUSSION** All exercise tests produced similar values in E and S athletes for mean HR and mean  $V\dot{V}O_2$  (%  $V\dot{V}O_{2max}$ ). However, E athletes performed the exercise trials with



lower RER even if the running speed was individually adjusted at the same relative level. This indicates the greater reliance of E athletes on oxidative metabolism pathway even during high-intensity exercise. Second, the short HII was performed fully aerobically. Third, unlike E athletes, S athletes performed the long HII mostly anaerobically. Therefore, one needs to be cautious if the development of the glycolytic metabolic pathway is the main aim of such a training program. References: Batterham, A.M., & Hopkins, W.G. (2005). Making meaningful inferences about magnitudes. *Sportscience*, 9, 6-13.

## **DON'T BE AFRAID OF LACTATE! PARADOX EFFECTS OF ELEVATED BLOOD LACTATE CONCENTRATION ON HIGH-INTENSITY EXERCISE PERFORMANCE**

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Introduction Lactate (La) has been termed a waste product, and still many believe this myth although La has been shown to be an energy source, a gluconeogenic precursor and a regulator (Brooks 2009). The Lactate Shuttle Theory (LST) describes the balance of La production and local and/or systemic La oxidation described for exercising muscles (Brooks 2009), for the healthy (Figley 2011) and injured brain (Dienel 2014), different tissues (Brooks 2009) and solid tumours (Draoui et al. 2011). This review addresses a theoretical position on the influence of high-intensity pre-load lactate elevation on subsequent high-intensity glycolytic exercise of non-pre-loaded muscles. Some-how paradox effects (Almer 2016) can be explained by the LST (Brooks 2009). Athletes usually perform an intense warm-up program elevating La substantially (Bishop 2003), but for the main workout they try to start at low La. It is generally suggested that elevated La always impairs subsequent performance by reducing the anaerobic energy contribution and/or interfering with muscle contractile processes (Bishop 2001, 2003; Mujika et al. 2012). Several studies showed that an elevated systemic La concentration inhibits the rate of glycolysis in subsequent anaerobic work bouts (Bishop et al. 2001), also shown for a La increase by arm exercise that decreased the rate of blood La accumulation in a subsequent cycle ergometer sprint by 50% (Bogdanis et al. 1994), and supported by own results (Müller et al. 2015). The inhibition of La production is due to an inverted gradient from an elevated systemic to the muscular La concentration consequently favouring oxidative energy production at the same workload which may be beneficial for high-intensity workouts of 1-8 min duration. The shift to an enforced oxidative metabolism may maintain better coordinated muscle recruitment due to the reduced local muscle anaerobic energy contribution. We applied this theoretical approach in various comparable situations in the laboratory and under field conditions which will be shown in detail (see also Almer 2016; Bierbaumer 2016). Conclusion Pre-elevated La levels by non-dominant muscle groups uniformly showed a markedly decreased net blood La increase of 30-50% in all experiments. This inhibition of La production did not reduce but instead enhanced high-intensity exercise performance in all dynamic workloads longer than 60 s and shifted metabolism to a more dominant oxidative one. We therefore suggest that this application of the La induction by non-dominant muscles may be used to enhance performance in several high-intensity sports if applied properly. References at the authors Contact: [lpeter.hofmann@uni-graz.at](mailto:lpeter.hofmann@uni-graz.at)

## **ORDER OF COMBINED STRENGTH AND ENDURANCE TRAINING MAY INFLUENCE NEUROMUSCULAR ADAPTATIONS**

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1:JYU (Jyväskylä, Finland), 2:ECU (Perth, Australia), 3:UPNA (Navarra, Spain) Introduction Previous studies have shown that combined strength (S) and endurance (E) training order (Cadore et al., 2013) and time-of-day of S (Sedliak et al., 2008) and E training (Hill et al., 1998) may influence the magnitude of training adaptations. The aim of this study was to examine the effects of 24 weeks of morning vs. evening single-session combined SE vs. ES training on neuromuscular performance. Methods 41 men ( $32.3 \pm 5.6$  years) trained for 24 (2x12) weeks (2-3 combined sessions per week) in the morning (m) or evening (e) using either SE or ES order (mSE n=9, mES n=9, eSE n=12 and eES n=11). 10 control subjects (C) continued their normal daily activities. Unilateral isometric knee extension force (KE), muscle activity of vastus lateralis (VL) by electromyography (EMG), maximal voluntary activation % by electrical stimulation (VA%) and maximal power during cycling (Wmax) were measured both in the morning and evening. Results Time of day when the training was performed did not influence the results and thus, the groups were combined into the SE (mSE+eSE) and ES (mES+eES) groups. KE force increased only in SE in the morning ( $10.9 \pm 18.0\%$ ;  $p < 0.05$ ) and evening ( $15.9 \pm 16.7\%$ ;  $p < 0.01$ ) by week 24. Evening force changes in SE were larger than in ES ( $p < 0.05$ ) or C ( $p < 0.05$ ). VL EMG activity increased in the morning by week 24 in SE ( $28.5 \pm 30.6\%$ ;  $p < 0.001$ ) and ES ( $29.3 \pm 36.4\%$ ;  $p < 0.05$ ). In the evening VL EMG increased only in SE during weeks 0-24 ( $38.3 \pm 31.7\%$ ;  $p < 0.001$ ), and this change was larger than in ES ( $p < 0.05$ ) or C ( $p < 0.05$ ). VA% increased in SE ( $3.2 \pm 5.9\%$ ) more than C ( $p < 0.05$ ) in the evening by week 24. Wmax increased in SE and ES throughout the training period in the morning ( $p < 0.05$ ) and evening ( $p < 0.05$ ). However, the changes were larger in ES compared to SE in the morning during weeks 0-24 ( $p < 0.05$ ) and in the evening during weeks 13-24 ( $p < 0.05$ ). Discussion These results suggest that changes in neural activation recorded by EMG and VA% may contribute to the magnitude of strength gains especially in SE in the evening during prolonged combined S and E training. ES order, however, may produce greater adaptations than SE in endurance performance both in the morning and evening. It is possible that the residual fatigue produced repeatedly from the first training mode may have compromised the adaptations to the second training mode (Chtara et al., 2005; Cadore et al., 2013). Therefore, the order of S and E in a training session could be selected according to the personal training goal. References Hill et al., 1998, *Med Sci Sports Exerc*, 30, 450-455 Chtara et al., 2005, *Br J Sports Med*, 39, 555-560 Sedliak et al., 2008, *J Sports Sci*, 26, 1005-1014 Cadore et al., 2013, *AGE*, 35, 891-903 Contact [maria.kuusmaa@jyu.fi](mailto:maria.kuusmaa@jyu.fi)

## Mini-Orals

### MO-PM19 Stretching

#### ACUTE EFFECT OF SINGLE WATSU THERAPY ON THE FLEXIBILITY OF YOUNG MALE SWIMMERS

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Watsu is a truly contemporary aquatic bodywork therapy. Watsu utilizes both static rotational stretches for the trunk and rhythmical, repeated trunk rotation by Rotating Accordion, Near and Far Leg Rotation. Objective: To find out the impact of Watsu therapy on flexibility. To compare the changes in upper and lower body flexibility after Watsu therapy. Tools and Methods: A group of twelve volunteer male subjects aged between 18 and 22 years studying at KFUPM, S.A. participated to our study. They underwent regular swimming workout more than a year. Only one watsu session was performed on the subjects. Trunk-neck and hip-trunk static flexibility tests were used to measure the flexibility values. The measurements were initially taken before the watsu session and within 5 minutes after the watsu session. Mean, S.D. and t-test were computed using Statistica Software for analyzing the data. Findings: Sit&Reach test score was found to be statistically significant. Trunk&Neck test result was found not to be statistically significant. Mean and S.D from pre to post test were 28.83, 8.31 and 30.08, 8.55, 54.75, 12.65 and 55.33, 12.82 respectively. Conclusions and Assessments: The results of this preliminary study suggest that one watsu session can help improve flexibility. This findings support the effects including increased flexibility and relaxation noted by Watsu therapy receivers. Further studies using true experimental designs with larger sample sizes, and more sessions should be conducted in order to confirm these results.

#### LOCAL VIBRATION STRETCHING: A NOVEL MODALITY ENHANCING MUSCULOTENDINOUS STIFFNESS WHILE MAINTAINING MUSCLE STRENGTH

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Introduction: Static stretching (SS) and dynamic stretching (DS) are the typical modalities to improve joint range of motion (flexibility). SS is known to lower the stiffness and hardness of the musculotendinous tissues [1, 2]. Even though SS is superior to DS in improvement of flexibility, it also induces a decrease in muscle function [3] unlike DS [4, 5]. In this study, we developed a novel stretching method 'local vibration stretching (LVS),' which provides tiny length changes to the muscle-tendon unit being stretched passively. The purpose of this study was to investigate the effect of LVS on the muscle strength and elastic properties of the ankle plantar flexors and Achilles tendon (AT). Methods: Ten healthy young males ( $25.0 \pm 2.8$  years) participated in this study. The maximal voluntary isometric plantar flexion strength, AT stiffness, and muscle hardness were measured before (pre) and immediately after (post) five trials of either of three types of stretching: SS, LVS with a frequency of 15Hz, and no intervention (CON). AT stiffness was calculated from the plantar flexion torque increasing gradually to the maximum over 5s and while elongation of AT (the displacement of the distal end of muscle belly of the medial gastrocnemius) was measured with ultrasonography. Muscle hardness (shear modulus – ankle joint angle relationship) was determined for the medial gastrocnemius at three angles ( $0^\circ$  (anatomical position) and dorsiflexion  $10^\circ$  &  $20^\circ$ ) by using shear wave elastography. Results: The maximal voluntary isometric plantar flexion strength significantly decreased in SS ( $p < 0.05$ ), but not in LVS. The AT stiffness significantly decreased both in SS and LVS ( $p < 0.05$ ), however there were no significant differences in the relative changes of AT stiffness between SS and LVS. The muscle hardness significantly decreased both in SS and LVS ( $p < 0.05$ ) with not significant differences between SS and LVS. All variables remained unchanged in the repeated measurements in CON. Conclusions: The present findings indicate that LVS improves flexibility by changing the muscle-tendon compliant while inducing no muscle function loss, unlike SS. It is suggested that LVS is suitable for a warm-up modality. References: [1] Kubo et al. (2001). J Appl Physiol, 90(2), 520-527. [2] Nakamura et al. (2014). Ultrasound Med Biol, 40(9), 1991-1997. [3] Fowles et al. (2000). J Appl Physiol, 89(3), 1179-1188. [4] Bacurau et al. (2009). J Strength Cond Res, 23(1), 304-308. [5] Yamaguchi & Ishii (2005). J Strength Cond Res, 19(3), 677-683.

#### SIMILAR CHANGES IN MUSCLE HARDNESS AT THE MEDIAL AND LATERAL HEAD OF THE GASTROCNEMIUS DURING STATIC STRETCHING

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INTRODUCTION Static stretching is widely used to adjust muscle tone. However, the effect of stretching depends on the individual condition of each muscle. Several muscles are stretched at the same time to maintain a single posture and the effect of stretching varies with each muscle. We have continuously measured muscle hardness using a wearable indentation tester to evaluate muscle tone during static stretching, and found that muscle hardness changes during static stretching (1) (2). Using this method, we can evaluate muscle tone at several points simultaneously. In this study, we have investigated the similarities in muscle hardness changes at the medial and lateral head of the gastrocnemius while the triceps surae muscles were stretched. METHODS Five healthy university students with no lower limb injuries participated in this study. To measure muscle hardness, wearable indentation testers were fixed to the skin over the medial and lateral head of the gastrocnemius. Each subject stretched both triceps surae muscles for 1 min on a stretching board, using arbitrary strength with no ankle joint rotation. Stretching was repeated three times with 1 min breaks between each trial. We calculated the correlation coefficient of the time series variation between the muscle hardness at the medial head and lateral head. RESULTS Muscle hardness at the medial head correlated highly with muscle hardness at the lateral head in 75% of trials (correlation coefficient  $R > 0.7$ ). In some trials, only one leg showed high correlation coefficient ( $R > 0.7$ ) and the other leg showed relatively low correlation coefficient ( $R < 0.5$  or negative value). DISCUSSION High correlation between muscle hardness at the medial and lateral head of the gastrocnemius means the time to decrease or increase muscle tone by stretching is similar at the medial and lateral head. Since muscle length is almost the same in both biceps, the changes in muscle tone are considered similar. In some trials, only one leg showed a high correlation coefficient; this may be explained by a bias in the center of gravity, meaning the other leg was not well stretched. In the future, we will investigate the effect of ankle joint rotation (3) and find the optimal conditions for adjusting the tone of specific muscles by static stretching. REFERENCES (1)

Okamura, N. et al. (2014). Conf Proc IEEE Eng Med Biol Soc. 6919-6922 (2) Okamura, N. et al. (2015). 20th Annual congress of the ECSS Book of abstracts. 414. (3) Edama, T. et al. (2012). J. Sports Injury. Japan. Vol. 17. 21-22. CONTACT n-okamura@toki.waseda.jp

### PRE-STRETCH AUGMENTATION AND ECCENTRIC UTILIZATION RATIO IN 15 TO 18 YEARS OLD ATHLETES OF DIFFERENT SPORT EVENTS

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**Introduction** Eccentric utilization ratio (EUR) is used as an indicator of power performance, and pre-stretch augmentation (PSA) is used to measure the ability to utilize pre-stretch of the muscles. The purpose of this study is to examine any differences in EUR and PSA in young male athletes between the ages of 15 and 18 years and between different sport events. **Methods** A total of 183 male athletes were measured representing five different sport events, specifically soccer (n=137), basketball (n=18), handball (n=6), rowing (n=15) and modern pentathlon (n=7). Four age groups were formed, 15 (n=27), 16 (n=49), 17 (n=55) and 18 years old (n=52). The athletes performed three squat jumps (SJ) and three counter movement jumps (CMJ) on a force platform, the best value for each jump type was recorded and used for analysis. Jump height was measured based on the flight time method. EUR was calculated by dividing CMJ height to SJ height, while PSA was calculated by subtracting the SJ height from CMJ height, dividing by SJ height and multiplying by 100. **Results** Results didn't reveal differences between the age groups in EUR or PSA, except the 17 years old athletes, who showed higher values especially compared to the 16 years old athletes. Neither were found differences between the sport events, basketball and handball players showed higher values in EUR and PSA, however these differences statistically were not significant. **Discussion** Power and explosive force production is critical in many sports, the ability to utilize the stretch shortening cycle of the muscle can be of great importance in athletic performance. Based on the results power performance as measured by EUR and PSA does not change with age in the examined age period and does not differ between the examined sport events, indicating perhaps that other factors (e.g. muscle fibres type, neuromuscular activation) have a more definitive role. The training regime of the athletes should be also considered, however, lack of detailed information didn't allow for such an analysis.

### EFFECT OF STRETCHING ON REDUCING THE INCIDENCE OF MUSCULOSKELETAL DISORDERS AMONG TEACHERS

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**Purpose:** Musculoskeletal disorders (MSD) are common occupational health problems around the world. The adverse impact of MSD on the teaching profession has been reported to be high with the prevalence rate of 39% to 95% (Erick & Smith, 2011). Stretching is a potential way to reduce work-related MSD (da Costa & Vieira, 2008). The purpose of study was to evaluate the effectiveness of stretching on reducing the incidence of musculoskeletal disorders among teachers in Hong Kong. **Methods:** A total of 21 teachers from a primary school were recruited and participated in the project. Participants received the stretching program which were adapted from the "Stretching Exercises to Prevent Musculoskeletal Injury Manual" of the Occupational Safety and Health Council of Hong Kong (2013). The stretching exercises were reviewed by a physiotherapist and a physical fitness specialist. The participants were advised to perform a set of 15 stretching exercises for around 15 minutes per day. Log books were provided to record their compliance rates. Nordic Musculoskeletal Questionnaire (Kuorinka, et al., 1987) was used. The assessments of the prevalence rates of MSD were conducted at baseline and third month of the intervention. **Results:** There was no difference (\*McNemar X2,  $p > 0.05$ ) in prevalence rates between baseline (95%) and posttest (100%) for the Intervention sample. There was no difference ( $F(1,17)=0.46$ ,  $p > 0.05$ ) in total number of trouble/pain areas between baseline and posttest after controlling for exercise days (frequent vs less). Participants with exercise frequency more than 22 days were doing better than that of less or equal to 22 days but not significant ( $F(1,17)=0.89$ ,  $p > 0.05$ ) statistically. **Conclusion:** The lack of intervention effects might be attributed to the lack of programme contents engagement and small sample size. Future studies should be on strategies to increase the compliance rate. Supervised preventive stretching exercise programmes for reducing occupationally related MSD should be further investigated. **References:** da Costa, B. R., & Vieira, E. R. (2008). Stretching to reduce work-related musculoskeletal disorders: a systematic review. *Journal of Rehabilitation medicine*, 40(5), 321-328. Erick, P. N., & Smith, D. R. (2011). A systematic review of musculoskeletal disorders among school teachers, *BMC Musculoskeletal Disorders*, 12, 260. Kuorinka, I., et al. (1987) Standardized Nordic questionnaires for the analysis of musculoskeletal symptoms. *Applied Ergonomics*, 18(3), 233-237. Occupational Safety and Health Council (2013). Retrieved on 3 July 2013 from, <http://www.oshc.org.hk/>. o not insert authors here

## Mini-Orals

### MO-PM20 Training & Testing: Mixed Session

#### THE EFFECT OF A MATCH ON PSYCHOMOTOR VIGILANCE IN FUTSAL REFEREES

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Futsal is characterized as an intermittent sport played between two competing teams of five players per team and it is officiated by two referees whom implement the Futsal laws of the game. Some previous studies have investigated referees' physiological demands but there is little research on cognitive performance, yet it is important to consider such perceptual-cognitive factors that may influence referees' performance (Weston, et al., 2012). The aim of the present study was to assess referees' performance on the psychomotor vigilance task (PVT) before and after a competitive Futsal match. **Methods:** After University Ethics Committee approval, Eleven Futsal referees (mean  $\pm$  SD: age,  $33.5 \pm 9.8$  years; height,  $180.6 \pm 7.5$  cm; weight  $82.9 \pm 15.3$  kg) from the FA National Futsal Group, FA Futsal Super League, London, UK, were studied in matches during the 2015/16 season. The referees had between 5 and 15 years of refereeing experience at the top level. Referees were required to undertake the 10-min PVT at 60 min before the match kick-off time (pre) and immediately after matches. They also completed the Brunel Mood Scale (BRUMS) questionnaire before the pre-match PVT and after the post-match PVT. **Result:** Data were analysed by paired t-tests comparing pre- to post-match results. There was no significant different in PVT pre- and

post-match, Lapses ( $RT > 500$  ms), Slowest 10% and Fastest 10% PVT scores (all  $P > 0.05$ ). However, there was significant difference in BRUMS in tension ( $0.8 \pm 1.0$  pre- vs  $0.1 \pm 0.3$  post-match,  $P < 0.05$ ), vigour ( $9.3 \pm 2.6$  pre- vs  $6.3 \pm 2.7$  post-match,  $P < 0.05$ ) and fatigue ( $1.3 \pm 1.5$  pre- vs  $4.8 \pm 2.6$  post-match,  $P < 0.05$ ). In conclusion, the present finding found that performance on the 10-min PVT did not decrease after a match, which was in opposition to our hypothesis. We had anticipated a decrease due to mental and physical fatigue induced by the match. However, the present results suggest that referees were able to maintain their cognitive performance over the course of a match, which could suggest resilience to negative effects of physical and mental fatigue. These findings were in response to a single match, however, and many referees are required to officiate multiple games on the same day (e.g. at tournaments) sometimes with minimal recovery between matches. In addition, there was a tendency for less experienced (less than 10 years) referees to have greater post-match decreases, so future research should compare referees of varying experience and also assess the effects after multiple matches in a single day. References Weston, M., et al. (2012). *Sports Medicine*, 42(7), 615-631.

## COMPARISON OF THE DIFFERENTIAL LEARNING APPROACH IN THE FORM OF GAMES AND TRADITIONAL TENNIS TRAINING

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**Introduction** According to the curriculum of the German Tennis Association (DTB, 1996) a tennis specific movement should be learned correctly under stable conditions and regularly repeated with sufficient number. Deviations from the prescribed standards during the learning process are considered as destructive. A constructive influence of errors on learning is suggested by the differential learning approach (Schöllhorn, 2000). Positive effects of DL training were shown for the tennis serve (Humpert et al., 2006). The aim of this study is to investigate the effect of DL in form of games and classical tennis training on longline and diagonal forehand stroke. **Methods** 20 subjects (14 male, 6 female;  $11.6 \pm 1.5$  years of age) were randomly assigned to two intervention groups. Each subject completed over six weeks twelve training sessions (TS) with 40 forehand trials. The classical group (CL) followed a standardized training protocol according to the curriculum. The differential learning group (DL) trained in form of games accompanied by a big amount of additional noise in the forehand executions. Precision data of pre-, post-, and retention-tests were analyzed by means of a repeated measurement ANOVA with additional post hoc paired t-tests and Bonferroni correction. Results Both groups started from the same initial level and improved their performance of the longline and diagonal task during the acquisition phase. In the retention-test the performance of the CL group decreased in both tasks back to its initial level. No statistically significant change in the DL group was identified. The repeated measurement ANOVA of the longline task showed significant results ( $p=.000$ ) with a high effect size ( $\eta^2=.355$ ) for the factor time. The interaction of the factor group and time ( $p=.455$ ) and the between-subject effect ( $p=.658$ ) was not significant. The paired t-tests indicated an improvement from pre- to post-test for both groups (CL:  $p=.024$ ; DL:  $p=.009$ ). However the CL-Group decreased their performance from post- to retention-test ( $p=.017$ ). The DL-Group stabilized their performance on a higher level compared to pre-test. For the diagonal task a statistical trend was observed. All factors were not significant (time:  $p=.077$ ; time x group:  $p=.329$ ; group:  $p=.876$ ). **Discussion** Both groups were able to increase their performance from pre- to post-test. The development of the DL group differs in comparison to the CL group mainly during the learning phase. While the CL group dropped back to the initial level, the DL group remained nearly on the post-test level. At least evidence for advantage during the learning phase is provided by the DL group. References DTB (1996). *Tennis-Lehrplan Band 2. Unterricht & Training*. München, BLV Verlagsgesellschaft. Humpert V, Schöllhorn WI (2006). *Trainingswissenschaft im Freizeitsport*, 121-124. Hamburg, Czwalina. Schöllhorn, WI (2000). *Acta Academiae Olympicae estoniae*, (8), 67-85. Contact hegenp@uni-mainz.de

## PREDICTING ELITE TRIATHLON PERFORMANCE BY A TRIATHLON COACH SURVEY AND ARTIFICIAL NEURAL NETWORKS

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**Introduction:** Performance prediction in triathlon could be useful for talent diagnostics and to develop individual race tactics (Landers et al., 2000). Thereby, anthropometric and physiological parameters measured in laboratory tests provide an important basis for race time predictions (Schabort et al., 2000). We conducted a survey with professional triathlon coaches followed by the development of artificial neural networks (ANNs) to identify performance relevant parameters and to predict overall race times of German male elite triathletes. **Methods:** Anthropometric and physiological parameters of 25 laboratory tests of eleven male elite triathletes (20-32 yrs) were collected at the IAT between 2008 and 2012. A dominance paired comparison with three German professional triathlon coaches was used to identify relevant parameters based on their professional expertise. Afterwards, two-layer feedforward ANNs (Levenberg-Marquardt algorithm) were computed to highlight appropriate parameters of elite Olympic distance triathlon performance and to predict overall race time. **Results:** The dominance paired comparison concerning anthropometric parameters led to BMI [ $\text{kg}/\text{m}^2$ ], Rohrer-Index [ $\text{kg}/\text{m}^3$ ], Quetelet-Index [ $\text{g}/\text{cm}^3$ ] and body fat [% and kg]. The dominance paired comparison concerning physiological parameters led to maximum running pace [ $\text{m}/\text{s}$ ], running pace at 3-mmol/l blood lactate [ $\text{m}/\text{s}$ ], relative  $\text{VO}_2\text{max}$  [ $\text{ml}/\text{min}/\text{kg}$ ], maximum running pace in mobilisation test [ $\text{m}/\text{s}$ ] and absolute  $\text{VO}_2\text{max}$  [ $\text{ml}/\text{min}$ ] as most important for Olympic distance triathlon performance. The ANN using anthropometric variables explained 58% of the variance in overall race time ( $R^2 = 0.58$ ;  $\text{RMSE} = 124.25$  [s]). The ANN using physiological variables explained 90% of the variance in overall race time ( $R^2 = 0.90$ ;  $\text{RMSE} = 58.80$  [s]). **Discussion:** The combination of a professional triathlon coach survey and ANNs provided two performance prediction models with high percentages of variance explained (anthropometric:  $R^2 = 0.58$ ; physiological:  $R^2 = 0.90$ ). These predictions outperformed a purely statistical approach comprising factor analysis and multiple regressions (Hoffmann et al., 2015). Furthermore, the RMSE was lower than the performance variation of elite athletes. Therefore, the trained ANN considering professional expertise can be used to predict individual race time based on the values of an actual performance diagnostic. References: Hoffmann M, Moeller T, Seidel I, Stein T (2015). *Book of Abstracts 20th ECSS Congress*, p.314. Landers GJ, Blanksby BA, Ackland TR, Smith D (2000). *Ann Hum Biol*, 27(4), 387-400. Schabort EJ, Killian SC, Gibson A, Hawley JA, Noakes TD (2000). *Med Sci Sports Exerc*, 32 (4), 844-849. Contact: marian.hoffmann@kit.edu

## GRADUAL SPECIFICITY DURING ACTUAL AND IMAGINED ISOMETRIC CONTRACTIONS

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**Introduction** Mental training with motor imagery (MI) has been shown to increase muscle strength (Ranganathan et al. 2004). During such training, maximal imagined contractions are generally instructed as the motor cortex being more activated in high imagined contractions



(Helm et al. 2015). However, the gradual specificity of MI, i.e., the parallel between neurophysiological processes and increasing imagined contractions, is not clearly demonstrated. The aim of this study was to better understand the neural correlates of this specificity. Methods Two experiments were performed, using transcranial magnetic stimulation (TMS) and electrical peripheral nerve stimulation (ES) on Flexor Carpo Radialis. In the first experiment, participants ( $n=11$ ) were instructed to rest or to actually perform grip strength of the right hand with a dynamometer from 25% to 75% of maximal voluntary contractions (MVC). In the second experiment, participants ( $n=10$ ) were instructed to rest or to imagine squeezing the hand from 25% to 100%MVC. In both experiments, TMS was applied during actual and imagined contractions with intensity set at 120% of rest or active motor threshold. The same protocol was realized with ES of median nerve, with the intensity set to induce Mmax. Results Motor Evoked Potential (MEP) amplitude, for all intensities and conditions was greater than that at rest ( $\chi^2=12.88$  and  $19.56$ ,  $p<0.01$  respectively). During actual contraction, MEP amplitude at 25%MVC was lower than that at 50%MVC ( $p=0.05$ ). During MI, MEP amplitude at 75%MVC was significantly greater than that at 25%MVC ( $p=0.03$ ). Discussion According to previous findings, we demonstrate a gradual specificity with strength increase during MI and actual movement (Helm et al. 2015; Pearcey et al. 2014). The same pattern for corticospinal excitability was observed: we found an increase up to 50%MVC during actual contractions and up to 75%MVC during imagined contractions, followed by a plateau. For highest levels of strength, cortical inhibitory and facilitatory processes may be modulated to change the modality, spatial and temporal, of motor units' recruitment (Oya, Riek, and Cresswell 2009). MI training has been showed to improve strength; it may be of importance to pay attention at imagined contraction intensities. It seems more effective to imagine a high intensity submaximal contraction whereas low or maximal intensity. References Helm F, Marinovic W, Krüger B, Munzert J, and Riek S. (2015). *Neuroscience* 290:398–405. Oya T, Riek S, and Cresswell AG. (2009). *The Journal of physiology* 587(Pt 19):4737–48. Pearcey GEP, Power KE, and Button DC. (2014). *PLoS one* 9(5):e98468. Ranganathan VK, Siemionow V, Liu JZ, Sahgal V, and Yue GH. (2004). *Neuropsychologia* 42(7):944–56. Contact elodie.traverse@u-bourgogne.fr

### ELECTROPHYSIOLOGICAL CORRELATES OF SKILL-SPECIFIC MODULATIONS OF COGNITIVE CONTROL IN BADMINTON PLAYERS

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Introduction Recently there have been increasing researches suggest that sports training involving cognitive skills (i.e., open-skilled sports) may be associated with enhanced cognitions. However, sports training has been associated with enhanced aerobic fitness, which is also beneficial for cognitive functions. Thus, it is unclear whether the skill-specific effect of sports training on cognitions can still be observed after accounting for the fitness effect. Accordingly, this study compared neurocognitive performance with those of athletes in other sports requiring less complex cognitive skills (i.e., track and field) to further address this issue. Method We examined the differences in behavioural and event-related potential (ERP) measures during a flanker task involving different levels of cognitive control between badminton players ( $n = 16$ ; aged  $20.68 \pm 1.9$  years;  $VO_{2max} = 55.69 \pm 0.9$  mL/kg·min) and fitness-matched athletic controls ( $n = 16$ ; aged  $20.94 \pm 1.1$  years;  $VO_{2max} = 55.20 \pm 2.1$  mL/kg·min). Result Behaviour data showed that badminton players responded faster than non-players selectively in the condition involving higher level of cognitive control (i.e., response conflict in the incongruent condition). In addition, the ERP data showed that, as compared to the athletic controls, badminton players exhibited smaller N2 amplitudes but greater P3 amplitudes at electrodes around fronto-central areas (i.e., Fz, FCz, CPz). Discussion These combined analysis of behaviour and ERP data suggested that long-term participation in a sport requiring intense cognitive skills (i.e., badminton) may be related to a reduction in task-relevant response conflict, with a concomitant increased top-down attentional control during task execution, thus better task performance. Based on these findings, we conclude that the sport-skill-specific changes in cognitive function might be independent of aerobic fitness, further supporting the claim that mental training in sports may be a medium for cognitive enhancement.

### COMPARISON OF BRJ AND WINGATE ANAEROBIC POWER TESTS ASSAYED BY LACTATE RECOVERY LEVELS IN ALPINE SKIERS

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Introduction Alpine skiers require enhanced anaerobic power capacity as well as explosive power and muscle strength. Therefore, two tests are widely used to elucidate such power values: the rebound squat jump (BRJ) test, pioneered by Bosco (Bosco. C, 1997), and Wingate tests (Petelin von Duvillard. S and Knowles. W. J. 1997). It is generally assumed that the two tests are interchangeable and the choice of which one to use is just a matter of preference. However, whether or not the two tests are indeed interchangeable has not been examined in detail. The purpose of this study is to compare at the physiological level, via lactate levels, the BRJ and Wingate tests, each of 90-s duration. Methods Ten competitive male alpine skiers were the subjects in this study. Subjects performed a 90-s BRJ test immediately after which subjects sat in a resting position and lactate levels were measured at one minute intervals over 30 minutes using a Lactate Pro 2 (Arkray Co., Ltd.) testing blood taken from their fingertips. A resting lactate level was obtained by measuring lactate levels of each subject following 30 minutes of resting in a sitting position prior to the start of a training session. BRJ tests were conducted on force platform equipment. The jump height and power were calculated based on the flight time using Bosco's equation. Subjects performed continuous vertical jumping from the squat position with counter movement. Subjects also did a 90-s Wingate test at 7.5% load of body weight performed at maximal effort on a different day in order to exclude the effects of fatigue and lactate levels were determined as above. Tests were performed using a Powermax II (Konami Co., Ltd.), which is a bicycle type ergometer of infinitely adjustable mechanical resistance in an automated system. Result and Discussion As expected lactate levels decreased over the 30 minute test periods, but there were significant differences between the two profiles. Data for the two methods were fit using linear regression yielding exponential functions for each test type. Maximum lactate values obtained immediately upon finishing each anaerobic power test were significantly different ( $p < 0.01$ ). The Wingate test average max lactate level was  $20.6 \pm 3.1$ mmol / L, while for the BRJ test the max lactate level was  $13.9 \pm 3.1$ mmol / L. Lactate values at the end of the monitoring period, 30 minutes, were also significantly different ( $p < 0.01$ ) between the two anaerobic test types: BRJ  $4.4 \pm 1.5$ mmol / L, and Wingate  $9.7 \pm 3.7$ mmol / L. The higher lactate levels at the 30 minute point in the Wingate test, indicates that cycling makes more anaerobic demands on the body than BRJ. The Wingate test thus appears better suited for analyzing overall anaerobic capacity, but the BRJ contains motions pertinent for alpine skiers. Thus, these current results do not favor one method over another, at least for alpine skiers. Reference Bosco. C, (1997) SCIENCE AND SKIING, 229-250. Petelin von Duvillard. S and Knowles. W. J. (1997) SCIENCE AND SKIING, 229-250.

## COMPARISON OF CHARACTERISTIC OF ANAEROBIC POWERS BETWEEN WORLD RANKED, NATIONAL RANKED SENIOR AND NATIONAL RANKED JUNIOR ALPINE RACERS.

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[Introduction] For alpine skiing, anaerobic power is used for producing the turn and dealing with bumps of surface (Kröll J et al., 2010). Aerobic power is used for continuing turns in entire runs, recovery between runs and competitions and keeping physical condition for a competition season (Neumayr G et al., 2003). To achieve success, alpine racers train both anaerobic and aerobic energy systems. However, the target values are required for the training. The aims of this study were to compare the anaerobic powers within world ranked, national ranked senior and junior alpine racers. [Method] All subjects (world ranked (WR); n=2, national ranked senior (NS); n=10 and national ranked junior (NJ); n=9) were members of the Japanese national team in the tested year. Measured parameters were the following: height (cm), weight (kg), % body fat (%BF: %), fat free mass (FFM: kg), isokinetic knee joint torque (IKKT: Nm/BW), vertical jump height (VJ: cm), counter movement jump height (CMJ: cm), squat jump height (SJ: cm), rebound jump height (RJ: cm) and repeated squat jump height (RSJ: cm). Furthermore, FIS point of slalom (SL) and giant slalom (GS) were obtained from the official FIS website. One-way ANOVA was used for comparisons between the results of senior and junior anaerobic power ( $p < .05$ ) performed by SPSS Statistics 19. Due to the small number of subject from world ranked races, no statistical calculation was used for comparison. [Result] All results of mean values from each group were following: IKKT of right leg extensor (Nm/BW); WR: 4.3, NS: 3.6 and NJ: 3.4, IKKT of right leg flexor (Nm/BW); WR: 2.0, NS: 1.9 and NJ: 1.8, VJ (cm); WR: 55.6, NS: 53.3 and NJ: 52.7, CMJ (cm); WR: 52.0, NS: 47.2, NJ: 45.4, SJ (cm); WR: 46.2, NS: 42.9, NJ: 41.3, RJ (cm); WR: 35.9, NS: 34.0 and NJ: 33.5 and RSJ (cm); WR: 45.6, NS: 44.0 and NJ: 41.2. There were no significant differences between anaerobic powers from the NS and NJ. Although not statistically different, all results of the WR were greater than NS and NJ races, and FIS point of SL from WR was smaller than NS and NJ. [Discussion] Junior races have had already same anaerobic power to senior racers. Greater anaerobic power from the world ranked racers was observed compared to national ranked senior and junior races. Remarkably, fat free mass from world ranked racers was greater than the other skiers (WR: 71.3kg, NS: 65.9kg, NJ: 65.8kg). This difference would influence the relative anaerobic power tests results. Conclusions of this study were to achieve success in the world, senior and junior alpine racers should train anaerobic powers and on snow training. [References] Kröll J, Wakeling JM, Seifert JG, Müller E. (2010), *Med Sci Sports Exerc.* 42(8),1545-56. Neumayr G, Hoernagl HP, R.Koller, A., Eibl G, Raas E. (2003), *Int J Sports Med.* 24, 571-5.

## SPRINT PERFORMANCE AND MAXIMAL STRENGTH: FOURTY YEARS AFTER... AN ANALYSIS OF MASTER SPRINTERS

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Introduction The age-related loss of strength and power is a well known phenomenon but the relationship between this loss and sprint performance has been not, still now, directly investigated. Therefore, the aim of our study was to analyse the decline in sprint and maximal strength performance in master sprinters. Methods We studied 7 master males sprinter aged  $57 \pm 6.1$  yrs who recorded their 1 RM on bench press and squat at the age of twenty. We used Italian Track and Field Federation historical data to get athletes' better performance on 100 mt at the age of twenty. We compared those data with the actual time on 100 mt, moreover we measured 1 RM on squat and bench press to compare with 1 RM recorded at twenty. We measured also squat jump (SJ) and counter movement jump (CMJ) performance. Results As expected there was a significant decreases in all measured performance: bench press from  $89.28 \pm 7.87$  to  $54 \pm 14.45$  ( $p < 0.0001$ ), squat from  $177.14 \pm 50.57$  to  $84 \pm 17.11$  ( $p < 0.0001$ ) and 100 mt time from  $11.13 \pm 0.11$  to  $13.76 \pm 1.66$  ( $p < 0.005$ ). There was no significant correlation between 100 mt performance and bench press or squat 1 RM at twenty (no data are available about SJ or CMJ at that time), moreover no significant correlation was found between current 100 mt performance and SJ, CMJ or bench press 1 RM. A significant correlation was found instead between squat 1 RM and current 100 mt performance ( $r^2 = 0.74$ ,  $p = 0.013$ ). Discussion Our data suggest that whilst there is no correlation between lower limb strength performance (squat) and 100 mt performance at the age of twenty a correlation could be found at the age of 55-60. Interestingly no correlation was found between lower limb power index (SJ and CMJ) and current 100 mt performance. Our data suggest that in older sprint athletes lower limb strength could be related with sprint performance. Contact antonio.paoli@unipd.it

## EFFECTS OF RECREATIONAL FOOTBALL PERFORMED ONCE A WEEK ON CARDIOVASCULAR RISK FACTORS IN MIDDLE-AGED MEN. A RANDOMISED CONTROLLED TRIAL DESIGN.

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Introduction It is well established that there is a strong relationship among physical activity, cardiovascular diseases and mortality. International guidelines recommend at least 150 minutes per week of moderate intensity aerobic training in order to achieve health benefits. Considering the lack of time the major barrier to active life style, the same benefits could be achieved also with lower amount of the recommended training volume. Regular recreational football training induces lowering blood pressure, heart rate at rest, fat percentage, maximal aerobic power (VO2max) and LDL cholesterol (Bangsbo et al., 2014; Krstrup et al., 2013). Despite the popularity and wide diffusion of this sport, no one has investigated the effect of one session per week on cardiovascular risk factors. This study analysed the effect of 1-hour football session per week on middle-aged men. Methods This study used a randomised controlled trial design. Participants were randomized between Football Group (FG) and Control Group (CG). FG performed supervised recreational football training (5-a-side futsal match) on 36 x 18.5 meters synthetic indoor once per week (1 hour) over 3 months. Results After 12 training weeks, VO2max and maximal aerobic speed (MAS) improved in FG respectively of 4.4% ( $p = 0.002$ ) and 5.95% ( $p = 0.01$ ). SBP and MBP improved respectively of 2.5% ( $p = 0.04$ ) and 2.2% ( $p = 0.044$ ) in FG, while DBP didn't change during protocol period ( $p > 0.05$ ). CG didn't show any meaningful variation over the training period. Anthropometric and blood parameters did not change in both FG and CG during the study. Discussion This study is the first examining the effect of 1-hour recreational football session per week on cardiovascular risk factors. Recreational football activity produces health benefits improving VO2max and blood pressure parameters in middle-aged men. This study may have important implications on the prevention of cardiovascular disease and for designing health programs. References Bangsbo J, Junge A, Dvorak J, et al. (2014). Executive summary: Football for health - prevention and treatment of non-communicable diseases across the lifespan through football. *Scand J Med Sci Sport*, 1:147-150. Krstrup P, Randers MB, Andersen LJ, et al. (2013). Soccer improves fitness and attenuates cardiovascular risk factors in hypertensive men. *Med Sci Sports Exerc*, 45, 553-560. Contact Marco Beato (beato.marco@libero.it)

**RUGBY: WHY SANZAR NATIONS WIN SO CONSISTENTLY ?**

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**Introduction** In International Sporting Success, there are several areas of research trying to determinate the critical. And, in spite of paying much bigger salaries, and having much more players, evidence shows that England and France national rugby teams underperform, compared to South Africa, New Zealand and Australia (SANZAR nations). Therefore, the aim of this PhD research was to find some indications on why SANZAR nations win so consistently. **Methods** The methodology used in this research was a bibliographic review, exploratory interviews to SANZAR players and coaches, in Portugal and Brasil. Then five Dimensions were drawn: Balanced Competitions, Resources, Public Policies, Branding and International Strategy. Three hypothesis were raised. We tried to figure out which indicators would best suit this research, to build the Questionnaire, which was applied in 87 interviews on local stakeholders (CEOs and Presidents), in a four months field research. Some semi-structured interviews took place, to understand and connect the data researched. The data was then analyzed through SPSS. **Results** Three countries handled the entire process of professionalization, from 1995, in a completely different pathway from European rugby. Club rugby remains mainly amateur, with representative rugby having an important significance to all three countries researched, and it's only semi-professional. All clubs' competitions are city-based, with compulsory grade teams. Super Rugby and International Teams are fully professional, with a Calendar built to promote sporting success, in all four-tier competition levels. There is no National Governments money in all three countries' rugby, although there are significant public policies that help rugby. The percentage of Pacific Islanders in New Zealand and Australian rugby is above 35% of professional players, most of them raised from local immigrants. There are still racial issues on South African rugby. Travelling so much is believed for some important stakeholders as a major reason for success. **Discussion** Whether this results can or will be replicated, either in Portugal or Brasil, we'll have to wait. In both cases, there are enough data to replicate. Although this research was geographically limited, the sample was a very strong one. In future researches, we would try to reproduce this study at High Schools, Women, 7s, and in under represented regions. **References** De Bosscher, V, De Knop, P, Van Bottenburg, M, Shibli, S, Bingham, J (2009). *Sport Management Review*, 12(3), 113-136. Gerber-Nel, C, Strydom, J (2006). *South African Journal for Research in Sport, Physical Education & Recreation*, 28(1). Harris, J (2013). *Sport in Society*, 16(7), 853-862. Mehra, S. K., Zuercher, T. J. (2006). *Berkeley Technology Law Journal*, 1499-1545. Morgan, M (2002). *Managing Leisure*, 7(1), 41-60.

**Mini-Orals****MO-PM37 Training & Testing: Children****THE EFFECT OF TASK-SPECIFIC PHYSICAL THERAPY ON THE MABC2 IN CHILDREN WITH DCD**

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**Introduction** Children with DCD have difficulties with fine and/or gross motor skills, resulting in slower and less accurate motor performance than their peers (APA, 2013). They participate less often in physical and group activities, making them vulnerable to social isolation and prone to health issues later in life. It has been shown that, on average, they have lower self-esteem and self-worth, higher BMI and lower muscle strength (Rivlis, et al., 2011; Zwicker et al., 2012). To date, however, there has been limited research on interventions designed to improve motor skills in children with DCD. The aim of the present study is to evaluate the effect of task-specific physical therapy on the motor skills of children with DCD measured on the MABC2 by scrutinizing the patient files of DCD-children. **Method** Clinical files of 75 children (4-14 years), diagnosed with DCD, will be used to acquire data on motor skill performance. MABC2 scores will be registered at base-line and at the end of rehabilitation. Descriptive statistics will be presented as mean and standard deviations. Paired sample t-tests will be used to compare pre- and posttests on the MABC2 scores. **Results** Preliminary findings based on the data of three clinical patients show that all three children (mean age 8.7 yrs., base-line MABC2 1st or 2nd percentile) score well over the 15th percentile (ranging from 16 up to 75) after physical therapy (average of 2 times pw, 30-50 min, 25 weeks). The therapy sessions focused on improving balancing skills and aiming and catching skills. **Discussion** The preliminary findings suggest that dedicated motor skill training might be effective in improving the motor skills of children with DCD. After physical therapy, the children's scores on the MABC2 are within the normal range instead of being clinical. Further analyses will be conducted to determine the relationships between age, gender, comorbidity, duration and nature of the training given, and improvements in the outcome scores on the MABC2. **References** American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorder* (5th edition). Arlington AV: APA. Rivlis, I., Hay, J., Cairney, J., Klentrou, P., Liu, J., & Faught, B. E. (2011). Physical activity and fitness in children with developmental coordination disorder: A systematic review. *Research in developmental Disabilities*, 894-910. Zwicker, J., Missiuna, C., Harris, S., & Boyd, L. (2012). *Developmental Coordination Disorder: A review and update*. *E J Paediatric Neurology*, 573-581. Email: j.wolfgang@hhs.nl

**DIFFERENCES IN PHYSIOLOGICAL CHARACTERISTICS BETWEEN PREPUBESCENT FEMALE ARTISTIC AND RHYTHMIC GYMNASTS**

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**1**Sports Medicine Unit, Umeå University, Sweden **2**Faculty of P.E. & Sports Science, National & Kapodistrian University of Athens, Greece **3**Medical School, National & Kapodistrian University of Athens, Greece **Introduction** Performance in gymnastics is the result of the optimal combination of muscle strength, speed and flexibility (Bassa et al., 2002). The purpose of the present study was to investigate differences in physiological characteristics between prepubescent female artistic and rhythmic gymnasts. **Methods** Fourteen prepubescent female rhythmic gymnasts (RG) (age: 10.8 ± 1.0 yrs, body weight: 31.6 ± 4.1 kg, body height: 139.2 ± 7.4 cm) and eleven prepubescent female artistic gymnasts (AG) (age: 10.0 ± 1.4 yrs, body weight: 29.7 ± 5.2 kg, body height: 136.0 ± 9.1 cm) participated in this study. All subjects participated regularly (≥4 days/week) in sport specific training and had a training experience of 4.6 ± 1.5 yrs. Anthropometric characteristics as well as aerobic capacity (20m beep test), flexibility (sit and reach test), lower limbs strength and explosiveness (squat and countermovement jumps respectively), speed (20m sprint) and agility (agility T-Test) were measured. Differences between groups were ana-

lyzed using student's t-test. Results are presented as mean  $\pm$  SD. Results There were no statistical differences between groups in age ( $p=0.16$ ), body weight ( $p=0.31$ ), body height ( $p=0.35$ ), flexibility ( $RG=15.4 \pm 3.8$  vs.  $AG=16.2 \pm 5.1$  cm,  $p=0.65$ ) and agility ( $RG=14.8 \pm 1.1$  vs.  $AG=14.9 \pm 1.3$  cm,  $p=0.81$ ). Artistic gymnasts performed significantly better than rhythmic gymnasts in speed ( $RG=4.1 \pm 0.2$  vs.  $AG=3.8 \pm 0.1$  sec,  $p<0.01$ ), lower limbs strength ( $RG=21.5 \pm 3.0$  vs.  $AG=26.4 \pm 4.2$  cm,  $p<0.01$ ) and explosiveness ( $RG=26.1 \pm 4.1$  vs.  $AG=30.8 \pm 5.5$  cm,  $p<0.05$ ), while rhythmic gymnasts performed better in aerobic capacity ( $RG=1234.3 \pm 288.2$  vs.  $AG=968.9 \pm 172.4$  m,  $p<0.05$ ). Discussion The results of the present study indicate that sport specific training in prepubescent female athletes seems to affect their physiological characteristics according to sports' demands. Both sports demand stability and control of body movement, but since artistic gymnastics is characterized by short and explosive efforts (Mellos et al., 2014), artistic gymnasts seem to perform better in sprint and strength tests, while rhythmic gymnasts seem to be more aerobically trained. References Bassa et al. (2002). J. Hum. Mov. Stud., 42: 213-217 Mellos et al. (2014) Sci. Gymn. J., 6(1): 33-43

## ACUTE METABOLIC, HAEMATOLOGICAL AND BODY COMPOSITION CHANGES IN AN 120 KM ENDURANCE CYCLE RACE

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Introduction Acute responses to endurance events such as triathlon and cycle races have focused on haematological changes, hydration status and physiological factors limiting endurance exercise capacity such as oxygen consumption, exercise economy, lactate threshold, available carbohydrates and fats/lipids and genetics. The research aim was to determine acute responses of metabolic, haematological, pulmonary and body composition changes to a 120km cycle race. Methods The research design, and approved by CDU ethics committee, was a pretest to posttest repeated measures design and data were collected before/after 120km race and participants were predominantly masters level cyclists (male  $n=8$ , mean age=50.6yrs,  $sd=\pm 6.6$ ; female  $n=9$ , mean age=47.8yrs,  $sd=\pm 12.8$ ). Data included age, sex, height, weight, waist circumference, hip circumference to calculate body mass index (BMI) and waist/hip ratio. Body composition and mass were evaluated by bioelectric impedance/analogue scale for body mass, percentage body fat, fat mass in kg, fat free mass (FFM) in kg, total muscle mass in kg, total body water (TBW) in percent and mass in kg, body muscle mass (BMM), bioelectrical impedance in ohms. Haematological factors were packed cell volume (PCV), triglycerides, blood lactate, haemoglobin and glucose. Basal metabolic rate (BMR in kJ/day) was assessed via the bioelectric impedance system with BMR estimation recursion formula multiple regressive analysis using FFM scores. Data were pooled to increase sample size for statistical analysis and a paired t-tests with Bonferroni multiple-significance-test correction was applied. Results Mean finish time was 178.95 and s.d.  $\pm 43.27$  mins. Significant changes occurred in body mass (pre 75.79 vs. 74.33kg,  $p<0.001$ ), BMI (24.00 vs. 23.55,  $p<0.001$ ), PVC (45.43 vs. 44.11,  $p<0.001$ ), blood lactate (3.02 vs. 5.18 mM,  $p=0.008$ ), BMR (7516 vs. 7632kJ,  $p=0.015$ ), % fat (19.52 vs. 16.11%,  $p<0.01$ ), fat mass (14.72 vs. 11.93kg,  $p<0.001$ ), total muscle mass (58.29 vs. 59.46kg,  $p=0.008$ ), bioelectric impedance (577 vs. 542 ohms,  $p<0.001$ ), and trunk fat mass (8.14 vs. 5.97kg,  $p<0.001$ ). Discussion As expected acute changes occurred as significant decreases in total body mass, BMI, PVC, fat mass and bioelectric impedance attributed to water/fluid loss and utilisation of fat/lipid substrates. Significant increases as expected occurred in BMR and blood lactate. All changes indicated a reasonable physical work tolerance in the athletes reflecting positive training adaptations. References Exercise and Fluid Replacement Position Stand, American College of Sports Medicine. (2007). Med Sci Sports Exer, 39; 377-390. Casa D, Armstrong L, Hillman S, Mountain S, Rich B, Roberts W, Stone J. (2000). National J Athletic Training, 35(2): 212-224. Waśkiewicz Z, Kłapcińska B, Sadowska-Krępa E, Czuba M, Kempa K, Kimsa E, Gerasimuk D. (2012). Eur J Appl Physiol, 112(5): 1679-1688. Australian Institute of Sport (2015). Australian Institute of Sport Guidelines – Hydration. <http://www.ausport.gov.au/ais/nutrition/factsheets/hydration>

## ADOLESCENT AWKWARDNESS ON THE SPRINT MOTION IN JAPANESE ELEMENTARY SCHOOL CHILDREN

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The adolescent awkwardness of sprint was investigated from the speed decline; however, the awkwardness of the motion is unclear. PURPOSE: To determine the adolescent awkwardness on the sprint motion in elementary school children. METHODS: Observational sprint motion causal model, which includes 36 checkpoints, was developed based on the biomechanical findings and the descriptive checkpoints of previous studies. All of the observation point was evaluated in the 2-3 category. Intermediate 50m sprint speed (SS) and sprint motion (SM) of 533 children, 1st - 6th grade of elementary school, were recorded by sensor timer and digital video cameras. Their forms were played in slow motion or frame-by-frame, and 4 investigator evaluated the checkpoints. Based on the categorical factor analysis, 25 checkpoints belonged one dimensional scale. These item characteristics, item difficulty and discriminant power, and sprint motion score (SMS) of each subject were calculated applying item response theory. RESULTS: The correlation coefficients between SS and SMS were  $r=0.608$ ,  $p<0.01$  for boys and  $r=0.599$ ,  $p<0.01$  for girls. The SS of both boys and girls were developing linearly. Although the SMS increased linearly until grade 4, the score was not improved at grade 5 (G5) and grade 6 (G6). Focusing on G5 and G6 children, the children was separated into 2 groups; short group (SG) ( $<140$ cm for G5,  $<147$ cm for G6, the criteria was based on the growth index) and Tall group (TG). The SMS of TG was less than that of SG (TG:  $-0.17 \pm 1.10$  vs. SG:  $0.23 \pm 0.84$  for G5 boys, TG:  $0.07 \pm 1.02$  vs. SG:  $0.24 \pm 0.69$  for G5 girls, TG:  $-0.10 \pm 0.63$  vs. SG:  $0.06 \pm 0.61$  for G6 girls) except G6 boys (TG  $0.58 \pm 0.95$  vs. SG  $0.57 \pm 0.58$ ). The correlation coefficient between SS and SMS is significant ( $p<0.05$ ) for both TG and SG of G5 (TG:  $r=.763$  and SG:  $r=.560$  for boys, TG:  $r=.635$  and SG:  $r=.595$  for girls) and for only SG of G6 (SG boys:  $r=.550$ , SG girls:  $r=.589$  vs. TG boys:  $r=-.160$ , TG girls:  $r=.170$ ). The uncorrelated results on TG of G6 is presumed to be due to adolescent awkwardness. CONCLUSIONS: The sprint speed and sprint motion do not develop linearly during growth spurt age. The relationship between sprint speed and sprint motion becomes very low during growth spurt phase on G6 children because of adolescent awkwardness. Supported by Grant-in-Aid for Scientific Research(C), (24500697) Japan.

## COMPELLING OVERUSE INJURY INCIDENCE IN YOUTH MULTISPORT ATHLETES

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Do not insert authors here Introduction Injury epidemiology is imperative for the development of prevention strategies. Apart from football, little is known about injury epidemiology among young elite athletes. The aim of the present study is to examine the incidence of injuries sustained by adolescent highly trained multisport athletes and to compare injury-related variables to exposure data. Methods The injury data were prospectively collected from 152 male adolescent athletes using an injury surveillance system and training exposure data



during 5 consecutive seasons according to injury type, body part, severity and mechanism. An injury was recorded as a physical complaint requiring the attention of the medical staff. Overuse injuries were defined as injuries resulting from the repetition of micro-trauma without a recognizable mechanism and with insidious onset. The severity of an injury was based on time-loss criteria: minor (1–7 days), moderately serious (8–28 days), serious (>28 days–6 months) or long-term (>6 months) (Timpka et al 2014). The training season was from September to the end of June. Results The mean age of the athletes was  $15.1 \pm 1.85$  years. Altogether 643 injuries were documented in 152 athletes. Of these injuries, 87% were time loss (TL) injuries with an incidence of 4.8 per 1000 hours; (95% confidence interval [CI], 4.4–5.2.0). The prevalence of growth related injuries accounted for 22 %. Exposure to training was associated with an increase of overuse injuries (relative risk [1.03]). The most commonly diagnosed type of injury was muscle and tendon injuries (30.1%). Most injuries were located at the lower extremities (67%), with the majority affecting the foot and ankle (22%). There were 53% minor injuries, 34% moderately serious injuries, and 13% serious injuries. TL overuse injuries amounted to 44% with an incidence of 2.4 (95% confidence interval [CI], 2.1–2.7) per 1000 hours exposure. Injury occurrence followed a seasonal fluctuation trend peaking in March. Discussion This study revealed high rates of overuse injuries resulting in time loss, although most injuries were minor. Even though many injuries were rated as minor which does not cause immediate impairment, these injuries in adolescents may have long-term consequences. A higher prevalence of growth injuries compared to previously reported studies. Comparing our findings on time-loss injuries are consistent with other studies of similar methodology in youth soccer athletes. Overuse injuries of the knee and traumatic injuries for the ankle were commonly reported in our study, suggesting a need for the implementation of specific injury prevention strategies. References Timpka T, et al. Br J Sports Med (2014); 48:483–490

## THE IMPACT OF LONG-TERM ATHLETIC TRAINING ON MOTOR, COGNITIVE, AND ACADEMIC PERFORMANCE IN YOUTH ATHLETES

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Introduction: Several sports (e.g., gymnastics) demand an early start into long-term athlete development because peak performances are achieved at a relatively young age (Myer et al., 2015). The challenging combination of extensive training loads and academic demands may impede youth athletes' cognitive and academic performance (Myer et al., 2015, Brettschneider, 1999). The aims of this study were to examine how long-term athletic training (AT) affects youth athletes' motor, cognitive, and academic performances. Methods: The study was conducted at a German primary school with a specific program for youth athletes. Overall, 45 prepubertal fourth graders from a youth athlete class (YC) and a regular class (RC) participated in this study. Twenty students were enrolled in YC (age  $9.5 \pm 0.5$  years, Tanner I+II) and 25 students in RC (age  $9.6 \pm 0.6$  years, Tanner I+II). Over one school year YC performed AT that consisted of physical education (PE) and sport-specific training (i.e., gymnastics, swimming, athletics, football, BMX) while RC conducted PE only. All students were tested for their motor (i.e., 20-m sprint, star-agility run, 1-kg ball push, standing long jump, stand-and-reach test, single leg stand, 6-min run), cognitive (i.e., d2-test), and academic performance (i.e., reading [ELFE], writing [Hamburger Schreibprobe], calculating [Deutscher Mathematiktest]). In addition, we obtained German, English, Mathematics, and PE marks from the school report. Analyses were conducted using an ANCOVA model. Further, Cohen's d was calculated. Results: At baseline, YC performed significantly better than RC in 4 out of 7 motor performance tests ( $p < 0.01$ ;  $d = 0.61$ – $2.29$ ), but not in cognitive and academic achievements. The AT volume amounted to 585 min/week for the YC and PE volume was 156 min/week for the RC. After the one-year intervention, significant differences were found in 6 out of 7 motor performance tests ( $p < 0.05$ ;  $d = 0.75$ – $1.40$ ) as well as in German and PE marks ( $p < 0.05$ ;  $d = 0.75$ – $1.56$ ) in favor of YC. Yet, AT did not produce any significant differences between YC and RC in the d2-test, in writing, reading, calculating, and in Mathematics and English marks ( $p > 0.05$ ;  $d = 0.20$ – $0.43$ ). Discussion: Our results revealed that a one-year AT in addition to PE improved motor and selected academic performances in YC compared to RC. It can be concluded that intensive training in combination with regular school demands does not impede youth athletes' cognitive and academic performances. References: 1. Myer, G.D., N. Jayanthi, J.P. Difiore, A.D. Faigenbaum, A.W. Kiefer, D. Logerstedt, L.J. Micheli, 2015, Sports Health: A Multidisciplinary Approach. 2. Brettschneider, W., 1999, European Physical Education Review. 5(2): p. 121-133.

## Mini-Orals

### MO-PM44 Molecular Responses to Exercise

#### EFFECTS OF SPRINT AND ECCENTRIC TRAINING ON APOPTOSIS AND MHC MRNA IN RAT SKELETAL MUSCLES

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Introduction Apoptosis or cell programmed death plays important roles in retain of tissue and cellular homeostasis. Many transcription factors regulate it that one of them is FOXO1. Also, it has been shown that FOXO1 induces fiber type transition (Sanchez et al., 2014). We aimed to see the effects of sprint interval exercise and eccentric exercise on FOXO1 as an apoptosis factor and fiber type transition in rat skeletal muscles Methods Forty young male Sprague-Dawley rats (190–235 g) divided into 5 groups of 8; chronic and acute sprint interval (CSI and ASI), chronic and acute eccentric (CE and AE) and control (C). ASI was running with 10 m/min to 85 m/min which gradually increased in 3 consecutive days that included 7 sets of 1 min with rest interval of 3 min in between. CSI was sprinting 1 min and 2–5 min rest between sets (6–10 sets/days, 5–6 days/weeks) on treadmill for 9 weeks (Ogura et al., 2005). CE was running on treadmill in 3 days of week for 9 weeks, that slope and duration gradually managed from  $-4^\circ$  to  $-16^\circ$  and 15 min to 90 min, respectively. AE group was running with 16 m/min on  $-16^\circ$  slope for 3 consecutive day that included 18 sets of 5 min with rest interval of 2 min in between (Chiang et al., 2009). Soleus and SVL muscles mRNA were analyzed by real-time PCR. Results FOXO1 mRNA did not change significantly in both muscles of sprint interval groups and in soleus of eccentric groups, but SVL FOXO1 mRNA levels increased by 3.92-fold in AE and decreased 0.56-fold in CE group. In soleus muscle of AE and CE groups, fast MHC isoforms mRNA expression decreased significantly and in CSI group slow MHC decreased. In SVL muscle, MHC I increased in ASI and MHC IIb decreased in CSI, MHC I, IIa and IIx increased in AE group and MHC IIa and IIx increased in CE group. Discussion AE increases and CE decreases FOXO1 mRNA in SVL muscle. Eccentric exercise produces more muscle damage that accompanies to more oxidative stress in skeletal muscles (Silva et al., 2013), that stimulates FOXO1 activation. If exercise bout repeated, adaptations stimulated such as decreased in muscle damage, that leads to a decrease in FOXO1

activation. Changes in transcriptional activation and/or in MHC mRNA stability could be alter MHC isoforms in mRNA level (Caiozzo et al., 1996), that can represent a more important factor in fiber type transition (Yuan et al., 2011). References Caiozzo, V.J., Haddad, F., Baker, M.J., Baldwin, K.M. (1996). *J. Appl. Physiol*, 80, 1503-1512. Chiang J, Shen YC, Wang YH, Hou YC, Chen CC, Liao JF, Yu MC, Juan CW, Liou KT. (2009). *Eur. J. Pharmacol*, 610, 119-27. Ogura, Yuji, Hisashi Naito, Junichiro Aoki, Jin Uchimaru, Takao Sugiura, and Shizuo Katamoto. (2005). *ijphysiol*, 55, 309-16. Sanchez, A. M., R. B. Candau, and H. Bernardi. (2014). *Cell Mol Life Sci*, 71, 1657-71. Silva, L., Bom, K., Tromm, C., Rosa, G., Mariano, I., Pozzi, B., Tuon, T., Stresck, E., Souza, C. Pinho, R. (2013). *Braz. J. Med. Biol. Res*, 46, 14-20. Yuan, Y., Shi, X.E., Liu, Y.G. Yang, G.S. (2011). *Mol Cell Biochem*. 348, 77-87. Contact N.khaledi@khu.ac.ir

## MUSCLE DAMAGE OF BODYBUILDERS AFTER AN UNACUSTOMED STRENUOUS RESISTANCE TRAINING SESSION

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**Introduction** Muscle damage is induced by unaccustomed exercise consisting of eccentric contractions, and is best indicated by a prolonged loss of muscle function [1]. Delayed onset muscle soreness (DOMS) is considered to be a symptom of muscle damage, but its magnitude does not necessarily correspond with the magnitude of muscle damage [2]. Anecdotally, bodybuilders experience DOMS after resistance training, however no previous studies have reported muscle damage of bodybuilders. Newton et al. [3] reported faster recovery of muscle function after unaccustomed elbow flexor eccentric exercise for resistance-trained than untrained men, but found similar magnitudes of DOMS between groups. Thus, the present study tested the hypothesis that reductions in muscle function and increases in plasma creatine kinase (CK) activity following an unaccustomed training session would be small, but DOMS would still be developed in bodybuilders. **Methods** Ten male bodybuilders (age:  $23 \pm 2$  y, height:  $176 \pm 4$  cm, body mass:  $85 \pm 8$  kg) with a minimum of 3-y resistance training experience were recruited for the study. They performed a large volume of exercises targeting the pectoral muscles, consisting of 5 exercises at 8-12 repetitions with a moderate load followed by 12 exercises to volitional failure. Muscle function measures in barbell bench throw (e.g. peak force, peak velocity), isokinetic maximal elbow extension torque and muscle pain during palpation of the clavicular and sternal portion of the chest using a visual analogue scale (VAS: 100-mm) were taken before, immediately after, and 1-3 days after exercise. Results Significant changes in all variables were observed after exercise ( $P < 0.05$ ). For example, peak force in barbell bench throw decreased immediately ( $23 \pm 20\%$ ) and 1 day after exercise ( $9 \pm 15\%$ ) but returned to baseline ( $930 \pm 129$  N) by 2 days post-exercise. Additionally, other muscle function measures showed similar changes. DOMS developed after exercise and peaked 1-day post-exercise (e.g.  $57 \pm 22$  mm for the clavicular portion of the chest). No significance changes in plasma CK activity were observed after exercise. **Discussion** These results were similar to that shown by the previous study of resistance-trained men [3]. Despite small decreases in muscle function 1-day post-exercise, DOMS showed higher values than the levels that the participants usually experienced after their regular training sessions. It appears that regular resistance training had conferred a protective effect against muscle fibre damage, but bodybuilders are still susceptible to DOMS, which may be associated with connective tissue damage and inflammation [2].

## DYNAMICS OF SKELETAL MUSCLE DAMAGE MARKERS IN THE BLOOD AND CHARACTERISTICS ASSOCIATED WITH FULL MARATHON-INDUCED IMMEDIATE ONSET MUSCLE SORENESS

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**Introduction** It has been reported that muscle soreness occurs during or immediately after prolonged exercise, such as after running a full marathon. Our group has termed this form of muscle soreness, immediate onset muscle soreness (IOMS) [1]. It was estimated that muscle damage due to extensive mechanical stress and metabolic stress occurred with the onset of IOMS. Primary skeletal muscle damage markers with delayed onset muscle soreness after excessive exercise were as follows: creatine kinase (CK) activity, lactate dehydrogenase (LDH) level, aspartate aminotransferase (AST) level and aldorase (ALD) level in blood. These markers all displayed similar dynamics [2,3]. However, it was unclear whether these markers exhibited the same dynamics for both DOMS and IOMS. This study aimed to elucidate the dynamics of each skeletal muscle damage marker following IOMS. **Methods** A total of 20 subjects (males: 18; females: 2) participated in a full marathon race. Muscle soreness was evaluated using a numeric rating scale (NRS) at before (pre) and immediately after (post) exercise, at 1-4 days (Day 1-Day 4), and 7 days (Day 7) after exercise. Skeletal muscle damage markers in the blood were measured, including serum CK activity, LDH level, AST level and ALD level at each time point. Results Peak muscle soreness was immediately observed after the full marathon-induced appearance of IOMS. With regards to the skeletal muscle damage markers in blood, CK significantly increased postexercise and peaked on Day 1, with AST exhibiting a similar trend. LDH demonstrated a peak value postexercise and maintained significantly elevated levels until Day 4 compared with the pre-exercise values. However, levels began to decrease after Day 1. ALD significantly increased from postexercise and peaked on Day 3. **Discussion** The appearance of IOMS was confirmed because muscle soreness peaked postexercise in each body part. Blood levels of LDH, CK and AST peaked at postexercise or Day 1 after the full-marathon involving IOMS, which was clearly different from DOMS dynamics, which peaked at 3 or 4 days after extensive exercise. However, ALD peaked on Day 3 in IOMS, which was different from the other makers. These were different from similarly peaked appearances after 3 or 4 days for DOMS in these markers. Future research should investigate the characteristics of these skeletal muscle damage markers in the blood following IOMS to determine the mechanisms by which this condition occurs. References 1.) Ishikura K, Miyazaki T, Song-Gyu R, Ohmori H (2014). *Adv Exerc Sports Physiol* 20 (1), 9-17. 2.) Ra SG, Miyazaki T, Ishikura K, Nagayama H, Komine S, Nakata Y, Maeda S, Matsuzaki Y, Ohmori H (2013) *J Int Soc Sports Nutr* 10:51. 3.) Kanda K, Sugama K, Sakuma J, Kawakami Y, Suzuki K (2014) *Exerc Immunol Rev* 20, 39-54. Contact Tokinoya, K. [s1521474@u.tsukuba.ac.jp] Ohmori, H. [ohmori@taiiku.tsukuba.ac.jp]

## MCP-1, TNF-ALPHA AND NGF CHANGES AFTER PROLONGED RUNNING

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Marathon and ultra-marathon running evokes significant changes in numerous body functions. Several biomarkers prove microtraumatic damage of skeletal muscles, connected to inflammatory reaction during prolonged continuous running performance. The changes of monocyte chemoattractant protein-1 (MCP-1), tumor necrosis factor alpha (TNF alpha) and nerve growth factor (NGF) were rarely studied. **PURPOSE:** To determine changes of MCP-1, TNF alpha and NGF after endurance running (duration 3 to 24 hours). **METHODS:** 35 volun-

teeres participated in 3 different runs covering 42.2 km, 100km and/or 24-hour run. Blood samples taken prior to the run and after the finish were studied with the help of immunoanalysis. RESULTS: Significant encrease after the run was observed in MCP-1 ( $423 \pm 163$  rose to  $909 \pm 327$  pg/ml), TNF-alpha ( $4.08 \pm 1.56$  rose to  $5.29 \pm 2.09$  pg/ml) and NGF ( $1.48 \pm 0.66$  rose to  $1.95 \pm 0.76$  pg/ml). From the personalized medicine point of view marked differences in the reaction of individual runners were found. However, no correlations between the running duration and MCP-1, TNF alpha and NGF were observed. CONCLUSION: Changes in MCP 1 and TNF alpha after the running race of long duration may be partly explained by inflammatory overstrain reaction of athletes' muscle tissue. The mechanism of increased NGF after the race is not clear and should deserve further investigations.

### IMPACT OF HFE GENE MUTATION ON EXERCISE PERFORMANCE IN MICE

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Introduction Iron is essential in erythropoiesis and other metabolic and physiological functions. Hfe is the central protein implicated in the regulation of iron metabolism. In elite athletes, its level appears to be increased. Hemochromatosis, caused by a homozygous mutation of the HFE gene, is characterized by a low level of hepcidin and iron overload in different organs of the body. A close relationship between heterozygosity for the HFE gene and physical performance has recently been demonstrated. Indeed, athletes who access the international podiums have a high frequency of heterozygous mutation of the HFE gene (80%) (Hermine and al., 2015). The objective of the study is to evaluate the effects of the HFE gene mutation on exercise performance in HFE - / - knock-out (KO), HFE + / + wild-type (WT) and heterozygote (HT) mice. Methods Twenty four (8 KO 8 HETE 8WT) male were used in this study. Mice were followed from the age of 7 months to 24 months. Their body composition was measured by magnetic resonance (Bruker, Germany). Rest parameters (i.e. energy expenditure (EE),  $\dot{V}O_2$ , respiratory exchange ratio ( $RER = \dot{V}CO_2 / \dot{V}O_2$ ), feeding behavior and motor activity) were analyzed over a 72 h period in 7 months old mice. All the animals performed running exercises on a motorized treadmill equipped with an indirect calorimetry system (Phenomaster, TSE, Germany) to evaluate their maximal oxygen consumption ( $\dot{V}O_2$  peak) and the maximal running speed at 75% of  $\dot{V}O_2$  peak ( $V_{max}$ ). Their heart function was monitored by echocardiography. Results KO mice at 7 months had a significantly higher body mass and lean mass until the age of 14 months ( $p < 0.05$ ,  $p < 0.001$ ). The 7 months old KO mice had a significantly lower energy expenditure than WT mice during daytime phase ( $p < 0.01$ ). In nocturnal phase, KO mice (7 months) had a significantly greater ambulatory activity.  $\dot{V}O_2$  were significantly lower in KO mice during daytime phase ( $p < 0.01$ ). These first results showed no significant difference of  $\dot{V}O_2$  peak (ml.kg<sup>-1</sup>.h<sup>-1</sup>) between the different groups. The distance (m) and the trip time (sec) observed for HT and KO mice at 7 months was significantly greater than WT mice ( $p < 0.01$ ). RER peak is lower in KO mice after exercise than in WT mice at 7 months. These differences disappear with aging. The study of cardiac function by echocardiography showed systolic dysfunction in young and old KO mice compared to HT and WT mice. Discussion Our results show that muscle mass seems to confer selective advantage in KO mice for exercise performance. After exercise, the RER of 7 months old KO mice was lower than WT mice suggesting that their higher lean mass could improve their recovery capabilities after exercise. Finally, the systolic dysfunction might be one of the causes that could explain the higher decline in exercise performance of KO mice with age. Reference Hermine, O. et al 2015. Eighty percent of French sport winners in Olympic, World and Europeans competitions have mutations in the hemochromatosis HFE gene. *Biochimie*, 119, 1-5.

### ASSOCIATION BETWEEN THE WEIGHT CLASS OF JUDO ATHLETES AND GENETIC POLYMORPHISMS RELATED TO THE PHENOTYPE OF SKELETAL MUSCLE

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Introduction Genetic polymorphisms influence sports performance, physical fitness, and body size (including skeletal muscle mass, fat mass), suggesting that the weight class of judo athletes can be affected by genetic factors. However, to date, there has been no research regarding the influence of genetic polymorphisms on weight class in sports. The purpose of this study was to investigate the association between the weight class of judo athletes and genetic polymorphisms related to the phenotype of skeletal muscle. Methods The study subjects included 156 male judo athletes from top-level universities in Japan. They were divided into three groups based on weight class. "Light class" was defined as -60 kg and -66 kg; "Middle class" as -73 kg, -81 kg, and -90 kg; and "Heavy class" as -100 kg and +100 kg. DNA was extracted from their saliva and genotyped for alpha actinin 3 (ACTN3) [rs1815739], angiotensin I-converting enzyme (ACE) [rs1799752], insulin-like growth factor 2 (IGF2) [rs680], interleukin 15 receptor subunit alpha (IL15Ra) [rs2296135, rs2228059], myostatin (MSTN) [rs1805086], ciliary neurotrophic factor (CNTF) [rs1800169], CNTF receptor (CNTFR) [rs41274853], and cyclin-dependent kinase inhibitor 1A (CDKN1A) [rs1801270] gene polymorphisms. Controls were individuals from the general Japanese population with known genotyping as reported in previous studies. Genotype distribution among the weight class of the judo athletes and controls were compared using chi-square tests. Results There was a significant difference in the genotype frequency of CDKN1A gene among the Light class but not the Middle and Heavy classes, compared with the controls (Light class: 42.9% for CC, 42.9% for CA and 14.3% for AA vs. Controls: 23.9% for CC, 53.7% for CA and 22.4% for AA). However, there were no significant differences in the genotype frequency of ACTN3, ACE, IGF2, IL15Ra, MSTN, CNTF, and CNTFR genes among all the weight classes of those judo athletes. Discussion and Conclusion CDKN1A gene (p21) is essential for myogenic stem cell function, such as cell cycle and differentiation. Hence, the CDKN1A gene polymorphism may be associated with the weight class of judo athletes, although further studies are needed. References Bray MS, Hagberg JM, Perusse L, Rankinen T, Roth SM, Wolfarth B, Bouchard C (2009). *Med Sci Sports Exerc*, 41(1), 35-73. Itaka T, Agemizu K, Aruga S, Machida S. *J Strength Cond Res*, in print. Contact machidas@juntendo.ac.jp

## Mini-Orals

### MO-PM42 Women's Health

#### STATISTICAL METHODS FOR THE ESTIMATION OF BODY SHAPE BY FITTING 3D WHOLE-BODY SCANNING DATA TO HOMOLOGOUS BODY MODEL IN JAPANESE ELITE FEMALE ATHLETES

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**Introduction** In anthropometry for the athletes such as to talent identification and development, characteristics in body shape are one of the most important parameters as the results of specific physical training and /or routine workout performed. Until now, these parameters were typically measured under manually skilled techniques in anthropometry. In recent years, high sensing techniques in whole body measurement system for humans (that is called "Bodyline Scanner", Hamamatsu Photonics K.K., Japan) was developed [1], which shape data converts to Homologous Body Model (HBM) and identify the characteristic of its shape using statistical methods [2]. The purposes of present study were to obtain 3D whole body laser scan data and by fitting HBM, statistical characteristics in body shape were to develop especially for Japanese female sedentary and athletes in different athletic levels. Methods Newly developed Bodyline scanner (BLS) was capable of digitizing whole body shape as three dimensional coordinates in the order of 2.5mm intervals in space (normal adult body shape put in ~500,000 points). The principle of the measuring method was optical triangle measurement, in which light source was using a laser diode. The color information was used to detect the position of land mark seals which was pasted on the skin according to the anatomical basis in human anthropometry. HBM was constructed by fitting the whole body laser scan data to standardized template (generic) model. Template model was used as Dhaiba model which was developed from Japanese in large populations by Digital human research group of National Institute of Advanced Industrial Science and Technology (AIST). A statistical body shape model (SBSM) was developed by using principal component (PC) analysis in specific HBM group. Fifty females including athletes and sedentary persons aged from 15 to 21yrs were served as subjects. Results and Discussion Using this newly developed methods, characteristic in body shape for female athletes were evident. Softball female athletes, for example, statistically characterized body shape was as follows; 1st PC: body size such as height and limb length, 2nd PC: circumference in lower trunk and hip, 3rd PC: thickness of upper trunk. PC scores were associated with anthropometric variables and specific body shape for elite athletes could be evaluated by plotting the PC scores in x-y coordinates. Conclusion The methods for evaluating body shape statistically by fitting the whole body scan data to homologous body model is useful for reliable prediction of specific body shape of female elite athletes. References [1] Funato, K. et al. (2012) Proc. Asian Workshop on 3D scanning technologies. [2] Park, B-K and Reed, M.P.(2015) Ergonomics, 58, 1714-1725. Contact: funato@nittai.ac.jp

#### INFLUENCE OF INCREASED TRAINING VOLUME ON IRON STATUS IN WELL-TRAINED FEMALE LONG DISTANCE RUNNERS

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**Introduction** Since iron is essential for providing oxygen into working muscles during exercise, iron deficiency leads to decrement of endurance capacity in endurance events. However, mechanism for iron deficiency among endurance athletes remains unclear. The purpose of the present study was to compare iron status among three periods with different training volume in well-trained female long distance runners. Methods Sixteen female long distance runners participated in the present study. During 8 months of intervention period, fasting blood samples were collected at the onset the intervention period with lower training volume (LOW), general training period with moderate training volume (MOD) and intensified training period with high training volume (INT) to determine blood hematological parameters, iron parameters, inflammatory parameters. Psychological parameters and 3 day of food diary were also assessed. Results Body weight did not differ significantly among three periods, while lean body mass was significantly higher in the MOD and INT compared with LOW ( $P < 0.05$ ). Hemoglobin concentration was not significantly different among three periods, but transferrin saturation (TSAT) was significant higher in INT than in LOW ( $P < 0.05$ ). Energy intake and iron intake from daily diet was significantly higher in INT than in LOW ( $P < 0.05$ ). However, 44% (LOW), 25% (MOD) and 25% (INT) of total subjects were evaluated as iron deficiency. Discussion The iron status was improved during intensified training period, with concomitant increase in iron intake. However, in spite of increase in iron intake during intervention period, 25% of the subjects remained iron deficient during intensified training period. Therefore, increased iron intake was not fully successful to overcome iron deficiency among female long distance runners. A potential mechanism may be augmented hepcidin (iron regulating hormone), which plays a role in inhibiting iron metabolism (Ziemann et al. 2013). Reference Ziemann E, Katarzyna K, Kasperska A, Zembron-Lacny A, Antosiewicz J, Laskowski R (2013). J Sports Sci Med, 12, 249-258

#### COMBINED ORAL CONTRACEPTIVES INCREASE OXIDATIVE STRESS INCREASE IN FEMALE ATHLETES

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**INTRODUCTION** In athletes oxidative stress is a recognized causative agent of muscle redox imbalance that can promote muscle fatigue and injury, thus impairing the exercise performance (Jakson et al. 2011). However, so far, few studies focused on female athletes. Some evidence suggested that female athletes were more susceptible to oxidative stress than male athletes (Sackeck et al, 2000), but the use of contraception was not addressed. We aimed to investigate oxidative stress in sportswomen of different disciplines according to oral combined contraceptive (OC) use and lifestyle/alimentary habits. **METHODS** Italian sportswomen, regularly performing 5 or more hours weekly of sport activity, including training and competitions ( $n=144$ ; mean age  $23.4 \pm 4.2$  years; body-mass-index  $21.2 \pm 2.2$  kg/m<sup>2</sup>; sport activity  $9.2 \pm 4.1$  hours/week) were analyzed, 48% were volleyball players, followed by soccer players (12.5%), track-and-field sports (10.4%), and other disciplines. Oxidative stress was evaluated by blood lipid peroxidation and free oxygen radical defense levels (according to Francescato et al, 2014) (FORT and FORD Units, respectively, Callegari, Italy) in OC-users ( $n=42$ ) compared to non-OC-users. Stratification of lipid peroxidation was performed by the threshold of 310 FORT Units as high level (Kamhieh-Milz and Salama 2014). **RESULTS** Elevated oxidative stress levels ( $\geq 310$  FORT Units) were found in 92.9% of OC-users and in 23.5% of non-OC-users (OR=42, 95%CI, 12-149).



Continuous values of oxidative stress FORT Units were 2-fold higher in OC-users versus non-OC-users ( $p < 0.001$ ), and were inversely related to free radicals defense FORD Units in OC-users ( $p = 0.01$ ). Hours of exercise/week, age, coffee consumption, and smoke had no association with continuous values of oxidative stress. In non-OC-users only, oxidative stress was positively correlated with weight ( $p = 0.009$ ), BMI ( $p = 0.002$ ), and inversely correlated with chocolate ( $p = 0.009$ ), and fish consumption ( $p = 0.029$ ). CONCLUSIONS Oxidative stress in competitive athletes is a matter of study and debate, because markedly elevated oxidative stress in athletes could be detrimental to physical activity and elevate cardiovascular risk (as effort thromboembolism). Further research is needed to extend our results, to clarify the biochemical pathways leading to increased lipid peroxidation and reduced anti-oxidant defense, and to elucidate the potential effects on athletic performance according to gender. OC use should be considered by clinicians, coaches, sport trainers and athletes themselves when developing strategies to reduce oxidative stress in female athletes. References Jackson MJ (2011) Antioxid Redox Signal 15:2477-2486. Francescato MP, Stel G, Geat M, Cauci S (2014) PLoS One 9:e99062. Kamhieh-Milz J, Salama A (2014) Oxid Med Cell Longev 2014:720347. Sackeck JM, et al. (2000) Eur J Appl Physiol. 83:40-46. CONTACT sabina.cauci@uniud.it

## THE ROLE OF ORAL CONTRACEPTION IN THE EFFECT OF BODY TEMPERATURE ON SKIN BLOOD FLOW DURING EXERCISE IN THE HEAT

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Introduction Progesterone-related elevation in core body temperature ( $T_c$ ; Rogers and Baker 1997) is observed in normally-menstruating women (WomenNM) during the luteal phase of the menstrual cycle and in women taking a combined oral contraceptive (WomenOC) when compared to WomenNM during the follicular phase (Kolka et al. 1997; Gruzca et al. 1993). Consequently, there is an increasing requirement for skin blood flow (BFsk) to mediate  $T_c$  in WomenNM in the luteal compared to the follicular phase during heavy-intensity exercise in the heat (Kolka et al. 1997). The purpose of this study was to compare  $T_c$  and BFsk responses to exercise in the heat between WomenNM (follicular) and WomenOC. Methods Eight WomenOC and eight WomenNM performed two (i. 22 (TEMP), and ii. 35 (HEAT) degrees Celsius), 3-stage cycling trials comprising  $T_c$  and BFsk measurements at laboratory arrival (i.e., baseline; BL), and after 60 min of seated rest in the prescribed environment (i.e., REST), 30 min of cycling at 90% of lactate threshold 1 (LT1; Stage 1), 15 min at 135% LT1 (Stage 2), and 7.5 min at 180% LT1 (Stage 3). Fully-factorial ANOVA with LSD pairwise comparisons was used to determine statistically significant differences at  $p < 0.05$ . Results WomenOC had higher  $T_c$  compared to WomenNM from BL until 22.5 min of Stage 1 in both conditions ( $p < 0.05$ ). There were no further differences in  $T_c$  between the two groups in either trial ( $p > 0.05$ ). The relative (%) increase in BFsk from REST to 7.5 min of exercise at LT1 was greater in the HEAT compared to the TEMP trial for both groups ( $p < 0.01$ ). BFsk was stable during Stage 1 of the TEMP trial ( $p > 0.05$ ) and increased similarly in both groups at Stage 2. After the sharp increase in BFsk from REST to 7.5 min of Stage 1 during the HEAT trial, no further change in BFsk was observed for WomenNM ( $p > 0.05$ ), whereas BFsk increased to 15 min of Stage 1 in WomenOC ( $p < 0.01$ ) and remained elevated. Discussion The findings of the present study demonstrate that women taking a combined monophasic oral contraceptive pill exhibit greater BFsk compared to normally-menstruating women (follicular) that is only evidenced beyond a certain requirement for heat loss i.e., during exercise in a hot, but not temperate, environment. This redistribution of blood flow during exercise would require increased cardiac output to maintain muscle perfusion during high-intensity exercise. 1. Rogers, S., Baker, M. (1997). Eur J Appl Physiol, 75, 34-38 2. Kolka, A., Stephenson, L. (1997). J Appl Physiol, 82, 1079-1083 3. Gruzca, R., Pekkarinen, H., Titov, E., Kononoff, A., Hanninen, O. (1993). Eur J Appl Physiol, 67, 279-285

## CHANGES IN ESTROGEN AND PROGESTERONE LEVELS DO NOT RELATE WITH VO2 DURING MENSTRUAL CYCLE IN FEMALE ATHLETES

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INTRODUCTION The most relevant hormones during menstrual cycle are estrogen and progesterone. These hormones levels change during the different phases of the menstrual cycle and may improved or decreased performance at different times throughout menstrual cycle (1). For this reason, those hormonal variations have been related with the difference VO2 values in woman athletes (1-3). Thus, the aim of this study is to investigate the relationship between hormone levels along menstrual cycle and VO2 during a constant endurance exercise. METHODS Six endurance-trained women ( $58.7 \pm 5.07$  kg,  $163$ ,  $2 \pm 4.9$  cm and  $37.1 \pm 4.3$  yrs) performed a maximal graded test and three continuous running sessions of 40 min at 75% of the VO2max velocity (vVO2max) on each phase of their menstrual cycle (early follicular phase, midfollicular phase and luteal phase). VO2 values of the two intermediate min of each 10 min period were averaged and considered for the analysis. A blood sample was obtained on each phase to measure estrogen, progesterone, FSH and LH levels. RESULTS There was not significant correlation between VO2 and estrogen, progesterone, FSH or LH levels ( $p > 0.05$ ) on early and midfollicular phases. However we found a borderline significant correlation in luteal phase between VO2 and progesterone ( $r = 0.771$ ;  $p = 0.072$ ), and between VO2 and FSH ( $r = 0.771$ ;  $p = 0.072$ ). DISCUSSION We found an increase on VO2 as progesterone and FSH levels rise, but only during luteal phase. These relations have not been previously reported, maybe because most of the studies compare VO2max instead of VO2 at a submaximal and constant intensity (1-3). These data suggest that from the two most relevant hormones of the menstrual cycle, the variations of progesterone during the luteal phase can affect VO2 levels, which could finally influence in athlete performance. REFERENCES 1. Sunitha G, Ravi BN, Sudhir. GK. (2013) Journal of Evolution of Medical and Dental Sciences, 2(23):4070-8. 2. Dean TM, Perrault L, Mazzeo RS, Horton TJ. (2003). Journal of Applied Physiology, 95:2537-43. 3. Smekal G, Von Duvillard S.P, Frigo P, Tegelhofer T, Pokan R, Hoffman P, et al. (2007) Medicine & Science in Sport & Exercise, 39(7):1098-106.

## INFLUENCE OF MENSTRUAL CYCLE ON RESPIRATORY AND PERCEIVED EXERTION VARIABLES: A PILOT STUDY

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Introduction Respiratory variables and Rating of Perceived Exertion (RPE) can vary depending on the menstrual cycle phase (Smekal et al., 2007; Janse de Jonge, 2003). Though many researches compare the luteal (LP) and follicular phase, there are few studies which split the latter into early follicular phase (EFP) and mid follicular phase (MFP), although hormone levels are different between both phases (Smekal et al., 2007; Janse de Jonge, 2003). Therefore, the main objective of this study is to compare the three phases of the menstrual cycle heading to respiratory variables as well as the RPE. Methods Seven endurance trained females ( $37.1 \pm 4.3$  yrs;  $58.7 \pm 5.1$  kg;  $163.2 \pm 4.9$  cm;  $50.17 \pm 2.83$  VO2max) performed a maximal graded test and three continuous running sessions of 40 min at 75% of the VO2max velocity

at each phase of their menstrual cycle (EFP, MFP and LP). Ventilation (VE), VO<sub>2</sub> and Respiratory Exchange Ratio (RER) were measured; values of the two intermediate min of each 10 min period were averaged and considered for the analysis. RPE was measured by Borg 6-20 Scale every 10 min. Results Friedman ANOVA showed no significant differences in RER and RPE among menstrual cycle phases. However, a trend to significance was found in the 20-30 period ( $p=0.06$ ) and 30-40 period ( $p=0.06$ ) for VE, presenting higher VE during these periods on LP session (20-30 period= $84.5 \pm 9.6$  l/min; 30-40 period= $86.2 \pm 9.8$  l/min) than VE on EFP session (20-30 period= $79.2 \pm 10.12$  l/min; 30-40 period= $81.56 \pm 11.8$ ). Another borderline significance appears for VO<sub>2</sub> measured within 20-30 period ( $p=0.084$ ), being higher for the value of LP session ( $44.18 \pm 6.09$  ml/kg/min) than the one of MFP ( $43.46 \pm 3.17$  ml/kg/min). Discussion Some studies reported higher VE and VO<sub>2</sub>max levels on LP compared to the follicular phase for athletes exercising at 80% and 100% VO<sub>2</sub>max (Williams et al., 1997; Janse de Jonge, 2003). Our results suggest a higher VE and VO<sub>2</sub> from min 20 of exercise during LP, being in accordance to other studies (Smekal et al., 2007; Janse de Jonge, 2003). Thus, indicating that during LP women seem to have a poorer running economy, though they are not large variations. References Janse de Jonge XAK. (2003). *Sports Med*, 33 (11): 833-851. Smekal G et al. (2007). *Med Sci Sports Exerc*, 39(7):1098-106. Williams TJ et al. (1997). *Med Sci Sports Exerc*, 29 (12): 1609-1618. Contact victor.alfaro10.va@gmail.com

## RELATIONSHIP BETWEEN HOFFMANN REFLEX AND VERTICAL JUMP DURING MENSTRUAL CYCLE PHASES IN YOUNG JAPANESE WOMEN

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**Background** Menstrual cycle reflects the reproductive function in women, and the menstrual cycle phase (MCP) affects physiological functions. MCP may impact the physical performance and athletic capability. The spinal cord is the final common pathway for all motor behavior, and the Hoffman reflex (H-reflex) can be used to evaluate activity in the spinal cord. Previous studies have investigated the H-reflex differences between men and women and have found that the modulation of spinal excitability is stronger in women than in men. The present study investigated the relationship between spinal  $\alpha$ -motoneuron excitability and vertical jumps during MCP in young Japanese women. **Methods** Five healthy women volunteered to participate in this study. Three MCPs were defined: the menstrual phase, follicular phase, and luteal phase. The H-reflex was measured twice during each phase with the subject in the prone position. The H-reflex of soleus muscle was evoked by electrical stimulation at the tibialis nerve in the popliteal fossa with a single square pulse of 1-ms duration. The maximal M-wave (Mmax) amplitude was defined as the peak amplitude of the M-wave in response to increases in stimulus intensity. The H-wave was evoked by electrical stimulation intensity recorded in 20% of the Mmax amplitude. The vertical jump was used as the performance measure. **Results and Discussion** The ratio of the maximum amplitude of the H-wave to the Mmax amplitude of varied according to MCP. The change in spinal  $\alpha$ -motoneuron excitability associated with MCP was probably related to changes in the reproductive hormone levels; therefore, the response was likely to be different in each phase. H-waves of the subjects were as follows: menstrual phase,  $32.1 \pm 14.8\%$  (mean  $\pm$  standard deviation); follicular phase,  $32.4 \pm 15.1\%$ ; and luteal phase,  $32.4 \pm 16.2\%$ . The vertical jumps of the subjects were as follows: menstrual phase,  $41.7 \pm 3.5$  cm; follicular phase,  $43.7 \pm 3.5$  cm; and luteal phase,  $43.4 \pm 2.3$  cm. When we assumed a standard menstrual-phase, each phase was lower or higher than the H-wave in the follicular phase for decreased spinal excitability. The relationship between spinal  $\alpha$ -motoneuron excitability and performance conforms to MCP. The change in spinal  $\alpha$ -motoneuron excitability related to MCP suggests the presence of differences in the excitability between each phase, as measured using the H-reflex. **Conclusion** When we assumed a standard menstrual-phase, each phase was lower than the H-wave and the vertical jump during the follicular phase for increased spinal excitability. Please include your email address at the very end of your abstract lw6312001@kwmw.jp

## PHYSICAL ACTIVITY AND NUTRITION INTAKE DURING PREGNANCY AND THEIR ASSOCIATED FACTORS IN CHINESE WOMEN

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**Introduction** Excessive gestational weight gain (GWG) is emerging as an important predictor of maternal and offspring future obesity (Rooney et al, 2005). More than 50% of women experienced excessive GWG in China (Jiang et al, 2012). The physical activity (PA) and nutrition intake are key modifiable factors associated with weight related outcomes in pregnancy. There is only one study evaluated PA level during pregnancy among women living in urban of eastern China (Zhang et al, 2014). It is not generalizable and there is much differences in lifestyle by regions in china. Therefore, there is a need to measure PA and nutrition intake and associated factors among Chinese pregnant women in other regions including rural and urban regions. **Methods** This cross-sectional study enrolled 1224 pregnant women in Chengdu, west of China. The pregnancy physical activity questionnaire (PPAQ) and food frequency questionnaire (FFQ) were used to assess their PA and nutrition intake during pregnancy, respectively. These data were also analyzed by multiple binary logistic regression to determine associated factors on PA and nutrition intake during pregnancy. **Results** Time expenditure of physical activities classified by type and nutrition intake was varied significantly through the three trimesters ( $p < 0.01$ ). More than 50% Chinese pregnant women met the international guideline for PA ( $\geq 150$  mins moderate and above intensity activities per week), but they expended little time on exercises. Most pregnant women had imbalanced nutrition intake with excessive energy derived from fat. The age, household income, habitual exercise before pregnancy and previous live births are associated with PA and nutrition during pregnancy. **Discussion** More than 50% Chinese pregnant women met the guideline for PA, but most Chinese pregnant women expended little time on exercises and had imbalanced nutrition intake. The primary reason maybe was the high proportion of habitual exercise before pregnancy, which related to PA during Pregnancy. Because of traditional Chinese culture which defines pregnancy as a vulnerable period, most women had not done exercise during pregnancy. This may also partly explain why the pregnant Chinese women reported that their most common form of exercise was slow walking. **References** Rooney, B. L., Schauberg, C. W., & Mathiason, M. A. (2005). *Obstetrics & Gynecology*, 106(6), 1349-1356. Jiang, H., Qian, X., Li, M., Lynn, H., Fan, Y., Jiang, H.,... & He, G. (2012). *Int J Behav Nutr Phys Act*, 9(12), 1-7. Zhang, Y., Dong, S., Zuo, J., Hu, X., Zhang, H., & Zhao, Y. (2014). *PloS one*, 9(10), e109624. Contact koumitsu@toki.waseda.jp

**THE EFFECTS OF SELF-REPORTED MENSTRUAL CYCLE PHASE ON PHYSICAL FOOTBALL PERFORMANCE**

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Introduction Despite the increasing scientific interest surrounding female football, gender-specific aspects of physiology, e.g. the menstrual cycle, remain largely unexplored (Datson, 2014). This is despite the known influence of the involved hormones on relevant aspects of exercise physiology and energy metabolism (De Jonge 2003). Therefore, the aim of the study was to investigate the effects of menstrual cycle phase on football specific performance. Method Sixteen sub elite female football players ( $19.4 \pm 3.0$  y,  $164.8 \pm 6.8$  cm) participated in the current study. Prior to testing all participants completed a menstruation diary for a minimum of 6 months. Females who had a cycle phase < 25 days or > 30 days were excluded. The phases of the menstrual cycle were determined by counting backwards from subsequent menses, and were then controlled using the onset of the following menses. Testing time-points were established as Follicular Phase (FP) day 5-7 and Luteal Phase (LP) day 21-22, where greatest hormonal variations are known to occur (Reilly, 2010). A battery of football specific performance tests was implemented (endurance capacity (Yo-Yo IE1), sprinting performance (3 x 30m) and explosive lower limb power (CMJ)). Data was collected in the early evening and training load was kept consistent for the 48 hours prior to testing. All measures were conducted outside on artificial turf under similar weather conditions. Results Magnitude based inferences indicated a possibly harmful effect in the LP for Yo-Yo performance. For all other performance variables, a most likely negligible effect was suggested. Standard null hypothesis testing indicated a tendency towards significance in Yo-Yo IE1 performance ( $p=0.065$ ) between phases. No significant differences in CMJ ( $p=0.544$ ) or 3x30m sprint at any distance splits (0-5m,  $p=0.787$ ; 0-10m,  $p=0.786$ ; 0-30m,  $p=0.772$ ) were found. Discussion The results suggest a possible reduction in endurance capability for female footballers, indicated by a decline in Yo-Yo IE1 performance. Further investigation is needed to corroborate this influence of menstrual cycle on performance and to establish the underlying mechanisms. Furthermore, although lab based performance appears to be reduced, the effects of menstrual cycle phase on game specific scenarios is warranted within future research on this topic. References Datson N, Hulton A, Andersson H, Lewis T, Weston M, Drust B, Gregson W. (2014). *Sports Med.* 44(9), 1225-40. De Jonge. 2003. *Sports Med.* 33(11), 833-51. Reilly T. 2010. *Biol Rhythm Res.* 31(1), 29-40. Contact ross.julian@uni-saarland.de

**16:20 - 17:50****Invited symposia****IS-PM11 Strategies to combat sarcopenia****IT'S NEVER TOO LATE – EXERCISE INTERVENTIONS TO ATTENUATE AGE-RELATED MUSCLE LOSS**

WESSNER, B.

*University of Vienna*

Sarcopenia as defined by the European Working Group on Sarcopenia in Older People is characterized by the age-related loss of muscle mass, strength and function [1]. In order to stay physically (and mentally) fit and healthy, exercise training (aerobic, muscle strengthening, balance and flexibility training) is suggested for older adults [2]. Especially, resistance training has been proven to effectively increase muscle mass, strength and function even at a higher age, whereby an intensity progression from about 40% to 80% of the individual one repetition maximum is suggested when starting an exercise program [3] indicating that high intensities would be needed to induce substantial gains in muscle strength and mass. However, a previous meta-analysis has shown that resistance training at lower than traditionally recommended intensities is also effective, when a sufficient number of repetitions is performed [4]. Besides the classical resistance training other training modalities (vibration training, elastic-band resistance training, concurrent training ...) will be discussed with respect to their effectiveness to prevent or combat sarcopenia. 1. Cruz-Jentoft AJ, Baeyens JP, Bauer JM, Boirie Y, Cederholm T, Landi F et al. Sarcopenia: European consensus on definition and diagnosis: Report of the European Working Group on Sarcopenia in Older People. *Age Ageing.* 2010;39(4):412-23. 2. American College of Sports Medicine, Chodzko-Zajko WJ, Proctor DN, Fiatarone Singh MA, Minson CT, Nigg CR et al. American College of Sports Medicine position stand. Exercise and physical activity for older adults. *Med Sci Sports Exerc.* 2009;41(7):1510-30. 3. American College of Sports Medicine. American College of Sports Medicine position stand. Progression models in resistance training for healthy adults. *Med Sci Sports Exerc.* 2009;41(3):687-708. 4. Csapo R, Alegre LM. Effects of resistance training with moderate vs heavy loads on muscle mass and strength in the elderly: A meta-analysis. *Scand J Med Sci Sports.* 2015. doi:10.1111/sms.12536.

**PHARMACOLOGICAL AND DIETARY APPROACHES TO COMBAT AGE-RELATED SARCOPENIA.**

KADI, F.

*School of Health and Medical Sciences*

There are several challenges facing the management of age-related sarcopenia, defined as both low muscle mass and muscle function. A major challenge is to identify major factors and underlying mechanisms contributing to the degradation of muscle function with increasing age in order to develop targeted interventions. The present talk focuses on the use of non-pharmacological tools with special emphasis on the different dietary approaches combined to exercise. Given the fact that it is currently acknowledged that sarcopenia is driven by multiple mechanisms, the use of combined non-pharmacological interventions might prove useful. Pharmacological approaches for elderly unable to engage in exercise and based on the use of hormones or new agents with putative myotrophic effects are discussed both in term of efficiency and side effects.

**IMMUNESENESCENCE, INFLAMMATION AND SARCOPAENIA**

LORD, J.

*University of Birmingham*

Ageing is associated with an increase in systemic inflammation and this is in turn correlated with sarcopaenia and frailty. The drivers for this age-related increase in inflammation are varied and include: increased adiposity, reduced physical activity, but also reduced anti-inflammatory and increased pro-inflammatory functioning of the immune system, which form part of the age-related decline in immune function known as immunosenescence. These include production of pro-inflammatory cytokines by monocytes in the basal state, reduced production of anti-inflammatory cytokines (IL-10) by regulatory cells and reduced migration efficiency by neutrophils leading to excess release of proteases and damage to healthy tissue. Chronic conditions which include increased systemic inflammation, such as COPD, liver cirrhosis and Rheumatoid Arthritis, are also accompanied by loss of muscle mass and strength. There is thus a wealth of data suggesting a connection between systemic inflammation, immune dysregulation and sarcopaenia. What is less clear is whether inflammation occurs in skeletal muscle itself and the mechanisms that might link inflammation with sarcopaenia. In relation to immunosenescence, our work has shown that neutrophil dysfunction is due to constitutive activation of the PI3 kinase pathway, moreover that inhibition of the pathway corrects the defect. We have also recently found an association between physical activity levels and neutrophil function in older adults which suggest that neutrophil migration can also be affected by exercise.

**Invited symposia****IS-PM12 Statins, physical activity and muscle dysfunction****STATINS, MITOCHONDRIAL FUNCTION AND PHYSICAL ACTIVITY**

DELA, F.

*University of Copenhagen*

Statin induced myalgia has been hypothesized to be linked to a dysfunction of the skeletal muscle mitochondria. In rat muscle it has been demonstrated that atorvastatin treatment leads to an increased ROS production following exercise, as well as a decrease in maximal mitochondrial respiration. In human studies, using PCr recovery following exercise, an impaired mitochondrial function is found in hypercholesterolemic patients receiving statin therapy. Furthermore, by high resolution respirometry of skinned muscle fibers it have been shown that converged electron flux through complex I+II elicit a decrease in state 3 respiration in statin treated patients. This may be due to a decrease of Q10 content, but studies using Q10 supplementation along with statin treatment are not conclusive. Along with other candidates for statin induced myalgia (genetic susceptibility, mitochondrial calcium handling, skeletal muscle protein turnover, Vitamin D insufficiency) altered oxygen flux in the mitochondrial respiratory chain may be culprit in statin induced myalgia.

**INTERACTION BETWEEN STATINS, EXERCISE AND MUSCLE SYMPTOMS**

TAYLOR, B.A.

*University of Connecticut*

Hydroxy-methylglutaryl (HMG) CoA reductase inhibitors or statins are the most effective medications for reducing low-density lipoprotein cholesterol concentrations and cardiac events. Statins can produce statin-associated muscle symptoms (SAMS) consisting of myalgia or pain, cramps and weakness. SAMS may compromise medication compliance and quality of life, and may reduce physical activity, which is prescribed as lifestyle therapy for hyperlipidemia. The majority of statin muscle side effects have been documented by patient self-report in the resting state. Consequently, the true frequency of statin-related muscle complaints is not known, as 30-50% may be non-specific (i.e., non-statin-related), and SAMS may also be exacerbated by exercise. Indeed, physically active individuals are less likely to tolerate statins because of SAMS (1,2). In addition, several studies have reported that exercise with a statin produces greater CK elevations than does exercise alone. For example, in one study, post-exercise CK levels were 62% and 77% higher in patients treated with lovastatin vs. placebo 24 and 48 hours after downhill treadmill walking (3). These findings were confirmed with a report of higher CK levels after the 2011 Boston marathon in statin-using athletes (4). Both human and animal studies indicate that increased exercise-associated muscle damage with statin myopathy may be attributable to alterations in pathways associated with protein degradation, apoptosis, carbohydrate oxidation, oxidative stress and inflammation (5-7). Similarly, recent studies looking at concentrations of muscle-specific microRNAs following exercise demonstrated that statin-using athletes exhibited higher extracellular concentrations of miR-499-5p relative to non-statin-using athletes (8). SAMS may also be influenced by genetic variants, Vitamin D exposure, diet and other medications/supplements. The interaction between statins, exercise and muscle symptoms will be more effectively diagnosed and treated as rigorous scientific studies accumulate. The purpose of this presentation is to detail the effects of statins on skeletal muscle, particularly following exercise, explore mechanisms underlying SAMS, and present emerging evidence supporting environmental and genetic modifiers that may influence the relationship between statin therapy, physical activity, and muscle side effects. References: 1. Bruckert et al. *Cardiovasc. Drugs. Ther.* 2005; 19(6):403-14. 2. Sinzinger et al. *Br. J. Clin. Pharmacol.* 2004; 57(4): 525-28. 3. Thompson et al. *Metabolism.* 1997; 46(10): 1206-10. 4. Parker et al. *Am. J. Cardiol.* 2012; 109(2): 282-87. 5. Hubal et al. *J. Appl. Physiol.* 2010; 108(6): 1651-58. 6. Mallinson et al. *J Physiol.* 2009;587(Pt 1):219-30. 7. Mallinson et al. *J Physiol.* 2015;593(5):1239-57. 8. Min et al. *J Appl Physiol* (1985). 2015 Oct 15:jap.00654.2015. Author Email: Beth.Taylor@uconn.edu

**THE IMPACT OF STATINS ON MUSCLE PROTEIN AND CARBOHYDRATE METABOLISM**

MALLINSON, J.E.

*University of Nottingham*

Statins are used clinically for cholesterol reduction and their use has been associated with a 30% reduction in cardiovascular events. Statins are generally well tolerated, but can have muscle specific side-effects (through poorly defined mechanisms), ranging from myalgia (muscle aches or weaknesses with and without elevated serum CK concentration), myopathy (muscle necrosis and elevated CK



respectively), and in the severest case, rhabdomyolysis (typically >10 times the upper limit of normal serum CK). Meta-analysis of randomised controlled trials suggests rhabdomyolysis is rare, however increased incidence of myalgia is seen in patients receiving statins compared to placebo. Current treatment for statin myalgia is the discontinuation of statin use, in which symptoms are most often reversible, and therefore it is important to identify the mechanism of statin induced muscle dysfunction, not least because older people are sarcopaenic and also at greatest risk from statin mediated musculoskeletal side effects. This presentation will provide novel pre-clinical insight pertaining to the molecular aetiology of statin induced myopathy, and will highlight a pharmacological approach to counteract statin induced myopathy. Focus will also be given to providing mechanistic insight of the association between statin myalgia and the dysregulation of muscle carbohydrate and protein metabolism in older volunteers.

## Invited symposia

### IS-SP03 Preventing injuries in football – What is evident? sponsored by Adidas

#### VIDEO ANALYSIS OF ACL INJURIES IN FOOTBALL

KROSSHAUG, T.

*Norwegian School of Sport Sciences*

A precise description of the injury mechanism is critical for the development of effective preventive measures for ACL injuries. Video analysis is the only way to systematically collect kinematic information from real injury situations. We have therefore analyzed 39 cases of ACL injuries in professional football where the injury mechanism was assessed through a description of the match situation and player-opponent behavior. However, a detailed biomechanical assessment is not possible using a visual assessment. For this reason, we developed a Model-Based Image-Matching technique to reconstruct the kinematics of the injured person. In this method, 3D models of the surroundings as well as a customized skeleton model are manually matched to the background video footage. With this technique, it is possible to produce estimate temporal joint angle histories, velocities and accelerations, which are necessary for detailed biomechanical analyses of the injury mechanism. After a 10-year effort to collect and analyze videos of 10 ACL injury situations that were filmed with at least two cameras, we found surprisingly consistent knee kinematics in the impact phase of the injury situation. All the 10 players showed immediate valgus motion within 40 ms after initial contact. Moreover, the tibia rotated internally during the first 40 ms. These results, in combination with other important findings in the literature, led us to propose a new hypothesis for the mechanism of ACL injuries.

#### FOOTBALL SHOES – ARE THEY A RISK FACTOR FOR INJURIES?

GEHRING, D.

*University of Freiburg*

The shoe of the football player is specifically discussed to be an external risk factor of injuries as the athlete wears a cleated football shoe that penetrates an uneven turf. Based on a systematic literature review this talk summarizes the current knowledge about the shoe-ground interaction in football and its relevance with respect to injuries. This talk will show how different surface conditions like dry vs. wet grass or different kinds of natural grass influence injury occurrences. Moreover, we will answer the question if newest generations of artificial turf increase the injury risk compared to natural grass (Williams et al. 2011). We will then describe the concept of traction, which is closely related to this question and which describes the resistance of the shoe against sliding and rotational motion on the ground. Literature reveals that there is a clear effect of traction properties on the athlete's performance (e.g. Sterzing et al. 2010) but as well on the injury risk. We will demonstrate that it is important to differentiate the traction properties of a shoe carefully; as for instance a higher rotational traction is associated with an increased injury risk but a higher translational traction with a reduced injury rate (Wannop et al. 2013). Finally, we will make conclusions about the 'ideal' shoe in order to prevent football injuries. References: Williams et al. (2011) Sports Med, 903-23 Sterzing et al. (2010) Footwear Sci, 37-49. Wannop et al. (2013) MSSE, 2137-43.

#### INJURY PREVENTION PROGRAMMES: WHAT HELPS?

BIZZINI, M.

*Schulthess Clinic, Zürich, Switzerland*

Most football injuries are caused by foul play: Fair Play and stricter application of the Laws of the Game are crucial in the prevention of contact injuries (few publications at today). However, non-contact injuries can be reduced with multi-modal programmes, as originally published by Ekstrand in the 80's. Further, two exercise-based prevention programmes, the PEP (Gilchrist 2008) and moreover „The 11+“ (Soligard et al 2008), were able to significantly reduce the incidence of lower extremity injuries in female college players. Similar results in term of injury reduction (ca. 50%) have been recently found in a large RCT in male US soccer teams adopting the FIFA 11+ as a standard warm up (Silvers et al 2015). Research has further reinforced the importance of neuromuscular control in sports injury prevention (Herman et al 2012). Specific eccentric exercises have shown to significantly reduce the incidence of new and recurrent hamstring injuries in male players (Petersen et al 2011). Countrywide prevention campaigns in amateur football (Junge et al 2011) showed both an overall reduction of injuries and of health-care related costs. Despite these findings, the dissemination and implementation of injury prevention programmes in the real world of sport, and moreover at community level, remains a major challenge.

## Oral presentations

### OP-PM37 Hydration Status

#### IMPACT OF EXERCISE-INDUCED DEHYDRATION ON SMALL AIRWAY FUNCTION IN THE HEALTHY ACTIVE HUMAN

LOWMAN, A., GONZÁLEZ-ALONSO, J., KIPPELEN, P.

*Brunel University London*

**Introduction:** Whole-body dehydration can impair cardiovascular and metabolic function during exercise, but its effects on lung function are still unclear. Preliminary results from our group suggest that exercise-induced mild dehydration causes gas trapping and small airway collapse in symptomatic individuals with a history of asthma (Simpson et al., 2015). Whether the impact of dehydration on small airway function is population-specific (i.e., only observed in susceptible individuals with a history of asthma) or present even in healthy individuals remains to be established. The primary aim of our research was to establish the impact of exercise-induced dehydration on small airway function in healthy, active humans. The secondary aim was to determine whether reduced endogenous production of nitric oxide (NO, a regulator of bronchial tone) mediates dehydration-induced lung function alterations in humans. **Methods:** Eight, healthy male athletes (aged 19 to 33 yr) cycled for 2 h in the heat at 55% of maximal oxygen uptake ( $\text{VO}_{2\text{max}}$ ) while not ingesting fluid and becoming dehydrated (dehydration trial), or ingesting fluid to minimize fluid loss (control trial). Hydration status was monitored through changes in nude body mass between pre- and post-exercise. Spirometry and full body plethysmography were conducted before and at several time points after exercise (up to 2 h). Exhaled NO was recorded before, immediately after, and at 30 and 95 min post-exercise. Data were analysed using repeated measures ANOVAs. **Results:** The dehydration protocol caused a  $3.8 \pm 0.7\%$  (range 3.3–5.3%) reduction in nude body mass (vs  $1.1 \pm 0.3\%$  in the control protocol,  $P < 0.001$ ). Dehydration caused a statistically significant ( $P = 0.039$ ), and clinically relevant decline in forced vital capacity ( $\text{FVC} = 221 \pm 248$  mL), as well as significant increases in residual volume ( $\text{RV} = 439 \pm 126$  mL,  $P = 0.003$ ) and in functional residual capacity ( $\text{FRC} = 336 \pm 190$  mL,  $P = 0.005$ ). No statistically significant changes in these lung function parameters were observed in the control condition. Dehydration did not alter post-exercise exhaled NO levels ( $\text{FeNO} -1.4 \pm 4.6$  vs  $-2.1 \pm 5.0$  ppb in control,  $P > 0.05$ ). **Conclusions:** Our results suggest that moderate-to-severe exercise-induced whole body dehydration impedes small airway function in the healthy, active human. Those changes are unlikely to be mediated by alterations in NO production within the airways. **References** Simpson A, Romer L, Kippelen P. (2015) *Respirology*, 20, 121. Contact: 1113349@my.brunel.ac.uk

#### BODY POSITION & WATER ABSORPTION ~AN INVESTIGATION WITH ISOTOPIC LABELED WATER~

MORIKAWA, A.1, SUZUKI, M.1, TANAKA, U.1, YAMADA, Y.3, NAKAE, S.3,4, HOJO, T.1, HIGAKI, Y.2, TANAKA, H.2, EBINE, N.1

*1:Doshisha University, 2:Fukuoka University, 3:National Institutes of Biomedical Innovation, Health and Nutrition, 4:Tokyo Gakuai University*

**Introduction** Previous studies that observe the relationship between body position and gastric emptying, have mostly focused on solid food and little is known about liquid in the gut. The bottom part of the stomach in an average human body resides below the pylorus when in the upright position, due to gravity. This phenomenon requires extra work for the stomach, as gastric components need to push up in order for gastric emptying to occur. The purpose of the present study was to verify the speed of water absorption in different body positions. A promoting position (PP), where the subjects were placed with the head and trunk slanted 20 degrees upwards parallel from the ground, was designed, to investigate whether water absorption will occur faster. **Method** Absorption was assessed by following the change in the enrichment of deuterium oxide in urine samples, after the intake of labeled water in seven healthy male students. Two trials were conducted: one remaining sitting in the standard position (SP) throughout the trial, and the other, being in the PP for the first 10 mins of the trial. After ingestion, subjects were instructed to remain in a rested state in which urine samples were obtained. At each sampling, subjects were required to conduct complete urinary retention in order to prevent contamination of left over urine in the bladder, most likely to affect the next urine sampling. **Results** Lower values were constantly observed in the PP trial in the enrichment of isotope than the SP trial. In comparison to the SP trial, urine taken after 60 mins of administration in the PP trial showed a significantly lower value in the enrichment of isotope ( $P = 0.013$ ). Although not statistically significant, body fluid in the PP trial reached equilibrium faster than the SP trial. **Discussion** In the process of rehydration, ingested water must mix with the extracellular and intracellular water to reach equilibrium with the rest of the body water pool. Isotope enrichment in the PP trial stayed near the equilibrium value and settled into equilibrium faster than the SP trial, which shows that the PP promotes water absorption. Meanwhile, in addition to the difference in the enrichment of isotope, a few physiological reactions due to the difference in body position were observed between the two testing occasions. **References** • Leiper, J. B. (2015). *Nutrition Reviews*, 73(suppl 2), 57-72. • Péronnet, F. et al. (2012). *European Journal of Applied Physiology*, 112(6), 2213-22. Contact a.morikawa93@gmail.com

#### ESTIMATION OF SWEATING PATTERNS DURING CYCLING EXERCISE BY MEANS OF THE CLOSED CHAMBER CONDENSER TECHNOLOGY

CLIJSEN, R., CLARYS, P., BAREL, A.O., SCHOUTEDEN, R., VAN OLST, B., AERENHOUTS, D.

*University of Applied Sciences and Arts of Southern Switzerland, SUPSI, Switzerland*

Knowledge of sweat loss and local sweating patterns is of importance in occupational and the exercise physiology setting. Techniques evolved from whole body mass measurement before versus after exercise, over absorbancy methodology, to the ventilated capsule methodology. The aim of the present study was to evaluate the applicability of an adapted closed chamber skin evaporimeter methodology (Bio Aquaflux® instrument) to estimate sweat production. Therefore, 14 healthy subjects performed a 20 minutes cycle ergometer trial at fixed heart rates of respectively 55% HRreserve and 75% HRreserve. Sweat production was estimated by measuring body weight before and after exercise, by calculated the amount of sweat collected in a patch placed on the upper back during exercise, and by measuring the water flux (in g.h<sup>-1</sup>.m<sup>2</sup>) with the Bio-Aquaflux® instrument on the back contralateral to the patch application site. Sweat rates (all in g.h<sup>-1</sup>.m<sup>2</sup>) at 55% of HR reserve as determined with the different methods were respectively  $389 \pm 206$  for the body weight method,  $363 \pm 280$  for the patch method and  $206 \pm 109$  for the Bio Aquaflux® instrument. At 75% of HRreserve these values reached respectively  $729 \pm 103$ ;  $1054 \pm 372$  and  $446 \pm 120$  g.h<sup>-1</sup>.m<sup>2</sup>. Correlations between the measurement methods were all significant at 75% HRreserve trial (with r ranging from .68 to .76) whilst at 55% HRreserve a significant relation was detected between the patch method and

the Bio Aquaflux® only (with  $r$  ranging from .41 to .79). The Biox instrument is a practical and direct method for the estimation of local sweat rates under field conditions. The high correlations between the Biox Aquaflux® instrument and the other methods used for sweat production indicates the potential of the closed chamber methodology as an additional field method.

### **HSP72 MRNA TRANSCRIPTION, AND SWEAT ADAPTATIONS ARE GREATER POST HEAT ACCLIMATION IN TRAINED VS. UNTRAINED INDIVIDUALS**

GIBSON, O.R., TAYLOR, L., WATT, P.W., MAXWELL, N.S.

*Brunel University London*

**Introduction** Heat shock protein-72 (Hsp72) is a cytoprotective protein with gene transcription (mRNA) proportional to the magnitude of cellular stress, notably elevated temperature. Following transcription, increased basal Hsp72 protein is an important component of thermotolerance, a cellular element of the inducible heat acclimation (HA) phenotype. The aim of this experiment was to determine whether training status influenced the magnitude of Hsp72 mRNA transcription during HA, alongside other typical phenotypic responses. **Methods** Six trained (T;  $\text{VO}_{2\text{peak}} = 4.58 \pm 0.46 \text{ L} \cdot \text{min}^{-1}$ ) and six untrained males (UT;  $\text{VO}_{2\text{peak}} = 3.25 \pm 0.53 \text{ L} \cdot \text{min}^{-1}$ ) matched for age ( $T = 22 \pm 3$  yrs,  $UT = 23 \pm 4$  yrs), body surface area ( $T = 1.97 \pm 0.10 \text{ m}^2$ ,  $UT = 1.91 \pm 0.13 \text{ m}^2$ ), mass ( $T = 75.7 \pm 6.0 \text{ kg}$ ,  $UT = 74.4 \pm 8.6 \text{ kg}$ ) and fat mass ( $T = 12.5 \pm 1.2\%$ ,  $UT = 13.5 \pm 3.5\%$ ) performed ten, 90 min sessions of isothermic HA (rectal temperature ( $T_{\text{rec}}$ )  $\geq 38.5^\circ\text{C}$ ). Leukocyte Hsp72 mRNA was measured pre and immediately post the first (D1) and last (D10) day of HA, with gene transcription quantified using RT-QPCR. On D1 and D10, resting  $T_{\text{rec}}$  and heart rate (HR), and sweat rate [SR; %body mass (%BM)] were quantified. Results Hsp72 mRNA increased ( $p < 0.05$ ) pre-post HA for both T and UT on D1 (Pre,  $T = 1.8 \pm 0.8$ ,  $UT = 1.5 \pm 0.7$ ; Post,  $T = 5.7 \pm 2.4$ ,  $UT = 3.3 \pm 1.3$ ) and D10 (Pre,  $T = 2.0 \pm 0.7$ ,  $UT = 1.8 \pm 0.9$ ; Post,  $T = 4.7 \pm 1.2$ ,  $UT = 3.0 \pm 1.1$ ), with no difference between D1 and D10. Hsp72 mRNA was significantly greater post HA ( $p < 0.05$ ) in T compared to UT. SR demonstrated a greater ( $p < 0.05$ ) magnitude of adaptation in T ( $+1.24 \pm 0.55\% \text{BM}$ ) compared to UT ( $+0.54 \pm 0.39\% \text{BM}$ ). No difference ( $p > 0.05$ ) in the magnitude of adaptation (D1 to D10) occurred for resting  $T_{\text{rec}}$  ( $T = -0.53 \pm 0.23^\circ\text{C}$ ,  $UT = -0.37 \pm 0.17^\circ\text{C}$ ) or HR ( $T = -12 \pm 4 \text{ b} \cdot \text{min}^{-1}$ ,  $UT = -11 \pm 12 \text{ b} \cdot \text{min}^{-1}$ ). During the HA, T demonstrated a greater ( $p < 0.05$ )  $\Delta T_{\text{rec}}$  (D1 =  $1.95 \pm 0.33^\circ\text{C}$ ; D10 =  $2.48 \pm 0.25^\circ\text{C}$ ) and mean  $T_{\text{rec}}$  (D1 =  $38.39 \pm 0.17^\circ\text{C}$ , D10 =  $38.36 \pm 0.23^\circ\text{C}$ ) than UT ( $\Delta T_{\text{rec}}$ : D1 =  $1.51 \pm 0.46^\circ\text{C}$ , D10 =  $1.71 \pm 0.33^\circ\text{C}$ ; mean  $T_{\text{rec}}$ : D1 =  $38.14 \pm 0.34^\circ\text{C}$ , D10 =  $38.08 \pm 0.31^\circ\text{C}$ ). No difference ( $p > 0.05$ ) in the  $\Delta$  or mean  $T_{\text{rec}}$  occurred between D1 and D10. **Discussion** Trained individuals demonstrate increased transcription of Hsp72 mRNA in comparison to untrained. It is unknown if this is due to improved gene regulation, or increased thermoregulatory strain during HA. Increased strain may account for the greater sudomotor adaptation. Equality of  $T_{\text{rec}}$  and HR adaptations demonstrates comparable adaptive capacity for these measures irrespective of training status.

## **Oral presentations**

### **OP-PM75 Health & Fitness: Exercise & Ageing**

#### **EFFECTS ON WHITE BLOOD CELLS IN SENIOR CITIZENS DURING POST EXERCISE RECOVERY IN DIFFERENT ENVIRONMENTS**

AHNESJÖ, J., BERGMAN, P.

*Department of sport science*

**Effects on white blood cells in senior citizens during post exercise recovery in different environments (indoors, simulated outdoors and outdoors)** **Introduction** Natural environments are known to promote health and may also provide extraordinary conditions for post exercise recovery (Kuo 2015). In the project Health Effects of Recreation Outdoors (HERO) we explore the hypothesis that post exercise recovery in natural environments may be reflected in white blood cell counts (WBC). In our study 50 seniors (age  $> 65$  years) performed moderate physical activity (20 min) followed by passive recovery (2h) in three different environments (indoors, simulated outdoors and "true" outdoors). **Method** The experimental setup was a randomized cross-over design, thus all test persons did all treatments in a randomized order. We sampled white blood cells (WBC-diff), which were used to detect and quantify inflammatory response. Results Our early findings provide some support for the hypothesis that environment may impose differences in recovery effectiveness. White blood cell count (WBC-diff) appears to differ between the treatments and there is a significant interaction between sampling time and recovery environment in the monocytes, suggesting that the monocyte numbers differ, not only between sampling times but also between environments. In addition, WBC also show that some of the test persons develop leukocytosis during exercise and that white blood cell levels decrease rapidly immediately post exercise to levels significantly lower than base line values. **Discussion** Our results suggest that moderate physical activity in senior citizens may result in acute leukocytosis (see e.g. Sand et. al. 2013) and that recovery effectiveness (e.g in monocyte response) may be dependent upon environmental factors. The clinical importance of our results are not fully understood but there has been suggested an "open window" immediately post exercise in which infection risk may be elevated (Pedersen & Toft 2000) and it is possible that recovery out of doors may reduce this risk. **References** Sand, K., L. Flatebo, K., Andersen, M., B., Maghazachi, A., A. (2013) *World J Exp Med* 20; 3(1): 11-20 Pedersen, B., K. & Toft, A., D. (2000) *Br J Sports Med* 34:246-251 Kuo, M. (2015) *Frontiers in Psychology* 6

#### **EFFECTS OF CREATINE SUPPLEMENTATION AND HIGH-LOW RESISTANCE TRAINING IN AGING ADULTS**

CANDOW, D., JOHANNSMEYER, S.

*University of Regina*

The purpose was to investigate the effects of high-low resistance training (2 sets of leg press, chest press, hack squat and lat pull-down exercises performed to muscle fatigue at 80% baseline 1-repetition maximum [1-RM] immediately followed by repetitions to muscle fatigue at 30% baseline 1-RM) and creatine supplementation in aging adults. Participants were randomized to one of two groups: Creatine (CR:  $n = 14$ , 7 females, 7 males;  $0.1 \text{ g/kg/day}$  of creatine +  $0.1 \text{ g/kg/day}$  of maltodextrin; age =  $58.0 \pm 3.0$  years) or Placebo (PLA:  $n = 17$ , 7 females, 10 males;  $0.2 \text{ g/kg/day}$  of maltodextrin; age =  $57.6 \pm 5.0$  years) during 12 weeks of high-low resistance training (3 days/week). Prior to and following training and supplementation, assessments were made for body composition (whole-body lean tissue mass, fat mass, bone mineral), strength (1-repetition maximum for the leg press, chest press, hack squat and lat pull-down exercise),

muscle endurance (total number of repetitions performed for 1 set using 70% baseline 1-RM for the chest press exercise and 80% 1-RM for the leg press exercise), tasks of functionality (hand-grip strength, balance, falls, walking speed), muscle protein catabolism (urinary excretion of 3-methylhistidine, 3-MH) and diet. Results showed that high-low resistance training improved lean tissue mass, muscle strength, endurance and tasks of functionality ( $p < 0.05$ ). The addition of creatine to high-low resistance training significantly increased body mass ( $p = 0.002$ ) and lean tissue mass ( $p = 0.007$ ) compared to placebo. Males on creatine increased muscle strength (lat pull-down only) to a greater extent than females on creatine ( $p = 0.005$ ). Creatine enabled males to train at a greater capacity over time compared to males on placebo ( $p = 0.049$ ) and females on creatine ( $p = 0.012$ ). Males on creatine ( $p = 0.019$ ) and females on placebo ( $p = 0.014$ ) decreased 3-MH, while females on creatine showed an increase. In conclusion, high-low resistance training is an effective intervention for improving muscle mass, muscle performance and functionality in aging adults. The addition of creatine to high-low resistance training augments the gains in lean tissue mass from resistance training alone.

### LOW INTENSITY RESISTANCE EXERCISE IMPROVES COGNITIVE FUNCTION IN ELDERLY

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**Introduction.** Decline in cognitive function (CF) is inherent to the aging process, impairing the performance in daily living activities and the elderly life quality. CF has being improved after endurance exercise sessions of various intensity and volumes (Kashihara et al., 2009). Regarding resistance exercise (RE), the ideal dose of resistance exercise prescription to improve CF need to be elucidated. A couple of RE protocols have been proposed for improve health in elderly, through increase in strength and muscle mass. Thus, our aim was to compare the effect on CF among some of these RE protocols recommended for elderly Health. **Methods.** In total, 21 healthy elderly (9 men and 12 women;  $64.3 \pm 5.04$  years; and  $1RM\ 161.67 \pm 63.01$ kg), volunteered for a cross-over design, containing a control session (CON) and three RE protocols performed in 45° leg press machine: HIRE, four sets until failure at 80% of 1RM; LIRE, four sets until failure at 30% of 1RM; and BFRRE 30 repetitions plus three sets of 15 repetitions, with 50% of blood flow restriction at 30% of 1RM. CF was measured before and after (5 min) the experimental protocols, through the three sections of Stroop test, which evaluate selective attention and processing speed. Since the data were not normally distributed, we applied non-parametric tests to compare the delta (post minus pre) among the 4 experimental protocols. The Bonferroni correction was applied for Friedman test ( $p < 0.0125$ ) and for Wilcoxon post-hoc test ( $p < 0.008$ ). Data is present in median and interquartile range. **Results.** For section 2 of Stroop test there was larger reduction of response time for LIRE ( $-255.6[-376.0$  to  $-65.1]$ ) compared to HIRE ( $-39.3[-206.1$  to  $182.5]$ ) and CON ( $-39.0[-198.6$  to  $178.2]$ ), without differences in number of hits. There reduction in response time of LIRE was not different from BFRRE ( $-130.5[-237.5$  to  $16.3]$ ). **Discussion.** Among other mechanisms, the stimulus from optimal sympathetic modulation after endurance exercise has emerged as a strong candidate to improvements in CF (Kashihara, 2009; Murray and Russoniello, 2012). RE do not arouse changes in autonomic control in the same fashion than endurance exercise. Nevertheless, LIRE, the RE likely more similar to the endurance exercise cardiovascular effects (considering its higher volume and low intensity), were the best for CF improvements. Complementary analysis, suggested variations in autonomic modulation also after RE would explain reduction in response time herein. We concluded that LIRE was the best RE for improve CF in healthy elderly, while HIRE and BFRRE showed no significant effects. **References** Kashihara K, Maruyama T, Murota M, Nakahara Y. (2009). *J Physiol Anthropol*, 28(4): 155–164. Murray NP, Russoniello C. (2012). *Appl Psychophysiol Biofeedback*, 37:219–227.

### MIDLIFE PHYSICAL ACTIVITY AND COGNITION IN LATE LIFE: A PROSPECTIVE TWIN STUDY

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**Midlife physical activity and cognition in late life: a prospective twin study** Iso-Markku P1, Waller K2, Vuoksimaa E1, Heikkilä K1, Rinne J3, Kaprio J3,4,5, Kujala UM2 1 University of Helsinki, Finland 2 University of Jyväskylä, Finland 3 University of Turku, Finland 4 THL, Finland 5 FIMM, FINLAND **Introduction** Physical activity has been associated with better cognition both in previous cohort studies and in randomized controlled trials (RCTs). However, the durations in RCTs have been short considering the long preclinical phase of dementia. Cohort studies are liable for selection bias and causality cannot be inferred solely on them. Twin studies, however, give an excellent opportunity to take into account potential confounding from genetic and environment influences. The majority of the earlier twin studies on the subject have studied physical activity roughly mainly with only one crude physical activity indicator as a covariate, in a subgroup of a cohort or with a crude outcome measure; register-based dementia deaths. The aim of this study was to study whether midlife physical activity has effect on late life cognition in an extensive twin population. **Methods** The study population is a subgroup of the older cohort of the Finnish Twin Study (the twins born in Finland before 1958 and both co-twins alive in 1967) who were at least 65 years old at the follow-up and to whom telephone administered cognition screenings have been done at the follow-up. Physical activity was queried in 1976 and 1981. We studied both the intensity (whether or not the participant engages in physical activity more strenuous than walking) and the volume of physical activity (metabolic equivalent of energy expenditure hours i.e. MET-hours). The risk of cognitive decline was assessed with logistic and linear regression models assessing separately the risk in individual-based analyses comparing individuals and in pairwise analyses comparing twins with their co-twins. **Results** In individual-based analyses, persistent engagement in vigorous physical activity in midlife was associated with reduced risk of cognitive impairment (covariate-adjusted OR 0.50, 95% CI 0.35- 0.73). The trends in the pairwise analyses were similar but statistically non-significant. In the analyses of the volume of physical activity, the participants who belonged to the more active quintiles at both questionnaire years had reduced risk of cognitive impairment compared with participants in the most inactive quintile (covariate-adjusted OR 0.61, 95% CI 0.43- 0.88). No dose-response was found in linear regression analyses in the individual-base or in the pairwise analyses. **Discussion** Vigorous physical activity was significantly associated with reduced risk of cognitive impairment in the individual analyses with similar trends in the pairwise analyses. A moderate amount of physical activity seems sufficient to render cognition-protective benefits.



## THE CONTRIBUTIONS OF URBAN PARKS TO PHYSICAL ACTIVITY AMONG OLDER ADULTS: THE SYSTEMATIC OBSERVATION WITHIN THE HONG KONG – LEIPZIG STUDY

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**Introduction** Urban parks have been acknowledged as important places for physical activity (PA) for urban residents, and particularly for senior city residents. There are numerous health benefits and a relatively low cost solution of park-based PA. However, parks are underused, especially for engaging in PA. More than half of park users are sedentary. In addition, only one third of park users engage in some types of PA with intensity during park visits – however, there are more park users in Hong Kong compared to western countries like Germany. This study took Hong Kong in China and Leipzig in Germany as example, to (1) describe and compare the characteristics of PA areas in urban parks in two cities; (2) to describe and compare the PA of the elderly within these areas in two cities. **Methods** Six parks were selected randomly in each city. Systematic observations were conducted in total twelve parks in the fall of 2014 and in the summer of 2015 by using a modified SOPARC (McKenzie et al., 2006) observation tool. Descriptive analysis and Chi2 tests were used. **Results** The selected result revealed that sports course (50.34%) and fitness stations (20%) ranked the first two PA areas in parks in Hong Kong while grassy areas (34%) and playgrounds (29%) were in Leipzig. Parks in both cities were highly accessible, available and lighted in the evening. Moreover, most Chinese elderly in parks used trails and paths (48.76%) as well as fitness areas (19.92%) while the majority of German elderly (96.28%) only used trails and paths in parks. The most common PA for Chinese elderly was walking and fitness exercise while walking and cycling for German. In addition, more Chinese elderly participated in individual exercise (72.76%) compared with German (48.72%) ( $X^2 [1, N = 6125] = 370.82; p < .001$ ). In terms of intensity of PA, more German elderly performed with moderate intensity (50.34%) and less with vigorous intensity (2.75%) compared with Chinese with moderate (30.42%) and vigorous intensities (20.59%) ( $X^2 [2, N = 4946] = 459.9; p < .001$ ). **Discussion** The findings of this study adds empirical knowledge regarding how to optimize park services to promote PA behavior among the elderly under different culture contexts. **References** McKenzie, T. L., Cohen, D. A., Sehgal, A., Williamson, S., & Golinelli, D. (2006). System for Observing Play and Recreation in Communities (SOPARC): reliability and feasibility measures. *Journal of physical activity & health*, 3, S208. Contact duanyp@hkbu.edu.hk

## THE CONTRIBUTIONS OF URBAN PARKS TO PHYSICAL ACTIVITY AMONG OLDER ADULTS: THE QUESTIONNAIRE SURVEY WITHIN THE HONG KONG – LEIPZIG STUDY

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**Introduction** Regarding population aging as global phenomenon, urban parks have been acknowledged as important places for physical activity (PA) for urban residents, particularly for older adults (Van Dyck et al., 2013). There are numerous health benefits and a relatively low cost solution of park-based PA. However, parks are underused, especially for engaging in PA. More than half of park users are sedentary. In addition, only one third of park users engage in some type of PA with intensity during park visits – however, there are more park users in Hong Kong compared to western countries like Germany (Han et al., 2014). While aiming to promote PA in parks, it is necessary to study the characteristics of PA and PA areas in parks as well as the correlates of park-based PA with a cultural comparison of Eastern and Western older adults. **Methods** The Hong Kong (HK) – Leipzig (LE) study consists of a systematic observation and a questionnaire survey for each city. For questionnaire survey, in each city 300 elderly park users (60+ yrs) were randomly recruited from six parks. Participants completed a face-to-face survey measuring socio demographic variables (i.e. age, gender, education, marital status), psychosocial factors (i.e. self-efficacy, enjoyment, perceived barriers, perceived benefits, social support), perception of park environment (safety, attractiveness, features and accessibility) and park-based PA (duration and intensity level). **Results** The study design and selected results from the questionnaire survey of the Hong Kong – Leipzig study will be presented. The influences of demographics, psychosocial factors and perceptions of park environment on park-based PA among seniors in HK and LE were examined using hierarchical multiple regression analyses. Psychosocial correlates, especially self-efficacy, perceived benefits and perceived barriers, provided stronger effects than perceived park environmental correlates on explaining PA in parks. **Discussion** Present findings of significant interactions suggest multi-level interventions that target park environment and individual change could be particularly effective. **References** Han, B., Cohen, D. A., Deroose, K. P., Marsh, T., Williamson, S., & Raaen, L. (2014). How much neighborhood parks contribute to local residents' physical activity in the City of Los Angeles: A meta-analysis. *Preventive Medicine*, 69:106-110. Van Dyck, D., Sallis, J. F., Cardon, G., Deforche, B., Adams, M. A., Geremia, C., & De Bourdeaudhuij, I. (2013). Associations of neighborhood characteristics with active park use: an observational study in two cities in the USA and Belgium. *International Journal of Health Geographics*, 12:26. Contact Petra.wagner@uni-leipzig.de

## Oral presentations

### OP-PM63 Taping & Injuries

#### KINESIOLOGY TAPE COUNTERS BALANCE IMPAIRMENT AFTER ECCENTRIC EXERCISE

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**Introduction** Exhaustive exercise has been shown to impair balance ability, thus increasing the risk of knee injury in sports (Changela et al., 2012). Even though the use of Kinesiology tape (KT) has lately gained popularity within the sporting community for injury prevention, there is a paucity of evidence demonstrating its effectiveness (Williams et al., 2012). Therefore, the aim of this study was to investigate the influence of KT on balance ability after eccentric exercise in healthy men. **Methods** Twelve young men (age:  $23.3 \pm 2.6$  years) with no prior history of lower limb injury took part in this study. All participants were invited to two visits separated by one week, to perform the scheduled tests once without the use of KT and once after application of KT at the knee joint. Upon each visit, the ability to maintain balance was assessed in a single-leg stance test using a computerized balance stability test system (Biodex Balance System®) prior to and

immediately after an eccentric exercise. The exercise protocol consisted of 30-minute downhill walking on a treadmill at an inclination of 20%. A stability index was calculated and statistically analyzed by repeated-measures ANOVA. Results Without KT, the stability index increased from 2.5° to 3.0° after downhill walking, which reflects an exercise-related deterioration of balance. Following application of KT, by contrast, the stability index remained almost unchanged (2.5° to 2.6°). The "time × taping" interaction effect was significant ( $p = 0.049$ ), indicating that the exercise-related change of the stability index differed between the two taping conditions, with the impairment of balance being significantly greater when no KT was used. Discussion Eccentric exercise resulted in a significant deterioration of balance ability which could be attenuated by usage of KT. Thus, KT applied to the knee joint counteracted the exercise-related decline of balance ability observed when no tape was used. As its elastic material pulls and stretches the skin, KT might increase the sensory feedback from various mechanoreceptors located in the skin, muscle, and joint capsule, thereby improving proprioceptive performance and balance ability (Chang et al., 2010). Since the exercise-related impairment of balance ability represents an important risk factor for knee injuries, application of KT may be a clinically useful tool for injury prevention by enhancing the balance ability of athletes in the fatigued state. References Changela PK, Selvamani K, Ramaprabhu. (2012). USRP, 2(3), 645-649. Williams S, Whatman C, Hume PA, Sheerin K. (2012). Sports Med, 42(2), 153-164. Chang HY, Chou KY, Lin JJ, Lin CF, Wang CH. (2010). Phys Ther Sport, 11(4), 122-127. Contact Simona.Hosp@uibk.ac.at

### KINESIO TAPE: WHAT DOES IT ACTUALLY DO MECHANICALLY?

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Introduction Kinesio taping (KT) has been increasingly used in the treatment of sports injuries and various neuro-musculoskeletal disorders. It is expected to improve muscle strength and activity, joint range of motion, position sense and proprioception, scar healing and lymph flow. KT effects reported in numerous studies are inconsistent or even too small, obscuring its effectiveness. Assessments are often done in the whole body level; yet, it is implicitly assumed that KT is selectively effective on targeted tissues, determined by the particular KT application. A scientific basis for KT effects and a control over the expected physiological outcomes requires determining what KT really does mechanically on the underlying tissues. Muscular and connective tissues are continuous across the limb (Yucesoy, 2010). Therefore, the loads imposed superficially on the skin can be transmitted to deeper tissues to produce heterogeneous mechanical KT effects. The aim was to characterize those objectively and to test the hypothesis that KT causes local deformations not necessarily aligned with tape adhering direction and limited to the directly targeted tissues. Methods Magnetic resonance image (MRI) sets were acquired in healthy human subjects ( $n=5$ ) before and acutely after KT is applied over the skin along m. tibialis anterior (TA) (Pamuk and Yucesoy, 2015). Joint angles were kept constant. Demons algorithm was used to calculate local tissue deformations within the lower leg (Yaman, et al., 2013). Strain artifacts due to subject repositioning for KT were quantified as well. Deformation maps were analyzed in the following anatomical regions: directly targeted tissues i.e., tissues superficial to TA (KT-to-TA) and TA; and non-targeted tissues i.e., the remainder musculature of the lower leg. Results Wilcoxon rank-sum test yielded significantly higher ( $p<0.05$ ) mean peak tissue strains compared to strain artifacts in all anatomical regions (10.9% vs 3.3% respectively). Directly targeted tissues: deformations only in part of KT-to-TA region agree with tape adhering direction. Skin, the rest of KT-to-TA and TA regions show deformations (up to 51.5%) in other directions. Non-targeted tissues: sizable heterogeneous deformations are found, but in smaller amplitudes. Discussion A specific superficial loading imposed by KT causes a multi directional, heterogeneous deformation of the targeted and non-targeted tissues within the entire limb. This confirms our hypothesis and shows that KT is quite effective. Yet the findings also show that tailoring the expected physiological outcomes according to the tape adhering direction alone is a simplistic approach. TUBITAK grant (111E084) is acknowledged. References Yucesoy CA (2010). Exerc Sport Sci Rev 38, 128-134. Pamuk U, Yucesoy CA (2015). J Biomech 48, 4262-4270. Yaman, A et al. (2013). J Biomech Eng 135, 91003. uluc.pamuk@boun.edu.tr

### EFFECTS OF AN ELASTIC TAPING APPLICATION ON ACTIVE CERVICAL R.O.M.

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Introduction: Elastic taping is largely used by professionals for sports practitioners and common people. The aim of this study was to measure the effects on perceived pain and active cervical Range of Motion (ACROM) of a classical application of elastic taping (ET). Previous studies (Saavedra-Hernandez et al., 2012; Gong, 2015) investigated the effects of neuromuscular taping or manipulation on cervical function and pain but the results are inconsistent. Methods: Fifty subjects ( $33.9 \pm 4.8$  yrs;  $174.5 \pm 8.2$  cm;  $73.5 \pm 11.2$  kg; 38M; 12F) for the study group (SG) and twenty subjects ( $32.6 \pm 3.9$  yrs;  $174.9 \pm 10.9$  cm;  $71.2 \pm 12.9$  kg; 11M; 9F) for the control group (CG) were respectively recruited. Each group performed three ACROM measurements with an inertial sensor (Moover, Sensor Medica, Guidonia-RM, Italy) and declared three times the perceived pain on neck basing on a 0-10 VAS scale: at the baseline, after 20' from ET application and after three days dressing the ET application. Between the first and the second ACROM and VAS measurement an ET (Taping Elastico®, ATS, Arezzo, Italy) was applied on the superior trapezius and cervical zone of the SG subjects. The ET was dressed in for three days and it was removed 1 hour before the last evaluation. The measured parameters were: maximum and average left and right rotation and lateral inclination, maximum and average flexion and extension, subjective perception of neck pain on a 0-10 VAS scale. ANOVA analysis was used to find out significant differences between repeated measurements and the level of significance was setting at  $p<0.05$ . Results: The CG did not show any significant change in any measurement session both for ACROM and VAS parameters. The SG showed higher significant values for all the measured parameters in ACROM test and lower values in VAS scale after three days respect to the baseline. Better values in ACROM and VAS parameters were measured also between the second and the last session of test. Finally, some significant differences were also found between baseline and after 20' from the ET application just for ACROM parameters. Discussion: The results give more information on the usefulness of ET and the results of other authors (Saavedra-Hernandez et al., 2012) are reinforced. Objective effects on ACROM and a reduced subjective perception of pain for ET are well documented in this study. The results underlines the usefulness of ET in terms to enhance ACROM in all directions and to reduce subjective neck pain when it is necessary. References: Saavedra-Hernandez M et al. (2012). J Orthop Sports Phys Ther 42(8):724-30. Gong W (2015). J Phys Ther Sci 27(5):1609-11. Contact info@esercizioposturale.it

## THE RELATIONSHIP BETWEEN MUSCULOSKELETAL SCREENINGS AND SUBSEQUENT SHOULDER INJURIES IN JUNIOR AND PROFESSIONALLY RANKED TENNIS PLAYERS

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**Introduction:** The shoulder has been commonly reported as the most prevalent upper limb injury region in sub-elite and elite tennis players<sup>1,2,3</sup>. Musculoskeletal screenings (MS) are used to determine intrinsic risk factors associated with such injuries. However, the relationship between MS outcomes and subsequent shoulder injuries in sub-elite and elite tennis players remains unclear. **Purpose:** To determine the relationship between selected MS tools and ensuing shoulder injuries in junior (sub-elite) and professionally (elite) ranked tennis players. **Methods:** Shoulder injury and MS data (2012-2015) from junior and professionally ranked (ITF junior and/or ATP/WTA ranking) Australian tennis players (n=88 males, 76 females, 10-31 years) were obtained from a security-protected database. In total, 354 unique MS and 124 shoulder injuries resulting in 679 days of interrupted training were identified. MS tests included shoulder internal (IR) & external (ER) range of motion (ROM), Empty Can (EC), shoulder IR & ER maximal contraction, scapular dyskinesis, thoracic ROM and extension, and elbow extension. The relationship of each MS measure to subsequent shoulder injury incidence was assessed. In addition, the association between MS measures was analysed to determine any mediating shoulder injury variables. Injury severity (days interrupted training; moderate ≤7, severe >7) was also analysed in relation to antecedent MS results. Comparisons between injured and non-injured were assessed via one-way ANOVA and Chi-Square tests. Regression analysis determined whether there were any interrelationships between MS measures ( $p < 0.05$ ) and odds ratios determined which MS measures increased/decreased injury risk. **Results:** Athletes incurring a shoulder injury in the 12 months post MS, had significantly less dominant (D) shoulder IR ( $< 40^\circ$ ;  $R = -0.11$ ,  $p = 0.05$ ). This reduction in D shoulder IR was also associated with 'subtle' and 'obvious' ratings of D scapular dyskinesis during flexion as compared to normal ratings ( $p < 0.01$ ). Greater D elbow extension pain ratings were reported in the post MS injured ( $R = -0.13$ ,  $p = 0.04$ ) compared to the non-injured athletes. Pain/abnormal D EC ratings resulted in athletes being 4.4 ( $p = 0.01$ ) and 5.2 times ( $p = 0.001$ ) more likely to have a severe shoulder injury respectively. No other MS measure was associated with shoulder injury occurrence of any severity. **Conclusions:** Dominant shoulder IR, elbow extension and EC measures may be intrinsic risk factors for shoulder injuries in sub-elite and elite tennis players. Additionally, D shoulder IR may also be an indicator for scapular dyskinesis. Although a large battery of MS measures are commonly performed, these may be the most appropriate tools for shoulder injury screening in tennis players. **References:** 1 Hutchinson et al. (1995). *Med Sci Sports Exerc.* 27(6). 2 Winge et al. (1989). *Int J Sports Med.* 10(5). 3 Sell et al., (2012). *Br J Sports Med.* 48. **Contact:** dgescheit@tennis.com.au

## THE LONG-TERM EFFECT OF ABDOMINAL STRENGTHENING EXERCISE ON FEMALE DIASTASIS OF RECTUS ABDOMINIS

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**1:University of Lisbon, FMH, LBMF, CIPER-Neuromechanics (Lisboa, Portugal) 2:Gdansk University of Physical Education and Sport (Gdansk, Poland); INTRODUCTION** Diastasis of rectus abdominis or the increased inter-rectus distance (IRD) is a common musculoskeletal condition on postpartum women. Previous studies showed that a single abdominal isometric contraction involved on abdominal crunch exercise has a positive acute effect on reducing the IRD (Pascoal et al. 2014). The aim of this study was to analyze the long-term effect of the abdominal strengthening exercise (e.g. crunch) on IRD magnitude. **METHODS** A sample of 45 healthy female volunteers was considered in three groups: 1) exercise-nulliparous group (E-N), including competitive bodybuilders (N=15); 2) non-exercise-post-partum group (NE-P), including early postpartum (18-24 weeks) women (N=15); and 3) non-exercise-nulliparous group (NE-N). Ultrasound images were recorded with a 12 MHz scanner in a supine resting position, 2 cm above the umbilicus, and exported in DICOM format for a posterior IRD offline measurement (mm) following previously described procedures (Mota et al. 2012). **RESULTS** A significant correlation was found between IRD and BMI. An ANCOVA [between-subjects factor: exercise-level; covariate: body mass index (BMI)] revealed a significant main effects of exercise-level,  $F(2,41)=30.82, p=.00, \eta^2=.601$ , no effect of BMI,  $F(1,41)=.10, p=.08, \eta^2=.003$ , and no interaction between exercise-level and BMI,  $F(2,39)=0.15, p=.86, \eta^2=.008$ . The E-N group had significantly lower IRD, controlling for the BMI, than the NE-P group [Mean Difference (MD):13.0; SEM:1.8; Confidence Interval 95% (CI95):16.6-9.4] or the NE-N group (MD:3.9; SEM:1.5; CI95:0.9-7.0). The NE-P group had significantly higher IRD than the NE-N group (MD:9.1; SEM:1.4; CI95:6.3-11.9). **DISCUSSION** The results on bodybuilders (E-N group) demonstrate the effect of long-term abdominal training (LTAT) on reducing female supraumbilical IRD. This is in agreement with those studies who suggest that an antenatal abdominal strengthening exercises program reduces the presence and width of postpartum DRA (Chiarello et al. 2005). However, further studies are needed to clarify if LTAT is effective to prevent or reduce postpartum DRA. The influence of pregnancy on IRD, revealed by the comparison between NE-N and NE-P groups, was similar in magnitude as reported previously (Pascoal, Dionisio et al. 2014). **REFERENCES** Chiarello, C. M., et al. (2005). *J. Women's Health Phys. Ther.* 29(1): 11-16. Mota, P., et al. (2012). *J. Orthop. & Sports Phys. Ther.* 42(11): 940-946. Pascoal, A. G., et al. (2014). *Physiotherapy* 100(4): 344-348. **ACKNOWLEDGMENTS** José Monteiro and Federação Lusa de Cultura Física on participants' recruitment and data collection. **CONTACT:** gpascoal@fmh.ulisboa.pt

## INCREASED ACL INJURY RISK IN THE COLD – AN ASSESSMENT OF POTENTIAL RISK FACTORS

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**Introduction** Epidemiological studies have provided evidence that in alpine skiing the risk for injuries of the anterior cruciate ligament (ACL) is increased when outer temperatures are particularly cold.<sup>1</sup> While this phenomenon may partly be related to altered surface conditions of skiing slopes, injury risk could be aggravated by temperature-associated changes in ACL stiffness or various neuromuscular parameters. The aim of this study was to test the effects of cold exposure on knee laxity as well as thigh muscle strength, explosiveness, proprioception, and electromyographic (EMG) activity. **Methods** Ten healthy females (age:  $23.4 \pm 3.2$  yrs, body mass:  $59.9 \pm 5.5$  kg, height:  $167.9 \pm 4.7$  cm) underwent 30 minutes of exposure to a cold environment ( $5^\circ\text{C}$ , 50% relative humidity) in a climatic chamber. Before and immediately after the intervention, knee extensor and flexor muscles were examined for EMG activity, maximum voluntary contraction strength, rate of force development and force sense. Measures of knee laxity, representative of ACL stiffness, were obtained by computerized arthrometry. **Results** Following cold exposure, rate of force development was reduced, with the effect being more pronounced in the knee flexor ( $r = 0.945$ ,  $p = 0.016$ ) than in the knee extensor muscles ( $r = 0.794$ ,  $p = 0.079$ ). Left-shifts of EMG power spectra indicated changes in neural drive to the medial and lateral head of the vastus muscle ( $0.638 < r < 0.856$ ,  $p < 0.05$ ). Antagonistic co-activation of knee flexors

during knee extension decreased non-significantly by 25-35%. No changes in maximum strength, force sense and knee laxity were found. Conclusions Cooling of the thigh and knee leads to a reduction in the capacity to generate force explosively. As indicated by left-shifts in EMG power spectra, this effect is likely mediated by changes in neural drive to muscles, and more pronounced in the knee flexor muscles. We further observed a reduction of hamstring co-activation during forceful contraction of knee extensors, although this result failed to reach significance. Since the hamstring muscles act to protect the ACL against excessive strain, these changes may contribute to the increased likelihood of ACL injuries when engaging in physical activity in the cold. Knee laxity, force sense and maximum strength, by contrast, were not significantly affected by cold exposure. References (1) Scand J Med Sci Sport 22(2): 185-9 Contact Dr. Robert Csapo, robert.csapo@uibk.ac.at

## Oral presentations

### OP-PM49 Exercise Testing

#### THE EFFECTS OF THE LOW RECUMBENT BODY POSITION IN MUSCLE DEOXYGENATION DURING RAMP INCREMENTAL EXERCISE

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Exercising in the supine position whereby the active muscles are held above the level of the heart compromises performance when compared with upright cycling. The lack of gravitational assist to muscle blood flow, results in a reduction of muscle perfusion pressure and subsequently oxygen delivery (Egaña et al., 2013; DiMenna et al., 2010). In the present study we investigated the impact of the low recumbent cycling position on cycling performance, muscle fractional O<sub>2</sub> extraction (estimated using deoxygenated haemoglobin), and rate of increase of pulmonary oxygen uptake (VO<sub>2</sub>) during incremental cycling exercise. Eleven young healthy male participants (mean ± SD; 22 ± 3 years; 181.5 ± 4.7 cm; 78.4 ± 10.5 kg) performed a ramp incremental cycling test to exhaustion in four cycling positions; upright, 30° recumbent (R), 15°R, and supine. Exercise was performed initially for 2-min at 10W, followed by 20 or 25 W/min increments on an electrically braked cycle ergometer, with pedal frequency held constant at an individually selected rpm. VO<sub>2</sub> was measured on a breath-by-breath basis using an online metabolic system, while the rate of muscle deoxygenation (deoxygenated haemoglobin/myoglobin, deoxy[Hb + Mb]) of the vastus lateralis (VL) muscle was continuously measured using near infrared spectroscopy (NIRS). Deoxy[Hb + Mb] responses displayed a sigmoidal shape across the four cycling positions. The slope of deoxy[Hb + Mb] / %workloadpeak was significantly (P<0.05) lower in the upright position (0.037±0.017) compared with the three other positions (30°R = 0.055±0.022; 15°R = 0.054±0.020; supine = 0.053±0.009), but was not different among the 30°R, 15°R and supine positions. These findings suggest that the reductions in cycling performance observed between the upright and low-recumbent (30°R & 15°R), and supine postures can be partially attributed to greater oxygen extraction levels in the 30°R, 15°R and supine postures, possibly due to a gravity-induced reduction in muscle oxygen delivery. However, factors affecting the differences in cycling performance between low recumbent and supine postures are less clear. References DiMenna F, Bailey S & Jones A (2010). Influence of body position on muscle deoxy[Hb + Mb] during ramp cycle exercise. *Respir Physiol Neurobiol* 173, 138-145. Egaña M, Columb D & O'Donnell S (2013). Effect of low recumbent angle on cycling performance, fatigue, and VO<sub>2</sub> kinetics. *Med Sci Sports Exerc* 45, 663-673

#### EFFECTS OF VOLUNTARY INCREASES OF VENTILATION ON BREATH-BY-BREATH O<sub>2</sub> UPTAKES

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**INTRODUCTION** Breath-by-breath (BbB) oxygen uptake values are obtained in humans by automatic devices that measure O<sub>2</sub> and CO<sub>2</sub> fractions and respiratory flow at the mouth; calculations are usually based on the open-circuit algorithm, applying the Haldane transformation. This approach is prone to introduce distortions of gas exchanges, especially when changes in the pulmonary gas stores take place (Capelli et al. 2011). We compared the O<sub>2</sub> uptake values calculated applying the open-circuit algorithm (OC) or an algorithm based on an alternative view of the respiratory cycle (AC), which likely takes into account the variations of the pulmonary O<sub>2</sub> stores (Cettolo & Francescato, 2015), when ventilation was voluntarily inconsistent with the actual metabolic demand. **METHODS** Respiratory flow, O<sub>2</sub> and CO<sub>2</sub> fractions at the mouth were continuously recorded over 20 min (CPET Metalyzer 3B, Cortex, Germany) in 9 healthy subjects (5 M; 4 F; 33±15 years old; 78±19 kg body mass) while they sat quietly on a chair. At 5 min intervals throughout the trials volunteers were asked to abruptly increase their ventilation for about 20 s, thereafter returning to quite conditions. Heart rate was recorded throughout by means of a chest belt (Polar, Finland). Computerised procedures were developed in C language for both OC and AC, allowing us to compute ventilation and BbB oxygen uptakes from the gas and flow traces. For each subject, three averages (over 10 breaths) were calculated just before each hyperventilatory period (REST) and three averages were calculated during the increased ventilation (HYPER), yielding overall 30 values for each condition. Standard statistical tests were used. **RESULTS** Ventilation amounted on average to 13.8±8.9 L/min during REST and increased about ten-fold (95.2±64.1 L/min) during HYPER. Average heart rate amounted to 79.6±15.8 bpm during REST and increased significantly to 84.2±16.2 bpm (paired t-test, p<0.001) during HYPER. Average oxygen uptakes during REST were not significantly different applying the two algorithms (0.288±0.063 L/min vs. 0.291±0.068 L/min for AC and OC, respectively; p=NS). Higher oxygen uptake were obtained during HYPER as compared to REST, the values calculated with AC being significantly lower than the those calculated with OC (0.622±0.172 L/min vs. 0.714±0.273 L/min, respectively; p<0.001). **CONCLUSIONS** In correspondence with the sudden increases in ventilation, although there was not an important increase in the metabolic requirement, the algorithms for the calculation of oxygen uptake yielded artificially high values. The new algorithm AC, however, provided lower values, suggesting that it likely was able to better compensate for the changes in the pulmonary O<sub>2</sub> stores. **REFERENCES** Capelli C, Cautero M, Pogliaghi S. *Eur J Appl Physiol* 111(3):331-42, 2011 Cettolo V, Francescato MP. *Eur J Appl Physiol* 115(9):1897-904, 2015 **CONTACT** mariapia.francescato@uniud.it



## THE EFFECTS OF EXERCISE MODALITY ON MAXIMAL AND SUBMAXIMAL EXERCISE PARAMETERS OBTAINED BY GRAD-ED MAXIMAL EXERCISE TESTING

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**Background.** Cardiopulmonary exercise testing (CPET) has become part of routine medical screening and evaluation of both healthy individuals and patients with various disorders. The modalities most often used to perform these tests are the treadmill (TM) and upright bicycle (UB). Nowadays, the supine bicycle (SB) is becoming more often used, especially when combined with medical imaging. However, it is not known if the same results are achieved with this last modality in comparison with the traditional TM and UB tests. **Aims.** The goal of the study was to examine whether a maximal CPET on a SB leads to similar results as the TM and UB in terms of peak oxygen uptake (peak VO<sub>2</sub>), peak heart rate and submaximal exercise measures. As a secondary goal, we preliminary explored how peak VO<sub>2</sub> relates to the person's preference and experience with the different exercise modalities. **Methods.** Twelve healthy individuals (8 male; mean age 21.6, range 21-24) participated in a randomized controlled cross-over trial performing three maximal exercise tests on a TM, UB and SB. During the tests, respiratory gas-exchange was monitored breath-by-breath and heart rate was continuously measured. Peak exercise measures where defined as the average of the last 10 s of the exercise test. Preference for a certain exercise modality was evaluated by a self-developed questionnaire. Post-exercise experience was evaluated with the Subjective Exercise Experiences Scale (SEES). Differences between the outcome measures obtained by the different CPET modalities were evaluated by means of repeated measures ANOVA. Intraclass correlation coefficients (ICC) and Bland-Altman plots were obtained for further evaluating agreement between the investigated parameters. **Results.** The SB exercise tests resulted in a significantly lower peak VO<sub>2</sub> ( $p < 0.001$ ) ( $2806 \pm 652$  ml.min<sup>-1</sup> (SB) vs  $3329 \pm 798$  ml.min<sup>-1</sup> (UB) and  $3550 \pm 799$  ml.min<sup>-1</sup> (TM)) and peak heart rate ( $p < 0.001$ ) ( $179 \pm 8$  beats.min<sup>-1</sup> (SB) vs  $192 \pm 7$  beats.min<sup>-1</sup> (UB) and  $193 \pm 11$  beats.min<sup>-1</sup> (TM)). ICC evaluation and supplementary Bland-Altman plots showed low agreement between peak VO<sub>2</sub> (ICC 0.545 (SB vs TM); 0.630 (SB vs UB)) and peak HR measures (ICC 0.308 (SB vs TM); 0.144 (SB vs UB)). No significant differences could be found when comparing the TM and UB post-hoc. Partial correlation, controlling for the possible influence of both preference and experience, did not change the initial differences in peak VO<sub>2</sub> between the exercise modalities. **Conclusion.** Upcoming maximal SB exercise tests, for evaluations in clinical settings, can't be considered as an evaluation of the maximal exercise capacity when compared to golden standard TM and UB.

## AGREEMENT BETWEEN THE STAGES CYCLING AND POWERTAP POWERMETER

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**Introduction** Training at high intensities can only be controlled inadequately by heart rate because it is considerably affected by internal and external factors and responding delayed to exercise intensity modifications. In contrast, mobile powermeters allow the assessment and control of cyclist's training intensities more accurately. Today, several powermeters are available and are now getting affordable for amateur athletes as well. The well-established PowerTap (PT; CycleOps) quantifies cycling power output (PO) via strain gauges in the rear wheel hub and has already been validated in previous studies. The Stages Cycling Powermeter (SCP; Stages Cycling) is a cheaper device that is more flexible for usage as PO is quantified in the left crank arm via integrated strain gauges. The aim of this study was to determine the agreement between these two devices. **Methods** An ordinary road bike was equipped with SCP and PT and mounted on a stationary cycle trainer (Flow T2200, Tacx). 38 participants performed a sub-maximal incremental test (100-400 W; 120s per level) and a sprint test (600 W; 30s). The levels were separated by recovery periods at 70 Watt. The PO was defined according to the cycle trainer. PO and cadence of PT and SCP were recorded simultaneously once per second. Differences in PO and cadence were determined and normalized to corresponding PT values and given in percentage. Agreement between methods was quantified by use of mean differences and limits of agreement (LoA). **Results** Compared to the PT, SCP underestimates PO across all intensities by a mean difference of  $-1.88 \pm 3.97$  %, while LoA range from 5.9% to -9.7%. Considering cadence, SCP calculates  $0.94 \pm 0.16$  revolutions per minute more than the PT (LoA: 0.63 to 1.25). Differences are almost consistent across all intensities. **Discussion** Confirming previous studies, SCP significantly underestimates PO though it is reliable. This may in part be due to differences in strain gauge configuration, the algorithms used to calculate PO and the potential influence that bilateral imbalances may have on these calculations. Although mean difference between SCP and PT is in an acceptable range, 95% of the individual PO differences account for up to 10 per cent. This means practical relevant PO differences up to 50 W between PT and SCP when cycling at higher intensities of 500 W or more. Precise training at high intensities can therefore only be warranted if precedent performance tests are carried out with the same powermeter. To determine the cadence, SCP uses an accelerometer while PT uses the repetitive PO peaks. Despite different measurement procedures, results show small differences that should be negligible for training control. Contact Patrick.Schneeweiss@med.uni-tuebingen.de

## A COMPARISON BETWEEN DIFFERENT METHODS OF ESTIMATING ANAEROBIC ENERGY PRODUCTION DURING CROSS-COUNTRY ROLLER-SKIING

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**Introduction** Two frequently used approaches for estimating anaerobic energy production during supramaximal exercise are the maximal accumulated oxygen (O<sub>2</sub>) deficit (MAOD) method and the gross efficiency (GE) method (Noordhof et al., 2011). Despite clear computational differences between the two methods, only one direct comparison has been performed (Noordhof et al., 2011). In cross-country roller-skiing, both the MAOD and the GE methods have been employed (Andersson et al., 2016). Therefore, this study aimed to compare the O<sub>2</sub> deficits obtained with these methods. **Methods** Eleven male and ten female cross-country skiers were tested on a treadmill employing uphill (7°) diagonal-stride roller-skiing. After collecting a 1-min baseline VO<sub>2</sub>, participants performed a 4 × 4-min continuous submaximal protocol (~ 60-90% of VO<sub>2</sub>max) followed by, a self-paced 600-m time-trial (TT). Speed and VO<sub>2</sub> were measured continuously during the TT. For the MAOD method, the linear relationship between treadmill velocity and VO<sub>2</sub> during the final 30 seconds of each 4 × 4-min submaximal stage was derived with the baseline VO<sub>2</sub> as a Y-intercept included (4+Y) in or excluded (4-Y) from the model. The two regression equations were then used to estimate the VO<sub>2</sub> demand during the TT. For the GE method, the metabolic rate during the TT was calculated by taking the average power output divided by the GE (an average of the four submaximal stages) and converted to a VO<sub>2</sub> demand. **Results** The VO<sub>2</sub> demand was significantly higher for the GE ( $68.9 \pm 8.5$  mL/kg/min) and 4-Y ( $68.4 \pm 8.7$  mL/kg/min) procedures compared with the 4+Y ( $64.3 \pm 7.6$  mL/kg/min) procedure ( $P < 0.05$ ). The corresponding O<sub>2</sub> deficits for the GE, 4-Y and, 4+Y proce-

dures were  $63.7 \pm 9.7$ ,  $62.3 \pm 10.4$  and,  $50.2 \pm 9.6$  mL/kg, respectively ( $P < 0.05$  for GE and 4-Y vs. 4+Y). The mean difference between the O<sub>2</sub> deficits estimated from the 4-Y and GE procedure  $-1.4 \pm 3.9$  mL/kg, and between the 4+Y and GE procedures was  $-13.5 \pm 2.5$  mL/kg. Corresponding typical errors for the two comparisons were 2.74% and 1.74% while the intra-class correlation coefficients together with linear equations were  $r = 0.93$  ( $0.99x - 0.8$ ) for [4-Y vs. GE] and  $r = 0.97$  ( $0.95x - 10.5$ ) for [4+Y vs. GE]. Discussion The main finding of the current study was the high agreement between the 4-Y and GE procedures which is in contrast to previous findings of Noordhof et al. (2011). Moreover, the inclusion of a Y-intercept for baseline VO<sub>2</sub> resulted in a 20% lower O<sub>2</sub> deficit compared to the 4-Y and GE procedures. References Andersson E, Björklund G, Holmberg HC, Ørtenblad N. (2016). Scand J Med Sci Sports. Noordhof DA, Vink AM, de Koning JJ, Foster C. (2011). Int J Sports Med, 32, 422-8 Contact erik.andersson@miun.se

## THE EFFECT OF COMPASSIONAL HYPERALGESIA ON EXERCISE-INDUCED PAIN DURING ENDURANCE CYCLING PERFORMANCE

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THE EFFECT OF COMPASSIONAL HYPERALGESIA ON EXERCISE-INDUCED PAIN DURING ENDURANCE CYCLING PERFORMANCE Astokorki, A.H.Y., Mauger, A.R University of Kent, Chatham, UK Introduction Pain is an unpleasant, subjective experience that includes sensory and emotional components (Rainville, 2002). Several studies have shown that observing other's pain can enhance the intensity of painful stimuli – an effect termed compassionate hyperalgesia (Godinho et al., 2012). Intense exercise causes a noxious environment in the muscle that elicits 'exercise-induced pain' (EIP), and tolerance of this sensation has been associated with endurance performance. It is unknown the degree to which this sensation is effected by top-down processing, such as compassionate hyperalgesia. Methods Twenty-one participants, trained in cycling, completed 5 laboratory visits. The first visit involved an assessment of aerobic capacity (VO<sub>2</sub>max test) and a familiarisation of the fixed power (FP) and time trial (TT) tests. The second visit provided a further familiarisation of the FP and TT. In the subsequent three visits, in a counter-balanced manner, participants performed a FP and TT. Immediately prior to these, participants viewed a collection of images from the International Affective Picture System database that were either pleasant, unpleasant (painful) or neutral. Participants were asked to rate each image with respect to affective valence and their level of emotion. During the TT and FP, participants were asked their EIP, RPE and had measures of HR and B[La] recorded. Results ANOVA revealed a significant difference in TT performance, PO and HR ( $P < 0.05$ ) between conditions during the TT cycling performance, but no significant effect of condition for mean RPE or EIP ( $P > 0.05$ ). For the FP, a significant main effect of condition for EIP, but no difference for RPE, HR or B[La]. A significant effect of condition for Depression, Tension, Anger, and Confusion following viewing the images ( $P < 0.05$ ). No differences were found for fatigue and vigour. Discussion The results of this study demonstrate that viewing painful images prior to exercise decreased TT performance. This study demonstrates that there is an emotional element to the processing of EIP that can be influenced by compassionate hyperalgesia. It is suggested that the dorsolateral prefrontal cortex (DLPFC) plays a crucial role in physical, somatosensory pain perception, and in emotional pain (Borckardt et al., 2007). Future studies should seek to examine cortical changes in the DLPFC during exercise that elicits sensations of pain. References Rainville, P. (2002). Curr. Opin. Neurobiol., 12, 195–204. Godinho, F., et al. (2012). European Journal of Pain, 16(5), 748-759. Borckardt, J. J., et al. (2007). Pain Res. Manage., 12, 287–290. Contact ahy3@kent.ac.uk

## Oral presentations

### OP-PM52 Adapted Physical Activity - Temperature

#### VALIDATION OF AN INGESTIBLE TEMPERATURE DATA LOGGING AND TELEMETRY CAPSULE DURING EXERCISE IN THE HEAT

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Introduction Gastrointestinal temperature measured via radio telemetry of an ingested capsule has been shown to be a valid index of core temperature (Byrne & Lim, 2007). However, the additional recording equipment that must be carried by athletes limits its use to a monitoring tool during training. Recent technological advances have led to ingestible telemetry capsules that are also capable of storing data for later analysis. The purpose of this study was to determine the validity and reliability of this new temperature logging and telemetry system. Methods A 3-point calibration in a temperature controlled water bath was initially undertaken in 24 pairs of pills for the e-Celsius (BodyCap; T-BC) and Equivital (Respiration; T-ELM) systems, along with rectal temperature probes (T-rec). Reference temperatures were determined from an uninsulated digital reference probe at 35, 38.5 and 42°C. Following calibration, 12 trained males performed 60 min of cycle exercise at ~50% peak power output in conditions of 35°C & 52% relative humidity. Gastrointestinal temperatures were compared to T-rec throughout. Results from the calibration were used to determine the mean bias and SEM. Results Calibration data indicated all measurement devices consistently underestimated water bath temperature at all three reference points ( $P < 0.05$ ) with the exception of T-rec at 38.5 and 42°C ( $P > 0.05$ ). Additionally, both T-ELM and T-BC consistently underestimated T-rec with a SEM of  $\pm 0.09$  and  $\pm 0.34$  at 35°C,  $\pm 0.37$  and  $\pm 0.10$  at 38.5°C and  $\pm 0.35$  and  $\pm 0.12$  at 42°C, respectively. When compared to T-ELM, T-BC was consistently lower with a mean bias of  $0.16 \pm 0.48^\circ\text{C}$ ,  $0.18 \pm 0.50^\circ\text{C}$  and  $0.15 \pm 0.46^\circ\text{C}$  at 35, 38.5 and 42°C, respectively ( $P < 0.05$ ). During the cycling trial, T-rec was significantly greater than T-BC from 15 min onward and greater than T-ELM at 50 and 55 min only ( $P < 0.05$ ). Furthermore, T-BC was significantly lower than T-ELM at several points following 20 min of exercise ( $P < 0.05$ ). Discussion T-BC and T-ELM consistently measured lower core temperatures compared to T-rec during exercise in the heat, contrary to previous reports (Byrne & Lim, 2006). This relationship was also consistent across a wide temperature range in controlled water bath manipulations, suggesting an inherent mean bias of the devices used in this study. However, T-BC consistently under-reported intestinal temperature by  $0.15$ - $0.18^\circ\text{C}$  compared to T-ELM. Therefore, we recommend calibrating these capsules before use in both field and laboratory settings to provide accurate and reliable measures of core temperature. References Byrne C, Lim C (2007). Br J Sports Med, 41(3), 126-133. Contact Gavin.Travers@aspetar.com

## RECTAL TEMPERATURE, FLUID INTAKE, DEHYDRATION RATE AND BIOCHEMICAL AND HEMATOLOGICAL DATA IN THE RUNNERS PARTICIPATED IN CITIZEN'S HALF-MARATHON IN SUMMER

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Introduction Marathon, a long distance running, is an aerobic exercise which promotes health and fitness, however it causes large heat stress and may induce heat illness, even in cool seasons, especially in the hot summer. We investigated the influence of the summer half-marathon on the runner's body in Obuse Mini-Marathon held at Obuse, Nagano, Japan, on 19th July, 2015. Methods Twenty-nine runners (24 men and 5 women) volunteered as the subjects. Body weight and tympanic temperature (T<sub>ty</sub>) were measured and venous blood samples were obtained for biochemical and hematological analysis before and after the race. Volume of fluid intake during the race was interviewed and rectal temperature (T<sub>re</sub>) was measured after the race. WBGT was monitored along the course every 1km. Sports drink and water were supplied every 1 km. Sweat loss was calculated as weight loss plus fluid intake, and dehydration rate (%) was calculated as weight loss divided by initial weight x 100. Results & Discussion The race started at 6 AM at 22 degrees C of WBGT and closed at 11 AM at 30 degrees C of WBGT. All subjects completed the race at the time between 1h 22min and 3h 42min without any symptom of heat illness. Mean T<sub>re</sub> immediately after the race was 38.5 C (range: 37.6-39.7 C), and 5 subjects finished with T<sub>re</sub> above 39 C. T<sub>ty</sub> showed a correlation with T<sub>re</sub>, but did not detect any of 5 subjects who's T<sub>re</sub> above 39 C, suggesting that T<sub>ty</sub> is not a substitution of T<sub>re</sub> for screening the heat illness. Mean weight loss was 1.13 kg in men and 0.45 kg in women. One man and two women finished the race with a slight increase in weight. Dehydration rate was 1.6+/-0.9% (range: 0.6% increase - 3.0% loss) and was above 2% in 10 subjects. Fluid intake was 1.2 L (0.1-2.4 L) in men and 0.8 L (0.5-1.3 L) in women. Sweat rate was 1.1 L/h (0.5-2.1 L/h) in men and 0.4 L/h (0.2-0.8 L/h) in women. The blood analysis before and after the race were as followed; Albumin: 4.6 to 5.0 g/dL, AST: 24.1 to 31.8 U/L, LDH: 213 to 275 U/L, CK: 145 to 251 U/L, BUN: 16.8 to 18.3 mg/dL, Na: 142 to 145 mEq/L, Cl: 101 to 102 mEq/L, WBC: 5514 to 9181 /micro L, RBC: 467 to 481 x 10000 /micro L, Hb: 14.2 to 14.6 g/dL, Hct: 46.3 to 47.4 %. Hemoconcentration rate was 8.0+/-0.9% calculated from the change of Albumin and 5.1+/-6.0% from the changes of Hb and Hct. Moderate increases in AST, ALT, LDH and CK greater than hemoconcentration rate indicate a minimum rhabdomyolysis. The less increase in Na and Cl compared to hemoconcentration rate, indicates insufficient intake of NaCl during the race.

## EXTREME HOT CLIMATIC CONDITIONS LIMITS PHYSICAL ACTIVITY PARTICIPATION

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Introduction Even though there are several studies showing seasonal variation in physical activity participation across the globe. There are only handful of studies that have assessed physical activity behaviour when weather is relatively hot for most part of the year. Qatar experiences summer months when temperature usually ranges from (25°C–46°C). This study aimed to assess longitudinal changes in pedometer-assessed physical activity as a result of hot weather. Methods In this study we enrolled 2088 adults (66.6% men) from a community health program in Doha. Daily physical activity was recorded using pocket-sized pedometer (Omron HJ-720ITC, USA) and each participant uploaded this on the community web-platform. Data related to daily climatic conditions of Doha city was obtained from the [www.wunderground.com](http://www.wunderground.com) website. Results A strong inverse relationship was found between participation of physical activity and average daily temperature. Further wind speed and visibility was associated with decrease in average physical activity participation. The negative influence of climatic conditions was similar across gender, age and nationality. Conclusions Hot weather reduces physical activity therefore interventions should be planned to promote physical activity at times of the day when temperature is warmer. Also campaigns should involve in-door activities to promote physical activity participation. References Hallal PC, Andersen LB, Bull FC, Guthold R, Haskell W, Ekelund U. (2012). The Lancet, 380(9838):247-257. Jones WK. (2003) Am J Prev Med, 25(3):2-4. Humpel N, Owen N, Leslie E. (2002). Am J Prev Med. 22(3):188-199. Schutzer KA, Graves BS. (2004) Prev Med, 39(5):1056-1061. Chan CB, Ryan DA. (2009). Int J Environ Res Public Health, 6(10):2639-2654. Rich C, Griffiths LJ, Dezateux C. (2012). Int J Behav Nutr Phys Act, 9:49. McCormack GR, Friedenreich C, Shiell A, Giles-Corti B, Doyle-Baker PK. (2010). J Epidemiol Community Health, 64(11):1010-1016. Ridgers ND, Salmon J, Timperio A. (2015). Int J Behav Nutr Phys Act, 12(1):77. Feinglass J, Lee J, Semanik P, Song J, Dunlop D, Chang R. (2011). J Phys Act Health, 8(7):934-943. Wolff D, Fitzhugh EC. (2011). Int J Environ Res Public Health, 8(2):579-589. Al-Kuwari MG, Al-Mohannadi AS, El-Jack II, Al-Mudahka FA. (2014). J Sports Med Phys Fitness, Epub ahead of print. Lemke B, Kjellstrom T. (2012). Ind Health, 50(4):267-278. Contact abdulla.almohannadi@aspetar.com

## THE SWEATING RESPONSE AND FLUID INTAKE OF ELITE PROFESSIONAL FOOTBALL PLAYERS DURING TRAINING AT DIFFERENT EXERCISE INTENSITIES IN HOT AND COOL ENVIRONMENTS

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Sweat rate and sweat composition vary between individual players of a team. To date no data is available on the fluid and sodium [Na<sup>+</sup>] losses or ad-libitum carbohydrate (CHO) or fluid intake of elite professional players in response to exercise at different intensities and in diverse environmental conditions. Data were collected from 12 male professional football players on four separate training occasions under the following conditions: cool (15 ± 7° C, 66 ± 6 RH) low/moderate intensity (RPE 1-5) (CL); cool high intensity (RPE 6-10) (CH); hot (29 ± 1° C, 52 ± 7 RH) low/moderate intensity (HL); hot high intensity (HH). Training sessions were 75 ± 15 min involving intermittent running and football specific play. Before and after the first training session of the day all players were weighed in minimal clothing. During training players had free access to sport drink (Gatorade Thirst Quencher) and water. Each player was allocated their own drinks bottles which were weighed before and after training. Any urine produced was also collected and measured during the training session. Sweat samples were collected from regional absorbent patches during exercise on the thigh and back of each player. Sweat was subsequently analysed for sodium concentration [Na<sup>+</sup>] (compact Horiba B-722). Results, mean ± SD (range). Urine specific gravity prior to exercise; CL: 1.024 ± 1.005 (1.016-1.032), CH: 1.014 ± 1.004 (1.014-1.028), HL: 1.023 ± 1.006 (1.011-1.030), HH: 1.026 ± 1.005 (1.017-1.034); F(3,33) = 2.0, P = 0.157. Sweat rate (L/h); CL: 0.66 ± 0.14 (0.40-0.87), CH: 0.88 ± 0.24 (0.70-1.50), HL: 0.99 ± 0.23 (0.60-1.37), HH: 1.56 ± 0.43 (1.08-2.70), F(3,33) = 22.7, P = 0.000. Sweat Na<sup>+</sup> loss (mg/h); CL: 558 ± 230 (198-978), CH: 739 ± 420 (288-1846), HL: 889 ± 355 (435-1482), HH: 1493 ± 458 (979-2272), F(3,30) = 14.9, P = 0.00 (n.=11). Fluid intake (ml/h); CL: 351 ± 159 (0-552), CH: 427 ± 261 (81-1058), HL: 551 ± 174 (330-791), HH: 650 ± 282 (266-1257), F(3,33) = 5.3, P = 0.04. Percentage dehydration; CL: 0.5 ± 0.3 (0.0-0.9), CH: 0.8 ± 0.4 (0.2-1.6), HL: 0.6 ± 0.4

(0.2-1.4), HH:  $1.3 \pm 0.3$  (0.8-1.9),  $F(3,33) = 22.7$ ,  $P = 0.00$ . CHO intake (g/h): CL:  $10 \pm 7$  (0-24), CH:  $12 \pm 11$  (0-35), HL:  $17 \pm 10$  (4-35), HH:  $14 \pm 11$  (0-38),  $F(3,33) = 1.6$ ,  $P = 0.195$ . Elite football players' fluid loss, Na<sup>+</sup> loss, ad-libitum fluid intake varies significantly in response to different exercise intensities in different environmental conditions. Ad-libitum CHO intake varies widely between players. These results may inform programs aimed to personalize player nutrition.

### THE EFFECTIVENESS OF ENCOURAGING INDIVIDUALS TO STAY WELL-HYDRATED IN THE PRE-TRIAL PREPARATION PERIOD

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The effect of hypohydration on endurance performance is widely known and extensively studied. However, many researchers limit their pre-trial hydration strategies to simply encouraging participants to stay well hydrated without providing any instructions on how to do so. It is still not known whether this encouragement is successful in minimising the risk of starting an exercise test in a hypohydrated state. Therefore, the main aim of this study was to measure the incidence of participants who were hypohydrated on their arrival to the laboratory after receiving encouragement to stay well-hydrated. Forty-five normally active (non-athletes) or moderately trained (athletes) men provided a first morning urine sample at home soon after waking. Approximately one hour after, they provided a second urine sample at the laboratory. Participants were instructed to fast overnight for 10 hours from all food and drinks except from water, which they were verbally encouraged to drink to stay well hydrated. The verbal encouragement given to participants was as follows: 'keep yourself well-hydrated throughout the day, especially in the evening, before the urine collection. This can be achieved by drinking an additional amount of water to your usual intake'. Participants were not informed about the real aim of the study in order to prevent them from modifying their behaviour which could make the results invalid. The results indicated that 35% of participants were significantly hypohydrated, 30% were likely hypohydrated, and 35% euhydrated on their arrival to the laboratory. First morning urine osmolality values were (mean  $\pm$  SD):  $1043 \pm 108$ ,  $801 \pm 44$ , and  $538 \pm 107$  mOsmol.kg<sup>-1</sup>, respectively. Mean urine osmolality of the first void was not significantly different than the second void ( $825 \pm 182$  and  $849 \pm 235$  mOsmol.kg<sup>-1</sup>, respectively;  $p = .71$ ). Furthermore, no significant differences were found between athletes and non-athletes ( $780 \pm 222$  and  $808 \pm 251$  mOsmol.kg<sup>-1</sup>, respectively;  $p = .69$ ). These results indicate that encouraging participants to drink water in the pre-trial preparation period is not sufficient to achieve euhydration in all participants.

### REHYDRATION REGIMES IN EXERCISE AND NON-INVASIVE HYDRATION METHODS; A FIRST ATTEMPT

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Introduction Human body water and sweat play vital roles in exercise, functioning as solution for physiological processes or as medium preventing hyperthermia. Certain blood electrolyte levels reflect either hypo- or hyper hydrated states that impair performance and are meant to be related to sweat composition. Real time monitoring through wearable technologies provide valuable opportunities assessing individual states in exercise. The aim of the study was first to assess individual hydration regimes non-invasively via so called Ion Selective Electrodes and second to analyze the effect of different rehydration procedures onto physiological strain. Methods 25 healthy, male subjects (Age:  $24 \pm 1.8$  years; Height:  $183 \text{ cm} \pm 9$ ; Weight:  $78 \text{ kg} \pm 9.8$ ) were tested in a controlled environment ( $t = 22-25^\circ\text{C}$ ; relative humidity = 45%;  $v_a = 0.1-1 \text{ m/s}$ ; clothing:  $0.1 \text{ m}^2\text{K/W}$ ) at 60 % of their  $\text{VO}_2\text{max}$  on an individually adjustable ergo meter for 70 and 90 minutes. Refractometry, weighing, absorbents, ion selective electrodes, and blood samples provided information about pre-, during, and post active hydration states and sweat rates. To control pre-test hydration, ACSM protocols were used. Three different rehydration regimes (reactive, anticipative, and ad libitum) were randomly assigned and compared with a baseline test to identify optimum ways for hydration homeostasis. Heart frequency and core temperatures were taken as parameters for physiological strain. Results None of the rehydration regimes showed significant results ( $p = .43$ ) on physiological strain and sweat loss ( $p = .64$ ). These results could be explained by any individual component, such as fat content or pre-test hydration state. Ad libitum rehydration was up to 50% lower than measured sweat loss. Local sweat compositions highly varied across subjects (Chest  $47.6 \pm 25.7 \text{ mmol/l}$ ; Lower Back  $26.2 \pm 19.4 \text{ mmol/l}$ ; Forearm  $42.2 \pm 25.8 \text{ mmol/l}$ ) and over time no changes in blood sodium concentration could be observed between three measurements ( $t_1 = 137 \text{ mmol/l}$ ;  $t_2 = 138 \text{ mmol/l}$ ;  $t_3 = 138 \text{ mmol/l}$ ). As result only low correlations ( $R^2 = .15$ ) were found between local sweat composition at core body parts and blood sodium levels. Discussion It's most likely, that protocol duration was key factor not observing any changes in blood volume. Due to manifold processes the body is able to counterbalance any decrease in blood sodium concentration. To current state correlations are likely to be detectable at a much later state ( $>2\text{h}$ ). It seems somehow irrelevant how to rehydrate in durations around 1 hour to reduce physiological strain, although ad libitum regimes underlined people's inability to sufficiently maintain a healthy water balance. It will be important how new systems deal with or compensate individual differences and feedback effective counteractions. Interestingly, described studies showed both the complexity but necessity of new feedback systems with more research to be done.

## Oral presentations

### OP-PM33 Pre-activation Exercises

#### BLOOD FLOW RESTRICTION AND RELEASE IN THE LOWER LIMBS DURING EXERCISE: EFFECTS ON TISSUE OXYGENATION AND EXERCISE PERFORMANCE

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Introduction Muscle ischemia is a limiting factor to performance. Ischemic precondition with application of repeated cycles of inflation and deflation of a blood pressure cuff on the limbs just before exercise has been shown to improve either maximal oxygen consumption (de Groot et al 2010) or exercise performance (Crisafulli et al 2011). However, it is not known whether the acute release of restricted muscle blood flow during exercise restores or improves exercise performance. The aim of this study was to investigate whether the acute release of muscle ischemia and the subsequent restoration of flow during incremental exercise can alter (i) cerebral and muscle oxygenation,



and (iii) exercise performance. Methods Thirteen healthy well-trained cyclists ( $33 \pm 2$  yrs), performed an incremental cycling exercise test to exhaustion on three separate conditions: a) with thigh cuffs (C) inflated to 120 mmHg on both legs throughout the exercise session, b) exercise with thigh cuff occlusion followed by deflation (CNoC) at 80% of PPO, and c) a control session, without occlusion (NC). Ventilatory and cardiovascular responses, as well as muscle and cerebral oxygenation were measured continuously throughout testing. Results Exercise performance was significantly attenuated during cuffs inflation exercise vs. control exercise, as indicated by the reduction in  $\dot{V}O_{2\max}$  ( $18 \pm 2\%$ ), PPO ( $27 \pm 2\%$ ) and time to exhaustion ( $28 \pm 2\%$ ); whereas, the CNoC exercise rapidly restored the aforementioned variables to values observed in the control exercise bout. The reduction of exercise performance was associated with attenuated maximal cardiovascular responses, i.e. significant reductions in maximal heart rate (by  $9 \pm 3\%$ ) and cardiac output ( $14 \pm 7\%$ ). Muscle blood flow restriction significantly altered muscle and cerebral oxygenation at exhaustion. A blunted response in oxygenated hemoglobin ( $\Delta[O_2Hb]$ ) was observed during cuffs inflation exercise vs. control exercise ( $-11.33 \pm 1.35$  vs.  $-6.29 \pm 1.11$   $\mu\text{M}$ , respectively;  $p < 0.01$ ), while cerebral  $\Delta[O_2Hb]$  was significantly lower during cuffs inflation compared with control exercise. The acute release of external thigh pressure during exercise restored all the aforementioned parameters to level observed during control exercise bout. Discussion Exercise performance, muscle and cerebral oxygenation were attenuated by venous occlusion. These reductions were entirely restored in response to cuff deflation, following occlusion. However, the rapid deflation of the cuff during exercise did not result in enhancements of exercise performance beyond the control session. References De Groot PCE, Thijssen DHJ, Sanchez M, Ellenkamp R, Hopman MTE (2010). Eur J Appl Physiol, 108(1), 141-146. Crisafulli A, Tangianu F, Tocco F, Concu A, Mameli O, Mulliri G, Caria MA (2011). J Appl Physiol, 111, 530-536. Contact echerouv@phed.uoa.gr Do not insert authors here

### IPSILATERAL MUSCLE ADAPTATION WITH BLOOD FLOW RESTRICTION TRAINING

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Introduction Traditional resistance training increases muscle strength in the trained limb, as well as the contralateral limb by cross-education through a mechanism that originates within the central nervous system (CNS) (Lee & Carroll., 2008). However, muscle strength adaptations do not occur ipsilaterally along the superior-inferior axis (West et al., 2007). In contrast, Madarame et al. (2008) showed muscle strength and size to increase in the limb that performed blood flow restriction (BFR) exercise, as well as the ipsilateral limb that performed light non-BFR exercise during the same training sessions. We aimed to validate this effect. Methods Untrained participants were allocated to a BFR ( $n=10$ ) or control (CON;  $n=12$ ) group and performed seven weeks of resistance training (3 days per week). During training, both groups performed three sets of dominant arm bicep curls (50% 1-repetition maximum (1-RM)) followed by four sets each of bilateral leg extension and knee flexion (30% 1-RM). The BFR group performed leg exercises with pressurised cuffs applied to the upper thighs, inflated to 60% of limb occlusion pressure ( $124 \pm 11$  mmHg; mean  $\pm$  SD). Maximum strength (1-RM) was measured using bilateral leg exercises and unilateral bicep curls in both the trained and untrained arms. Total muscle cross-sectional area (CSA) was measured via peripheral quantitative computed tomography in the dominant thigh and both upper arms individually. Results Bilateral leg extension 1-RM increased to a significantly greater extent following training in the BFR group ( $16.6 \pm 1.5$  kg; mean  $\pm$  SEM) when compared with CON ( $8.3 \pm 1.6$  kg) ( $P < 0.05$ ). Knee flexion 1-RM increased similarly between groups. Bicep curl 1-RM in the trained arm showed a greater increase in the BFR group ( $2.3 \pm 0.5$  kg) compared with the contralateral untrained arm ( $1.0 \pm 0.4$  kg), and the trained arm of CON ( $0.6 \pm 0.3$  kg). Muscle CSA of the thighs and trained arms increased similarly between groups, but did not change in the untrained arms. Discussion BFR training of the lower-limbs increased muscle strength in the active upper arm greater than the non-dominant arm and the CON dominant arm. However, there was no effect on muscle size. This suggests that BFR training may induce an ipsilateral (or whole body) strength transfer to muscle that is 'sensitised' by exercise. The mechanism for this effect seems likely to originate via the CNS, similar to cross-education, or via an unknown systemic circulatory mechanism. Both of which require further exploration. References Lee M, Carroll TJ. (2007). Sports Med, 37, 1-14. Madarame H, Neya M, Ochi E, Nakazato K, Sato Y, Ishii N. (2008). Med Sci Sports Exerc, 40, 258-263. West DWD, Burd NA, Tang JE, Moore DR, Staples AW, Holwerda AM, Baker SK, Phillips SM. (2010). J Appl Physiol, 108, 60-7.

### EFFECTS OF POST-ACTIVATION POTENTIATION ON MUSCULAR ENDURANCE PERFORMANCE: IS IT POSSIBLE TO DO MORE REPETITIONS AFTER ECCENTRIC LOADING?

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Introduction Effects of post-activation potentiation (PAP) on jumping, sprinting, swimming and explosive type activities has been well documented. However, its effects on muscular endurance performance remains limited. Furthermore, loading protocols for PAP were comprised of muscle contractions of different varieties including isometric, dynamic and electrical stimulation but not eccentric-only. Therefore, the aim of this study is to investigate the effects of PAP on muscular endurance performance after eccentric loading. Method: 42 physically active male participants (PAP Group  $n=32$ , Control Group  $n=10$ ) who have at least 1 year of resistance training experience and who exercises 3 times/week participated in this study. On the first testing session, after the standardized warm up, 1 Repetition Maximum (RP) of participants was found. 65% of the 1 RM was calculated to find the weight that were going to be used for the muscular endurance performance. Participants completed repetitions to failure with 65% of their 1 RM. Tempo was set at 4 seconds for each repetition. On the second testing session which was done 48 hours after the first session, PAP group did eccentric Bench Press with their 120 % of 1 RM. Resting interval was decided as 8 minutes to elicit the effects of PAP. After the resting period, muscular endurance test with 65 % of 1 RM was completed. The control group did same protocol as the first day on the second test day. Results: No statistical difference was found between the repetitions that were done in the first and second test session of control group ( $p > 0.05$ ). Whereas significant increase was found for the PAP group ( $p < 0.05$ ). No relationship between training age and the number of increased repetitions was observed ( $p > 0.05$ ). Discussion: The results of this study showed that performance enhancing effects of PAP can be elicited by eccentric loading. Furthermore, although inter-individual variability was relatively high, it was observed that PAP can also increase muscular endurance performance. Therefore, PAP protocols in resistance training sessions might be used for athletes who want to improve their muscular endurance performance. Key Words: post activation potentiation, resistance training, bench press, muscular endurance, eccentric loading References Seitz, B. L., Haff, G. G. (2015). Factors modulating post-activation potentiation of jump, sprint, throw, and upper-body ballistic performances: a systematic review with a meta-analysis. Sports Med. 2016 Feb;46(2):231-40. doi: 10.1007/s40279-015-0415-7 Arabatzis, F., Patikas, D., Zafeiridis, A., Giavroudis, K., Kannas, T., Gourgoulis, V., & Kotzamanidis, C. M. (2014). The Post-activation potentiation effect on squat jump performance: age and sex effect. Pediatr Exerc Sci, 26(2), 187-194. doi: 10.1123/pes.2013-0052 Kilduff, L. P., Cunningham, D. J., Owen, N. J., West, D. J., Bracken, R. M., & Cook, C. J. (2011). Effect of post-activation potentiation on swimming starts in international sprint swimmers. J Strength Cond Res, 25(9), 2418-2423

**INSPIRATORY MUSCLE LOADING DURING REPEATED-SPRINT EXERCISE**

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This project examined the addition of an inspiratory load on locomotor muscle tissue reoxygenation during repeated-sprint (RS) exercise. **METHODS:** Ten healthy males completed three trials of ten 10 s sprints, separated by 30 s of passive rest. The first two trials were performed randomly without (CONTROL) and with inspiratory loading (INSP). The third trial (MATCH) consisted of ten 10 s intervals that were work-matched to the mean power output during the INSP trial. Breath-by-breath oxygen uptake (VO<sub>2</sub>) was monitored and expressed as percentage of VO<sub>2peak</sub>. A 5-breath rolling average was applied, and peaks and nadirs calculated for each 40 s sprint and recovery period. Vastus lateralis deoxy-haemoglobin (HHbVL) was monitored with near-infrared spectroscopy, and expressed as percent of limb arterial occlusion. Peaks and nadirs were calculated for HHbVL, and reoxygenation rate during the recovery periods was calculated as the time from peak to nadir. Respiratory muscle deoxy-haemoglobin (HHbRM) was expressed as a percent of baseline, and an average was calculated for each 40 s sprint/recovery period. Data was analysed using a one way ANOVA and magnitude-based inferences. **RESULTS:** Mechanical work completed was similar between INSP and CONT ( $\Delta$ mean  $-2.7 \pm 6.4\%$ ;  $p=0.482$ ; Standardised effect:  $-0.18 \pm 0.43$ ), despite a substantial difference in inspiratory mouth pressure, and there were trivial differences between MATCH and INSP ( $\Delta$ mean  $-0.6 \pm 0.1\%$ ;  $p<0.001$ ;  $-0.04 \pm 0.01$ ). Peak and nadir VO<sub>2</sub> was  $5.3 \pm 3.2\%$  ( $p=0.011$ ;  $0.65 \pm 0.38$ ) and  $5.97 \pm 4.63\%$  ( $p=0.037$ ;  $0.73 \pm 0.55$ ) higher respectively during INSP than CONT. In contrast, VO<sub>2</sub> was  $22.9 \pm 4.8\%$  ( $p<0.001$ ;  $-5.35 \pm 1.27$ ) and  $21.8 \pm 3.6\%$  ( $p<0.001$ ;  $-3.57 \pm 0.66$ ) lower during MATCH compared to INSP. Average HHbRM was  $61.2 \pm 62.9\%$  ( $p=0.054$ ;  $0.49 \pm 0.39$ ) higher during INSP than CONT. Conversely, HHbRM was  $-57.2 \pm 11.1\%$  ( $p<0.001$ ;  $-1.76 \pm 0.53$ ) lower during MATCH compared to INSP. There was a trivial difference in peak HHbVL between INSP and CONT ( $\Delta$ mean  $-2.5 \pm 6.7\%$ ;  $p=0.702$ ;  $0.15 \pm 0.40$ ), and possible small difference in nadir HHbVL ( $\Delta$ mean  $-12.1 \pm 15.1\%$ ;  $p=0.374$ ;  $-0.31 \pm 0.41$ ). Reoxygenation rate was similar between INSP and CONT ( $\Delta$ mean  $2.2 \pm 13.4\%$ ;  $p=0.809$ ;  $0.04 \pm 0.26$ ). **CONCLUSION:** A functional reserve in pulmonary O<sub>2</sub> uptake may exist, to be called upon to support both an elevated work of breathing and locomotor muscle tissue reoxygenation during RS exercise. The lack of difference in reoxygenation between INSP and CON implies that for 'all out' sprint exercise, local control of muscle blood flow may override neural mechanisms arising from a respiratory metaboreflex. **CONTACT:** ramon.rodriguez-anderson@live.vu.edu.au

**Oral presentations****OP-PM51 Animal Models in Health****EFFECTS OF DIETARY RESTRICTION, METHIONINE RESTRICTION AND ENDURANCE EXERCISE ON INSULIN SENSITIVITY IN RATS**

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**Abstract Aim:** The purpose of this study was to investigate an 8-week dietary restriction (DR), dietary methionine restriction (MR), and endurance exercise (EE), on insulin sensitivity in rats. **Methods:** Forty-eight male Sprague-Dawley (SD) rats (26-week-old) were randomly assigned into six groups, which were the control (CON, n=8) group, 40 % dietary restriction (DR40%, n=8) group, 20 % dietary restriction (DR20%, n=8) group, methionine restriction (MR, n=8) group, endurance exercise (EE, n=8) group, and a positive control group, which subjected to daily pioglitazone treatment (PIO, n=8) groups. Animals of the EE group were subjected to treadmill running at a speed of 16 m/min, 1 hour/day and five days a week. The MR rats were fed by food with 80% lower methionine content. After experimental interventions, the animals were subjected to intraperitoneal glucose tolerance test (IPGTT). Statistical methods of one-way ANOVA were used for comparing the different among groups. **Results:** In body weight, the DR40%, DR20%, and EXE groups showed significantly decreased body weight compared to the CON and the PIO groups. During IPGTT, serum insulin of the DR40%, DR20%, MR, PIO groups were significantly lower than the CON group. And, DR40% showed the most significantly change as compared with other groups. In serum glucose, the DR40%, DR20%, PIO and MR groups were significantly lower at 30 min and/or 60 min after glucose loading as compared to the CON groups. **Conclusion:** Our results indicate that DR, MR, and EE effectively reduced body weight and/or enhanced insulin sensitivity.

**HEAT TREATMENT AND EXERCISE PREVENTS SKELETAL MUSCLE INSULIN RESISTANCE IN WISTAR RATS FED A HIGH-FAT DIET**

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**Background:** Insulin resistance (IR) is associated with many related health complications. Previous studies demonstrated that heat and exercise could have positive function on IR separately. Earlier our study in IR rats induced by high-fat diet showed that exercise combined with high temperature had more effective on IR. **Methods:** Male Wistar rats were randomly divided into five groups: exercised (NE; n=10), heat (HC; n=10), exercised and heat (HE; n=10), sedentary (NC; n=10), and normal diet sedentary (CC; n=10). The subjects were fed a high-fat diet (60% calories from fat) for 10 weeks and treated heat and/or exercise for 8 weeks. Protein expression of soleus and extensor digitorum longus (EDL), serum, and brown fat was analyzed using Western blotting. **Results:** Our results show that heat treatment accompanying exercise shifts the metabolic characteristics of rats on a high-fat diet toward those on a standard diet. Eight weeks of heat accompanying endurance exercise increased PGC-1 $\alpha$ , CnA, CaMKIV and p38 MAPK protein expression in the soleus ( $P < 0.01$  or  $P < 0.05$ ), Insulin protein expression in the serum ( $P < 0.05$ ), and UCPI protein expression in the brown fat ( $P < 0.05$ ) compared to the sedentary group. **Conclusions:** Exercise combined with high temperature treatment mitigates the development of IR from Irisin pathway. The study also provides potential "green" methods for therapeutic treatment of insulin resistance.

**DEVELOPMENT AND COMPLETE MORPHOLOGICAL AND FUNCTIONAL REVERSIBILITY OF ATHLETE'S HEART IN A RAT MODEL**

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Purpose: Long-term exercise training is associated with characteristic structural and functional cardiac adaptation termed athlete's heart. However the effect of discontinuation of the training (detraining) on left ventricular (LV) function is still unclear. Our aim was to evaluate the development characteristics of athlete's heart and the reversibility of morphological and functional changes during detraining. Methods: Rats were divided into trained (n=15) and control (n=17) groups. Trained rats swam 200 min/day for 12 weeks, while control rats were taken into the water for 5 min/day. Detrained rats remained sedentary for 8 weeks after completion of the training protocol. We regularly performed echocardiographic measurements to investigate development and regression of exercise-induced cardiac changes. LV pressure-volume analysis was performed to calculate cardiac functional parameters. LV samples were harvested for histological examination. Myocardial gene expression analysis was performed using qRT-PCR. Results: Echocardiographic examinations showed rapidly developing LV hypertrophy in the trained group according to wall thickness values (LVmass index after training period:  $2.45 \pm 0.09$  vs.  $2.07 \pm 0.07$  g/ttkg,  $p < 0.05$ ). This adaptation regressed after detraining (LVmass index:  $1.94 \pm 0.02$  vs.  $2.05 \pm 0.05$  g/ttkg,  $p = 0.0634$ ), which was confirmed by post-mortem measured heart weight and histological morphometry. Unchanged myocardial expression of TGF- $\beta$  and  $\beta$ -MHC and unaltered amount of LV collagen confirmed the physiologic nature of the observed cardiac hypertrophy. Hemodynamic measurements indicated decreased LV end-systolic volume (LVESV:  $75 \pm 5$  vs.  $100 \pm 7$   $\mu$ l,  $p < 0.05$ ) along with unchanged end-diastolic volume (EDV), improved systolic function and contractility (slope of the dP/dtmax-EDV relationship:  $35.9 \pm 2.6$  vs.  $25.8 \pm 2.8$  Hgmm/s/ $\mu$ l,  $p < 0.05$ ), ameliorated active relaxation and mechanoenergetics (mechanical efficiency:  $53 \pm 2$  vs.  $45 \pm 2\%$ ,  $p < 0.05$ ) after long-term exercise training. After the detraining period regression of exercise-induced cardiac functional changes were observed: LVESV ( $117 \pm 5$  vs.  $115 \pm 6$   $\mu$ l,  $p = 0.7846$ ), active relaxation, LV contractility (slope of the dP/dtmax-EDV relationship:  $30.5 \pm 1.7$  vs.  $28.4 \pm 4.3$  Hgmm/s/ $\mu$ l,  $p = 0.5871$ ) and mechanoenergetic (mechanical efficiency:  $50 \pm 2$  vs.  $48 \pm 5\%$ ,  $p = 0.7760$ ) enhancement reverted completely to control values. Training and detraining did not affect myocardial stiffness. Conclusions: Our results confirm that the morphological and functional properties of exercise-induced physiologic LV hypertrophy completely regressed after an eight week detraining period.

**Oral presentations****OP-SH06 Psychology: Soccer & Cognitive Function****THE ORGANIZATION OF COGNITIVE REPRESENTATION OF GROUP-SPECIFIC TACTICS IN SOCCER**

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Introduction Scientific protocols describing tactical performance usually investigate indicators (e.g., running distances, maximum running speed etc.) derived from post-hoc video analyzes (Garganta, 2009). However, the results of a novel scientific approach showed that more experienced soccer players possess a functional cognitive re-presentation of team-specific tactics in soccer. More experienced soccer players end up with faster decisions, because of their functional representation structure allowing to coordinate their gaze behavior aligned to tactical needs (Lex, Essig, Knoblauch, & Schack, 2015). In soccer, performance is not only determined by team-specific tactics. Thus, the present study investigates the cognitive representation of group-specific tactics in soccer. Methods The present study investigated whether cognitive representations are established for group-specific tactics in defense (i.e. defense triangle, four-man backfield defense, golden zone defense) and offense (i.e., give and go pass, overlap, two players crossing) with regard to players expertise. Participants (N = 45) made similarity judgments of 2 x 9 match situations displayed on a tactic board (i.e., 144 decisions) in a successive splitting procedure regarding the required tactical behavior. The decisions informed about the proximity between the match situations, and formed the basis for an unweighted average cluster analysis ( $p = .01$ ,  $d_{crit} = 4.48$ ) complemented by an invariance measure testing structural homogeneity ( $\lambda_{crit} = .68$ ). Results Experienced soccer players possess, in contrast to less experienced players ( $\lambda = 0.0$ ), a structural invariant cognitive representation for offense and defense tactics identical with the representation structure of experienced coaches ( $\lambda = 1.0$ ) and players from the Bundesliga ( $\lambda = 1.0$ ). We found no differences between players specialized for defense and offense tactics. However, players with a coaching license showed as well a functional cognitive representation of group-specific tactics ( $\lambda = 1.0$ ). Discussion This innovative experimental approach measuring individual cognitive representations of group-specific tactics in soccer reveals a well-integrated network of single match situations that each corresponds to functional meaningful group-specific tactics based on soccer specific playing experiences. The cognitive representations of group-specific tactics form an individual profile of each player, which allows to refer to tactical decision making on the pitch. References Garganta, J. (2009). Trends of tactical performance analysis in team sports: bridging the gap between research, training and competition. *Revista Portuguesa de Ciências do Desporto*, 9(1), 81-89. Lex, H., Essig, K., Knoblauch, A., & Schack, T. (2015). Cognitive Representations and Cognitive Processing of Team-Specific Tactics in Soccer. *PLoS ONE*, 10(2), e0118219.

**QUESTIONING THE ROLE OF BLUE VERSUS RED UNIFORMS IN FOOTBALL'S PENALTY KICKS**

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Introduction Past research revealed an impact of uniform colour in sports: Most notably, beneficial effects of the colour red in combat sports were reported (Hill & Barton, 2005). However, also Greenlees Eynon and Thelwell (2013) found a benefit in football's penalty kicks: Penalty takers succeeded less often when facing a goalkeeper wearing a red instead of blue or green jersey. By deepening the approach of their field study, the current experiments were aimed at particularise our understanding of the impact of goalkeepers' but also of penalty takers' uniform colour. Methods Twenty-four video clips showing a football player taking a penalty kick from the perspective of a goalkeeper (experiment 1) and 25 clips showing a goalkeeper preparing himself for saving a penalty from the perspective of the penal-

ty taker (experiment 2) were recorded. Uniform colour of the players/goalkeepers were chromatically changed to red and blue. Each clip lasted four seconds and ended when the player kicked the ball. Thus, ball's trajectory was not shown. Participants rated each clip twice: Once in a red condition, once in a blue condition. The order of the videos was randomized. Thirty-nine experienced male football players ( $25.64 \pm 4.90$  years) participated in experiment 1 and rated the level of players' resoluteness from 1 (minor) to 9 (high) and the position where the ball should hit the goal by using a 23-in. touch-screen. In experiment 2, 118 students of sport science ( $63 \text{ m}/55 \text{ f}$ ,  $22.25 \pm 2.87$  years) judged the videos following the same criteria as in experiment 1 but also rated the probability of success for saving the penalty kick from 1 (minor) to 9 (high). Results Paired t-tests did not reveal significant differences for penalty takers wearing red versus blue in resoluteness and anticipated lateral position of the ball. However, for ball's anticipated height a small effect was observed ( $T(38) = 2.42$ ,  $p = .02$ ,  $d = .16$ ): The kicks of red-glad penalty takers were judged to be shot lower at the goal ( $M = 109.52 \pm 12.75$ ) than those of the blue-glad players ( $M = 111.69 \pm 13.52$ ). In experiment 2, no impact of goal keepers' uniform colour was found for resoluteness, probability of success and the anticipated position of the ball. Discussion Both experiments did not find any impact of uniform colour on ratings of resoluteness and probability of success in penalty kicks. Thus, an experimental corroboration of the results of Greenlees et al. (2013) failed. However, a rather small effect was observed for the height of the anticipated ball position. Further research is needed to clarify the origin and significance of this effect more comprehensively. References Greenlees, I.A, Eynon M, Thellwell RC. (2013). Percept Mot Skills, 117(1), 1-10. Hill RA, Barton RA. (2005). Nature, 435, 293. Contact bjoern.krenn@univie.ac.at

## EFFECTS OF STRESS-LEVEL ON HAND-MOVEMENT BEHAVIOR WITH FOCUS ON SELF-TOUCH IN FEMALE PRE-AND POST-PUBERTAL SOCCER PLAYERS

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Introduction: Self-touch (ST) may serve for arousal regulation, both of hyper- and hypoarousal, as it may be observed in presence as well as absence of external stimulation. It remains unclear if ST with varying structural features occurs in different contexts, and if this potentially regulatory mechanism is learned or inherent. The aim of this study was to discover if the rate of ST increases with higher stress-levels, to identify structurally different forms of ST used in different contexts, and to find out if there are age differences in stress processing between pre- and post-pubertal female soccer players. Methods: We compared hand movements of 10 pre- ( $11.9 \pm 0.72$  y.) and 10 post-pubertal ( $21.6 \pm 1.73$  y.) soccer girls in non-stress (NS) and stress (S) settings. As NS setting we used an interview about a positive experience, whilst the arithmetic part of the Trier social stress test (TSST) was used as S-inducing setting. All settings lasted 5 minutes and were filmed. All hand movements as well as structural components of ST were analyzed with the NEUROGES-ELAN system by two independent raters. Results: A decrease in repetitive ST was found (right hand (rh):  $1.47 \pm 1.54$  s/min vs.  $0.11 \pm 0.24$  s/min,  $p = 0.023$ ; left hand (lh):  $3.81 \pm 3.72$  s/min vs.  $0.92 \pm 2.53$  s/min,  $p = 0.007$ ) in the post-pubertal girls in the S situation compared to the NS situation. The post-pubertal girls displayed less hand movements, including phasic (rh:  $9.89 \pm 6.76$  s/min vs.  $0.73 \pm 0.97$  s/min,  $p = 0.000$ ; lh:  $8.7 \pm 4.57$  s/min vs.  $1.61 \pm 1.93$  s/min,  $p = 0.000$ ) and repetitive (rh:  $2.13 \pm 2.75$  s/min vs.  $0.03 \pm 0.09$  s/min,  $p = 0.002$ ; lh:  $1.35 \pm 1.26$  s/min vs.  $0 \pm 0$  s/min,  $p = 0.000$ ) movements in space in the S setting. Pre-pubertal girls showed no change in hand movements in NS and S. The post-pubertal group displayed a stronger decrease in activation (rh:  $1.58 \pm 13.79$  s/min vs.  $-19.29 \pm 12.79$  s/min,  $p = 0.004$ ; lh:  $-3.42 \pm 8.05$  s/min vs.  $-17.09 \pm 14.31$  s/min,  $p = 0.043$ ) and phasic movements (rh:  $-2.25 \pm 1.57$  s/min vs.  $-9.17 \pm 6.88$  s/min,  $p = 0.001$ ; lh:  $-0.93 \pm 1.92$  s/min vs.  $-7.1 \pm 4.28$  s/min,  $p = 0.000$ ) in the S situation compared to the pre-pubertal girls. Discussion: The puberty seems to influence regulatory mechanisms for stress-regulation and structurally different groups of ST are used in different contexts. This is unlike earlier studies which show an increase of ST movements with increasing the complexity of a test, which might be due to the cognitive complexity or the stress level of the test. Our results suggest that there are differences in stress processing between younger and older female soccer players, which should be accounted in training situations. Contact: kyra.densing@freenet.de

## DIFFERENT OPPORTUNITIES TO INFLUENCE THE VISUAL "ATTENTION WINDOW"

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Visual attention is essential in many areas and situations ranging from everyday life to the workplace. People have to allocate their visual attention from a focused target to a wide scope and vice versa in fractions of a second. Other events require the conscious perception of two objects or scenes at the same time. Many situations including traffic or sports suggest that the focus of attention has a limited size and can be influenced by various factors. We introduced the attention window task, a new measurement of attention breadth, in which people must observe two equally attention-demanding stimuli at the same time in order to respond correctly. Our findings indicate that differences in the spatial distribution of attention result from, for example, effects of age or experiences as well as emotional processes and those affected by current motivation. The maximum spatial extent of attention is ellipsoidal with greater breadth along the horizontal axis than the vertical one. In contrast to the visual field, the elliptical shape of the attention window does not alter by a change of the head position but constantly maintains its oval shape parallel to the ground. We discuss the application of different strategies and factors to improve and adjust performances in different everyday occurrences requiring the ability to pay attention to two peripheral objects at the same time.

## THE EFFECT OF TRAIT EMOTIONAL INTELLIGENCE AND PERSONALITY ON HEART RATE VARIABILITY AND SKIN CONDUCTANCE RESPONSE IN RECOVERY PERIODS AFTER STRESS MANIPULATION

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Introduction Stress is one of main factors in regard to peak athletic performance. Physiological stress responses occur when athletes are stressed, and some individual traits may contribute to how athletes regulate these responses. Coping with stress is important in competitive sport fields, and appropriate coping strategies are found to associate with personality (Allen et al., 2011). Therefore, the aim of this study was to investigate the effect of trait emotional intelligence (EI) and personality on stress responses of elite athletes in recovery periods after stress manipulation. Methods Schutte EI Scale and Five Factors Personality Inventory were completed by 54 elite athletes. At laboratory tests; participants were exposed to social stressor (duty of speaking in front of people) and cognitive stressor (Stroop color-word test). There were five minute resting periods between and after stressors. Heart rate variability and skin conductance response (SCR) were recorded as stress responses by a portable biopotential amplifier. Results Participants, who had high score on dimensions of



optimism/mood regulation and utilizations of emotions, had lower low frequency/high frequency (LF/HF) Ratio in all resting periods, while participants with high openness trait, also had lower LF/HF ratio between stressors. Participants with high EI level had lower SCR Ratio in both resting periods, and also lower LF/HF ratio in the last resting period. In addition, participants with high conscientiousness trait, had lower SCR between stressors. Discussion The results show that EI and personality may lead to different levels of stress responses. Generally, EI and its dimensions were related to lower stress responses, in all periods. Laborde et al (2011), similarly, found that the increase of LF/HF ratio was lower for high trait EI handball athletes after stress exposure. Results may indicate that participants with high EI recovered better after stress manipulation. Also, participants with high conscientiousness trait had lower SCR between stressors. Apparently, in another study, negative significant correlation was found between conscientiousness and SCR measured before the competition (Binboğa et al. 2012). Additionally, it could be said that athletes with high openness trait may be less affected by challenging conditions. References Binboğa E, Guven S, Çatıktaş F, Bayazıt O & Tok S. (2012). Psychophysiological responses to competition and the big five personality traits, *Journal of Human Kinetics*, 33:187-194. Laborde S, Brüll A, Weber J & Anders LS. (2011). Trait emotional intelligence in sports: A protective role against stress through heart rate variability? *Personality and Individual Differences*, 51(1):23-27. Laborde S, You M, Dosseville F & Salinas A. (2012). Culture, individual differences, and situation: Influence on coping in French and Chinese table tennis players. *European Journal of Sport Science*, 12:265-261. Contact gamze.ungur@deu.edu.tr

## ELECTROCORTICAL ACTIVITY IN A COGNITIVE INHIBITION TASK IMMEDIATELY AFTER MAXIMUM PHYSICAL EFFORT

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**Introduction** The ability to inhibit irrelevant and to focus on relevant stimuli is essential for skilled performance in sports (Abernethy et al., 2007). Elite athletes have to perform well not only in the motor but also in the cognitive domain under maximum physical load and immediately afterwards. Up to now it is still unclear to what extent physical exertion influences basal cognitive processes and associated electrocortical (EEG) activity. The aim of the study was to analyse the time course of the impact of physical exertion on information processing speed in a cognitive inhibition task as assessed by the P300 of the event related potentials (ERP). **Methods** A total of 14 sport students (4 f +10 m; age = 21.14 y; max. power: 4.56 W/kg) carried out a maximal graded exercise test on a cycle ergometer using a continuous incremental exercise protocol (initial power output: 30W f and 40W m; increment 15W f and 20W m each minute). A modified version of the Eriksen flanker (EF) task (Pontifex, & Hillman, 2007) was administered preceding (t1) and two times immediately after exhaustion (t2 and t3) as well as after a break of five minutes (t4). Reaction times (RT) and EEG was recorded and latency and amplitude of the P300 component of electrode positions Fz, C3, Cz, C4 P3, Pz and P4 were analysed. Results For RT and for ERP, 2 (TASK: congruent vs. incongruent) x 4 (TIME) ANOVA-RM's were calculated. Significant main effects in RT were obtained for TIME ( $F(3,39) = 5.08$ ,  $p = .02$ ,  $\eta^2 = .28$ ) and TASK ( $F(1,13) = 222.17$ ,  $p < .001$ ,  $\eta^2 = .95$ ). Post hoc analyses indicated that RT were significantly lower at t3 and t4 as compared to t1. Concerning to P300 latency, statistics revealed significant TIME effects for electrode positions C3, Cz, C4, Pz and P4. In comparison to t1, post hoc results demonstrated a significant decrease in latency at C3 and Cz for t3 and t4 as well as at C4 for all three post-exercise tasks. The P300 amplitude showed no significant exercise induced alterations. **Discussion** Maximum physical exercise had a positive impact on information processing speed. The decrease of P300 latencies at central regions is well in line with improved information processing. It was expected that the P300 amplitude will increase after exercise in order to cope with the high physical stress while performing the EF task. However, the results do not indicate a higher allocation of attentional resources. Further studies are encouraged to research the impact of maximum physical loads on basal cognitive processes. **References** Abernethy, B, et al. (2007). *Handbook of sport psychology*, 245-263. Pontifex, M. B., & Hillman, C. H. (2007). *Clinical Neurophysiology*, 118, 570–580.

## Oral presentations

### OP-PM73 Coaching: Effects of Training

#### EFFECTS OF STRENGTH AND CONDITIONING ON CRITICAL VELOCITY IN RUNNING AND SOCCER

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A regular strength training should be an integral part of the coaching process in team sports such as football. To-date no research has investigated the effects of such training on the velocity-duration relationship of Critical Velocity (CV). **Objectives:** To examine the effects of a moderate intensity strength training on changes in CV and sprint performances in recreationally trained football players. **Methods:** two football teams were divided in a football training only group (FO;  $n = 13$ :  $19 \pm 1$  127 yr., height  $177.3 \pm 5.2$  cm, body mass  $73.2 \pm 7$  kg). and a strength and football training group (ST;  $n=13$ :  $18 \pm 1$  yr., 126 height  $174.8 \pm 5.4$  cm, body mass  $72.4 \pm 6.6$  kg). Both groups were tested for values of CV and 30-m sprint time prior and post training intervention. The ST group performed a concurrent 6-week upper and lower body strength and football training, whilst the FO group performed a football only training. **Results:** after the re-test of all variables, the ST demonstrated significant improvements for CV values by 0.32 m/s (95% C.I. = 0.16 233 to 0.48;  $p=0.000$ ) after completing the specific training, with no significant changes in the FO group. 30-m sprint performance were slightly improved in the ST group ( $p=0.078$ , 0.12 m/s, 95% CI = -0.25 to 0.15) with FO players significantly worsening their performance ( $p=0.000$ ) by about 0.98 m/s (95% CI = -1.11 to -0.84). **Conclusions:** combining a 6-week moderate strength training with football training significantly improves CV, whilst moderately improving 30-m sprint performances in non-previously resistance trained male football players. An integrated regular strength training can consequently be recommended to coaches to enhance critical velocity and sprint performances in football.

#### EFFECTS OF HIGH-INTENSITY INTERVAL TRAINING ON AEROBIC FITNESS

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**EFFECTS OF HIGH-INTENSITY INTERVAL TRAINING ON AEROBIC FITNESS** Karabiyik, H.1, Gurses V.V.2, Akgul.M.S.1, Koz M.1 1:Ankara University Faculty of Sports Sciences (Ankara, Turkey), 2:Kastamonu School of Physical Education **Introduction** Recently, a novel type of high-intensity interval training known as sprint interval training has demonstrated increases aerobic and anaerobic performance. However, It

has not been done a study which investigated the effects of eight-week high intensity interval training on aerobic fitness. This study aimed to establish the effects of 8-week high intensity interval training on aerobic fitness. Methods Ten adolescent boys (23,62  $\pm$  3,021years), completed 24 sessions of Wingate -style high intensity interval training over a 8-week period. The first session consisted of four sprints with training progressed to seven sprints in the final session. Each training session involved a 10 min warm-up followed by a HIIT program consisting of 6x30s all-out sprint a 4 min recovery. A 5 min cool down period was then performed. On the purpose of determine VO<sub>2</sub>max (maximal oxygen uptake), VO<sub>2</sub>peak (peak oxygen uptake) and TTE (time to exhaustion) all subject performed maximal oxygen consumption test in beginning and in the end of the study. A paired t-test was used to determine the differences in aerobic parameters between pre- and post- values. Data were expressed as mean values  $\pm$  standard deviation (SD) and standard error (SE). Results Significant improvements ( $p < 0.05$ ) were found by the end of eight week, VO<sub>2</sub>max (%23,96), VO<sub>2</sub>peak (%16,05), and TTE(%12,57) following the HIIT program among subjects. Discussion: Results showed that eight-week wingate style of high intensity interval training program very effective on aerobic indices. References 1.Laursen, Pb., Blanchard, Ma., Jenkins, Dg. (2002). Acute high-intensity interval training improves Tvent and peak power output in highly-trained males. *Can J Appl Physiol.* 27:336-48. 2.Tom, K, Tong., Pak, Kwong, Chung., Raymond, W, Leung., Jinlei, Nie., Hua, Lin., Jun, Zheng.(2011).Effects of non-wingate-based high intensity interval training on cardiorespiratory fitness and aerobic based exercise capacity in sedentary subjects. *J Exerc Sci Fit.* 75-81. 3.The influence of 2 weeks of low-volume high-intensity interval training on health outcomes in adolescent boys.*Journal of Sport Sciences.*32:8,757-765. 4. Esfarjani, F., Paul, B., Laursen. B. (2007). Manipulating high-intensity interval training: Effects on VO<sub>2</sub> max, the lactate threshold and 3000m running performance in moderately trained males. *Journal of Science and Medicine in Sport.* 10:27-35 Contact: karabiyik@ankara.edu.tr

## EFFECT OF MODERATE AND HIGH INTENSITY SQUATS ON COUNTERMOVEMENT JUMP PERFORMANCE ACROSS MULTIPLE SETS OF A CONTRAST PROTOCOL

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Introduction Post-activation potentiation (PAP) of countermovement jump (CMJ) performance following the completion of a conditioning activity (CA) is well-documented (Suchomel et al., 2015). However, the precise effect across multiple sets of paired exercises (CAs and CMJs) remains to be elucidated. The present study was designed to evaluate the PAP effects of moderate (MI) or high intensity (HI) squat exercises on CMJ performance across multiple sets compared to a control session with CMJs only (CTRL). Methods Fifty-one resistance-trained male subjects (mean  $\pm$  SD: age, 23.2  $\pm$  3.7 y; body mass, 87.4  $\pm$  14.2 kg; squat 1RM, 158.1  $\pm$  30.8 kg) participated in a randomized, cross-over study. After baseline assessment they performed a contrast PAP protocol comprising three sets of either MI (6 $\times$ 60% of 1RM) or HI squats (4 $\times$ 90% of 1RM) alternated with seven CMJs that were performed at 15 seconds, 1, 3, 5, 7, 9 and 11 minutes after the squats. A CTRL session was used where the sets of squats were replaced with one minute of recovery. Jump height recorded with a force plate during MI and HI was compared to that recorded during CTRL to calculate the PAP effect. A repeated measures ANOVA was used to assess the effects of condition (CTRL, MI and HI) and time and their interaction on JH. The alpha level of .05 was adjusted using the Bonferroni method for all ANOVA pairwise comparisons. Results A significant interaction between conditions  $\times$  time was found ( $F(18,01, 900.61)=3.99, p<.001$ ). Further analysis indicated a significant decrease in JH at 15 seconds across all three sets of MI and HI compared to CTRL. Both squat protocols produced significantly higher JH at three minutes during the first set (+3.5  $\pm$  8.8% and +3.1%  $\pm$  8.5%), whereas performance at five minutes was only increased in MI squats. No significant improvement was found in the second and third sets at any time point ( $p>.05$ ). Discussion Consistent with previous research, the present investigation demonstrates that CMJ performance was potentiated at three minutes during the first set of a contrast PAP protocol involving MI and HI squat exercises. Conversely, no PAP effect was observed in the second and third sets. These findings contrast with previous studies reporting an improvement in jump performance across three sets of squat contrast protocol (Baker, 2008). One possible explanation for the present findings is that fatigue may have accumulated in the second and third sets thus masking the PAP effect. Suchomel, T.J., Lamont, H.L. & Moir, G.L. (2015). *Sports Med.*, published online 28. December 2015 Baker, D.G. (2008). *J. Aust. Strength Cond.* 16(2):10-18. CONTACT: pascal.bauer@univie.ac.at

## A NEW METHOD FOR MEASURING THE AVAILABILITY OF THE MIDDLE ATTACKER IN VOLLEYBALL.

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Introduction In volleyball, some authors have considered the availability of the middle attacker as a measure of success (Costa et al., 2013). The use of measures that capture coordination in sports, such as geometrical centres as network analysis, have been increasing in different levels of team sports (Davids, 2013). These variables are expected to describe accurately complex systems states of coordination and temporal dynamics (Duarte et al., 2012). Notwithstanding, the spatial precision supposes a common limitation on observational studies. The present study intended (a) to develop a support tool to improve the registration of the position in the court; (b) to discover the area of action of the setter when there is availability of the middle attacker; and (c) to find a summary value that allows the comparison between teams and their relationship with other variables. Methods Volleyball Men's World Championship 2010 in Italy was analyzed, with a total of 23 games and represented by 12 national teams, using the variables Latitude and Depth of the setter, and calculating the centroid, the vector and the angle for each team. These variables were calculated by the developed support tool, which allows us to register exactly the position of the setter using an adaptable grid on the court. The data were recorded with the software of observational analysis applied to volleyball VA-Sports. Results From the positions of the setter were created specific profiles of each team where the centroid was calculated from the weighted average of the density of the frequencies. This makes possible to calculate the availability of the middle attacker through the vector, which is the distance between the centroid and the ideal zone of setting. The centroids of the teams vary between 1.049 and 1.468 meters. Discussion In conclusion, the centroid is a summary value of the area of availability of the middle-attacker, allowing us to make comparisons between teams, from the setting frequencies distribution, as well as it could be a future performance indicator. References Costa, G. D. C. T., Barbosa, R. V., & Gama Filho, J. G. (2013). The modulation of attack on the volleyball High-level: the case of women's Superleague 2011-2012. *Revista da Educação Física/UEM*, 24(4), 545-557. Davids, K. (2013). *Complex systems in sport* (Vol. 7). Routledge. Duarte, R., Araújo, D., Correia, V., & Davids, K. (2012). *Sports Teams as Superorganisms*. *Sports medicine*, 42(8), 633-642. Contact: eliamp92@correio.ugr.es

## THE RELATIVE AGE EFFECT IN SCHOOL SPORTS

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**Introduction** An overrepresentation of participants born in the first months after the cut-off date, known as the Relative Age Effect (RAE), has been observed in some sports, such as football, hockey, rugby and basketball, particularly in elite youth competitions (1). However, less is known about this phenomenon in lower performance levels. Thus, the aim of the present study was to investigate the presence of the RAE in different sports at school level. **Methods** The date of birth of 38644 participants, aged 9-15 years old, of the school sports was analyzed (65.1% boys and 34.8% girls). These children participated in 40 different sports. Football and basketball had 3 and 2 different competition levels, respectively. The percentage of children born in each semester (1S: January-June and 2S: July-December) was compared to the distribution of the children born in the same period using a Chi square Goodness of Fit. **Results** The most popular sport in boys was football (57.4%) followed by basketball (7.3%) and in girls basketball (28%), rhythmic gymnastics (10.6%), handball (9.7%), football (9.4%) and athletics (8.7%). In boys, there was an overrepresentation of participants born in the 1S in football (52.7% vs. 47.6%;  $p < 0.001$ ), basketball (52.4% vs. 47.6%;  $p < 0.05$ ), and also in the whole group (51.7% vs. 48.3%;  $p < 0.001$ ). This uneven distribution was the largest in the highest competition level of the youngest football players aged 9-10 years old (68.5% vs 31.5%,  $p < 0.001$ ). In girls, the overrepresentation was significant in athletics (52.9% vs. 47.1%;  $p < 0.05$ ), basketball (54.2% vs 45.8%;  $p < 0.001$ ), football (54% vs 46%;  $p < 0.05$ ), Basque pelota (59.9% vs. 40.1%;  $p < 0.05$ ) and the total (52% vs. 48%;  $p < 0.001$ ). Within basketball there was a significantly uneven distribution in the highest competition level (61% vs. 39%;  $p < 0.001$ ). **Discussion** In school sports the RAE is particularly evident in the most popular sports and in the highest competition levels, even at the youngest ages, both in boys and girls. This implies that there is a selection process towards the participants born in the first months after the cut-off date, presumably due to their larger body size and a better physical performance (2). A special effort should be made to assure that all children have the same opportunities to participate in the sport, particularly from the very young ages. **Acknowledgements** We would like to thank the Provincial Council for School Sports (Bizkaiko Foru Aldundia) for the collaboration and the data provided. **References** 1-Cobley S, et al. Annual age-grouping and athlete development. *Sports Med.* 2009;39(3):235-56. 2-Gil SM, et al. Relationship between the relative age effect and anthropometry, maturity and performance (...). *J Sports Sci.* 2014;32(5):479-86. Contact: Susana.gil@ehu.es

## THE RELATIONSHIP BETWEEN LEADER-CREATED MOTIVATIONAL CLIMATE AND DISADVANTAGED YOUTHS' PERSONAL AND BEHAVIOURAL CHARACTERISTICS IN COMMUNITY-BASED SPORT

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**Introduction.** Organised sports programs offer a unique opportunity for positive youth development (Fraser-Thomas, et al., 2005), and the sports coach plays a fundamental role in optimising participants' experiences within that setting. Considerable sport-based research has demonstrated the positive correlates of an 'Empowering' (i.e., autonomy supportive, task-involving, and socially-supportive), and negative correlates of a 'Disempowering' (i.e., controlling and ego-involving), coaching approach for young participants' motivation, engagement and psychological health (Duda, 2013). Nonetheless, research has yet to consider the correlates of these coach-created motivational climates for youths from deprived communities. In light of the current social problems associated with young people growing up in lower income areas (e.g. poor social-emotional skills, increased antisocial behaviour; Sandford, et al., 2006) the current study aimed to examine outcomes beyond the typical motivational and well-being variables studied in the mainstream sport context, with a focus on those more pertinent for the deprived youths both in and beyond the community sport setting. **Method.** In a cross-sectional design, young participants of 42 community-based sports clubs (N=503; 404 males; age range 9-28;  $M = 15.2$ ) in the UK completed a multi-section questionnaire. **Results.** A series of multiple linear regressions indicated that the leaders' empowering climate was associated with lower levels of aggression from the young participants, ( $\beta = -.14$ ,  $p = .05$ ) and greater pro-social behaviour, both within ( $\beta = .26$ ,  $p < .001$ ) and outside of ( $\beta = .20$ ,  $p < .001$ ), the sports context. Conversely, a disempowering climate was negatively associated with emotional-control ( $\beta = -.25$ ,  $p = .001$ ) and self-control ( $\beta = -.24$ ,  $p = .001$ ), whilst being positively associated with aggression ( $\beta = .27$ ,  $p < .001$ ) and antisocial behaviour ( $\beta = .18$ ,  $p > .05$ ) within the sport context. **Discussion.** The current study offers insight into the relationships between leader-created motivational climates and the personal and behavioural characteristics of young people from disadvantaged areas. The findings point towards the need for education opportunities (e.g., the Empowering Coaching™), to ensure coaches, leaders and volunteers working in these settings are creating the most adaptive climates for their young participants. **References** Duda, J.L. (2013). *Int J Sport & Ex Psych*, 11, 311-318. Fraser-Thomas JL, Côté J, & Deakin J. (2005). *Phys Education & Sport Ped*, 10, 19-40. Sandford, R. A., Armour, K. M., & Warrington, P. C. (2006). *British Ed Research J*, 32, 251-271. J.Stebbing@bham.ac.uk

## Oral presentations

### OP-SH18 Skills of Physical Education Teachers

#### CASE STUDY OF CREATIVE DANCE TEACHING METHODS IN JAPANESE TEACHER EDUCATION PROGRAMS: FOCUSING ON THE USE OF OBJECTS FOR EXPRESSION

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**Introduction** In Japan, we hear from teachers that the free movement and improvised expression of creative dance are hardest to teach and to evaluate, but creative dance exercises that make use of objects for expression get favorable reviews from both teachers and students. Therefore, this study examined the potential of a method of teaching creative dance with the use of objects (such as newspapers and disposable chopsticks) for expression at its core, using dance classes within the Japanese teacher education programs as a case study. **Methods** Of the ten dance lessons held between April and June 2014, there were two lessons on the theme of expression using objects. These were captured on video. We also interviewed the teacher about the reason for the selection of the content. In addition, we had the students describe their impressions and thoughts about the classes in their end-of-term report, and analyzed the reports

using Tiny Text Miner. Results The expressions using newspapers were structured into 4 areas: playing with the newspaper, becoming a newspaper, handling the newspaper, and ripping the newspaper. The reasons for the use of newspapers were because its flexibility elicits diverse qualities of movement and expression, and because it requires children to stimulate their imagination and sense of theatricality in order to become a newspaper. Further, the expression with the disposable chopsticks was structured in two parts. Two students held the chopsticks between their fingers and moved, first with their eyes open and then with their eyes closed. The exercise with the chopsticks was chosen because it twisted the entire body, making it move about a point rather than a line, and also because the students were able to spontaneously improvise with the chopsticks as objets d'art. When talking about the newspaper, the words "becoming" and "getting into character" were used often. We heard that it was hard to get into the character of a newspaper, but that they were surprised at how much fun they had coming up with new movements and enjoying dancing using just a single newspaper. When talking about the expressions using chopsticks, many students said they were amazed that they could create a dance simply from expressions using an everyday item. It can be inferred that they brought this up because it had remained in their memories. Also, it is likely that this kind of exercise encourages students to try to actively engage in interactions with other people. Discussion From this case study, it can be said that expression using objects is an exercise that can be used to teach even students who have a resistance to dance. This is because this method lets students experience the enjoyment of improvisational expression and get caught up in the moment before they know it, and helps them become genuinely aware of the pleasure of movement. Furthermore, even though not even one formal piece of dance is taught, we believe that it is an exercise that can convey the essence of creative dance, which is that "expression comes from within."

### PRE-SERVICE PHYSICAL EDUCATION TEACHERS' EFFECT AND CONCERN ATTITUDES TOWARD TEACHING

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Introduction Education is process that build upon the interaction between teacher and students and guided by curriculum. From the perspectives of teachers, values, attitudes and behaviours toward education and factors that affect educational process are important to investigate. It has been previously emphasized that teachers beliefs and attitudes take shape through three consecutive process which are 1) interaction with teachers during pre-university education, 2) interaction between other students during whole educational life, 3) lastly, during their teacher education process. (Nash, 2003). Therefore it is important to hear voice of pre-service teachers in educational instructing in order to improve quality of educational process. Methods Research was conducted on 469 pre-service physical education teachers (PST) (Mage=21,35, SDage= 24,49) from 5 different universities in Turkey. "Attitude Scale For The Profession Of Physical Education Teaching" (Ünlü, 2011) was implemented. Five-point likert-type scale consisted of two factors; (1) effectation for profession (EP), (2) concern about the profession (CP). Results Research variables were university, class levels, genders, whether students participate in sports or not. Independent sample t-test results indicated that there was no significant difference between genders in both factors and total attitude points ( $p>.05$ ). Subjects who participate in sport have significantly higher points in EP and total scale comparing to subjects who dont participate in any sport activity ( $p<.05$ ). One-way Analysis of Variance results indicated that there is a significant difference between PST's from different universities in all factors and total attitude and class level in CP and total attitude ( $p<.05$ ). 1st graders have significantly lower level of CP comparing to other class levels and they also have significantly higher attitude scores comparing to 3rd and 4th graders ( $p<.05$ ). Discussion Universities location, teaching methods and materials in these universities might be the factor that affecting these differences between students of different universities. Students concern about employment may have influence on grade level differences on their attitude in relation concerns (Pehlivan, 2010). Students who participate sports could have higher affective feature and that can be reason why they had higher attitude level (Pehlivan, 2010). Both male and female PSTs going through same instructional process and they were undergo the same higher education curriculum. Thus this might be the reason of similarities between genders. References Nash R, (2003). International Studies in Sociology of Education, 13, 171-191. Unlu H, (2011). Educational Sciences: Theory & Practice, 11(4), 2005-2020. Pehlivan Z, (2010). Education and Science, 35(156), 126-141.

### THE NEEDS AND CHALLENGES OF FOUNDATION PHASE LIFE SKILLS TEACHERS IN DELIVERING PHYSICAL EDUCATION PROFICIENTLY IN SOUTH AFRICAN SCHOOLS

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Introduction Before the education transformation processes in South Africa started, the Life Skills teacher did not exist. In 1997, curriculum reform commenced in earnest by steering education in a new, outcomes-based direction. Subsequently the curriculum was simplified twice, and the most recent version, the Curriculum and Assessment Policy Statements (CAPS) for each subject transpired (DBE, 2011). Currently, in the Foundation Phase (Grade R-3), Physical Education (PE) is located in the subject Life Skills, which comprises 4 subject areas. The decline of PE and the deteriorating health of South African children (Discovery Vitality, 2014) question the effective implementation of the CAPS curriculum. The aim of the study is to determine the needs and challenges of the LS teacher with specific focus on the effective implementation and deliverance of Physical Education in the Foundation Phase (FP) in selected primary schools in the Free State province, South Africa. Methods Primary schools (N=100) were randomly selected from which 94 FP teachers (N=94) returned questionnaires. The data were analysed descriptively using absolute and relative frequencies and histograms. Comparisons to test for associations of ordinal variables between districts or school classification were done using a Chi-squared test. SAS Version 9.3 TS Level 1M2 was used for all the statistical analyses. Results The findings highlighted a number of issues and needs concerning the implementation of the CAPS. The most challenging issues were a lack of qualified PE teachers and resources, support with assessment, learners with special needs and the training of teachers. The majority of teachers indicated that an in-service training workshop would be useful. Discussion Teachers have a pronounced need for being capacitated regarding new developments within LS (programme planning, content and presentation ideas). If children are to benefit in their early childhood years when the foundation is laid for lifelong participation in physical activity and the focus is on holistic development (DBE, 2011), teachers should be supported to live up to the expectations. It is recommended that the Department of Basic Education should prioritise the training and re-skilling of LS teachers, with specific reference to PE, in pursuit of proficient delivery of quality PE. References Department of Basic Education (DBE). (2011). National Curriculum Statement: Curriculum and Assessment Policy Statement. Foundation Phase, Grades R-3. Pretoria: Department of Basic Education. Discovery Vitality. (2014). Healthy Active Kids Report Card (HAKSA). Discovery. Contact stroebelce@gmail.com



## ASSESSMENT OF COMPETENCY-BASED EDUCATION BY NEWLY QUALIFIED PE TEACHERS ACCORDING TO THEIR EDUCATIONAL BACKGROUND

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**Introduction** The Austrian Ministry of Education commissioned an educational standard for PE in 2009. The document was published in 2014 as a guideline for planning, teaching and evaluating PE lessons. (Amesberger, Stadler & Grossrubatscher, 2014) The educational standard is based on an output-oriented competency model (Kurz et al., 2008, S. 211-212) and can be regarded as a paradigm shift for PE in Austria. The aim of this study, which is a part of my diploma thesis, is to analyse the assessment of competency-based education by newly qualified PE teachers according to their educational background. **Methods** In order to carry out this study quantitative research was conducted. Valid data sets of 72 newly qualified PE teachers were collected via an online questionnaire. The variable assessment was operationalised with perceived advantages and disadvantages of competency-based education. A factor analysis was used to identify related items. Variables of interest of the participants' educational background were their second subject (Austrian teachers are usually qualified in two subjects) – with or without educational standards – and motivation for studying PE – extrinsic or intrinsic based on pedagogical interest and experience or exercising sports (Baillod & Moor, 1997, S. 45-47). **Results** Three main factors of the variable assessment were determined: practical concerns, planning vs. heterogeneity of students and differentiated instruction. There is no significant difference when participants teach a second subject in which educational standards have or have not already been implemented. There are weak positive correlations between the variable differentiated instruction and motivation for studying PE based on pedagogical interest as well as on coaching experience. **Discussion** Assessment of competency-based education cannot be explained by the variable second subject. This is also true when the variable sex – male and female participants tended to choose different second subjects – is taken into account. It might rather be dependent on various personality traits of newly qualified PE teachers, suggesting further research. Intrinsic motivation based on pedagogical interest and experience for studying PE partly leads to a more positive assessment of competency-based education. However, additional results for extrinsic motivation and intrinsic motivation based on exercising sports were not found. **References** Amesberger, G., Stadler, R. & Grossrubatscher, S. (2014). Bildungsstandard für Bewegung und Sport. Handreichung für kompetenzorientiertes Lernen und Lehren (Version 1.0). Salzburg & Wien: BMUKK (Hrsg.). Baillod, J. & Moor, R. (1997). In Bewegung. Sportlehrer und Sportlehrerinnen sprechen über ihren Beruf. Magglingen: Eidgenössische Sportschule Magglingen. Kurz, D. (2008). Der Auftrag des Schulsports. Sportunterricht, 57(7), 211-218. Contact andreas.raab@gmx.at

## IDENTIFYING PATTERNS IN EYE-TRACKING SCANPATHS TO SUPPORT TEACHERS' AND NOVICES' ABILITY TO NOTICE CLASSROOM AND MOTOR SEQUENCE LEARNING

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**Introduction:** Eye-tracking systems have been used in various fields (e.g. research of perception, cognition, marketing, usability), measuring people's viewing behaviour. Likewise, eye-tracking systems have been applied in various sports (e.g. cricket, table tennis, ice speed skating, basketball, handball, volleyball, shooting, Formula 1, gymnastics). One of the most important factors measured by eye-tracking systems is the scan path, indicating the order and time-frame of perceived pieces of information. Such data can be analyzed to investigate and compare the scan paths of e.g. experts and novices. **Methods:** Data collection was conducted in terms of objective data (i.e. static and dynamic measurements of scan paths) and subjective data (i.e. guided interviews). Objective quantitative data, collected by means of an eye-tracker (SMI Eye Tracking Glasses) and processed statistically, are distinguished into process metrics (e.g. efficiency) and performance metrics (e.g. number of fixations, fixation durations, scan path similarities) and serve to understand tendencies of viewing behaviour in observed situations of motor sequence learning (acquisition and correction) along the time axis. Analysis results were compared by means of string edit method. As suggested by Privitera and Stark (2000), scan path data were sorted and analyzed in a Y-matrix (parsing diagrams) which serves as a basis for the investigation of data according to various indices (e.g. repetitive, idiosyncratic, local, global) for similarities and differences. Of particular importance is the analysis result of local indices reports regarding between-subject correlations of scanning patterns (experts vs. novices) with similar stimuli (i.e. the same images). Subjective qualitative data, e.g. satisfaction, helpfulness, etc., were recorded by means of guided interviews. **Results:** The leading question aims at determining whether teachers (experts) observe differently from students (novices) (n=20 experts and novices): which aspects do experts focus on during the conduction of motoric learning sequences and situations of classroom interaction, and which cognitive patterns do they utilize to explain their behaviour? Professional vision implies the ability of selective perception (selective attention; noticing) as well as its knowledge based justification. Both are to be understood as dynamic processes which are influenced by the probands' knowledge, values and motives. The experts' vision differ from novices' vision firstly in their improved ability of pattern recognition and anticipation and secondly in their differing observation foci and theoretical perspectives. We demonstrate the usefulness of eye-tracking by exploring the ability to discern import from unimportant incidents in motoric learning sequences and complex teaching situations, as well as the ability to decide where to direct one's attention. This ability, which seems to be influenced by implicit knowledge, turns out to be a central aspect of the teachers' expertise.

## „ERZIEHENDER SPORTUNTERRICHT“ BETWEEN DEMANDS AND REALITY – A DIFFERENCE-ORIENTATED ANALYSIS FOCUSING ON PEDAGOGIC PERSPECTIVES

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**„Erziehender Sportunterricht“ between demands and reality – a difference-orientated analysis focusing on pedagogic perspectives** **Introduction** In Germany, the discussion about physical education has been influenced highly by the pedagogical concept named „Erziehender Sportunterricht“. It means interpreting and arranging physical education under pedagogic perspectives such as „cooperation“ and „accomplishment“ (Kurz, 2000). The implementation of the concept primarily depends on the didactic actions and the didactic beliefs of the physical education teacher. In face of desiderata concerning this matter, the study focuses the question, how the didactic demands concerning the „Erziehende Sportunterricht“ become to realization in the beliefs and actions of physical education teachers. **Methods** The study uses a difference-orientated approach including the following steps (Neumann, 2014): 1) Analysis of demands (document analysis): Publications of the science community regarding the perspectives „cooperation“ and „accomplishment“ (N=28) were interpreted by content analysis. 2) Analysis of reality (case studies): Didactic actions and beliefs of physical education teachers (N=9) regarding „cooper-

ation" and "accomplishment" were surveyed by video observation, problem-centered interviews and stimulated recall interviews. The data again was interpreted by content analysis along the cases and finally summarized in types. 3) Analysis of differences: Differences were discovered and interpreted by comparing demands and reality. Results In terms of the teachers' didactic actions and beliefs in reality three diverging types could be discovered: a conservative type (substantial differences), an inconsistent type (partial differences) and an intermediate type (rarely differences). All types show differences especially regarding the topics "competition" and "integration". The conservative and the inconsistent type also show differences regarding the intention to educate pupils to "maturity" and the principals "cognitive stimulating", "openness" and "individualization". Reasons can be derived from the teachers' biography or deficient structures of knowledge transfer from science to practice. Discussion The study explored how the pedagogical concept "Erziehender Sportunterricht" is realized in practice. Further research about the quantitative representation of the three types would be rewarding. Besides, the study points to possibilities for reducing differences. For example it's recommended to arrange teacher education more as knowledge exchange than as knowledge transfer. References Kurz, D. (2000). Die pädagogische Grundlegung des Schulsports in Nordrhein-Westfalen. LfSuW (Ed.), Erziehender Schulsport. (9–55). Bönen: Kettler. Neumann, P. (2014). Zur Charakteristik des differenzanalytischen Forschungsansatzes. E. Balz & P. Neumann (Eds.), Schulsport: Anspruch und Wirklichkeit. (51–60). Aachen: Shaker. Contact julia.hapke@fau.de

## Oral presentations

### OP-SH04 Effects & Statistics

#### THE EFFECT OF METER STRUCTURE ON BIMANUAL RHYTHMIC TAPPING

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**Introduction** The coordination of a physical action in time with a rhythmic sequence such as dancing or playing in a musical ensemble is one of the fundamental human skills. Several articles have discussed how to coordinate accurately or stably and suggested that subdivision benefit can be an effective method for reduces the variability of the asynchronies between actions and auditory cues (Repp, 2003; 2010). The aim of the present study was to examine the extent to which physical subdivision of inter-onset intervals (IOIs) in an isochronous sequence reduces the variability of the asynchronies. We compared the relative benefits of duple and triple subdivision. **Methods** Twenty healthy university students participated in the experiment. The participants performed bimanual finger tapping in time with an auditory metronome. Two metrical conditions were tested: in 2-beat condition, metronome sound was given every other tap; and in 3-beat condition, it was given every three taps. Six different tempi were tested: 300, 280, 260, 240, 220 and 200 ms of inter-tap-intervals (ITIs). The timing of the tapping was measured by using two load cells. Mean and standard deviation of asynchrony, defined as the time interval between metronome sound and tapping, were calculated to quantify the temporal accuracy and stability of tapping. Two-way repeated measures ANOVA was used to test the effect of metrical structure and tempo. Results Mean asynchrony data revealed no significant main effect of tapping conditions, whereas the standard deviation of asynchrony data revealed statistically significant main effects of tapping conditions (2beat : 17.7 ms, 3beat : 20.5 ms,  $p < .01$ ) and of tempi (ITI = 300-200 ms : 22.3 ms, 20.2 ms, 18.4 ms, 18.2 ms, 16.9 ms, 18.6 ms,  $p < .01$ ). **Discussion** The results showed that that subdivision are more stable than triple, suggesting that metric structure affect local synchronization performance. According to the Farey sequence (Yamamoto et al., 2015), a principle of frequency locking indicate 1:2 is more temporally stable than 1:3 in coordination. Three reasons can be considered why duple subdivision is stable; one is that the auditory cues are more frequently, thus it is easy to correct the asynchronies. Another is that the same hand always taps on-beat. We considered that tapping on-beat with the left and right hands alternately induces variability. The other is that we have two hands, thus spatial condition influences temporal coordination. Future studies would be interesting to investigate these issues. References Repp, B. H. (2003). Journal of Motor Behavior, 35(4), 355-370. Repp, B. H. (2010). Music Perception, 27(5), 389-397. Yamamoto, K., Tsutsui, S., & Yamamoto, Y. (2015). Human Movement Science, 44, 102-110. Contact haruta0109@gmail.com

#### ANTICIPATION AND RECALL OF EXERCISE RELATED AFFECT

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*Northumbria University*

**INTRODUCTION:** It is proposed that upon completion of exercise the recall of affective responses mirrors the exercise experience and remains constant over time. However, research examining memory processes indicates that the recall of an experience often differs from the actual experience and affective memory is more influential than the actual experience when predicting future behaviour. Therefore, the aim of this study was to examine individuals' recall of exercise-related affect over a period of two weeks and determine the influence of affective recall on anticipatory feelings prior to exercise. **METHODS:** A randomized controlled, cross-over design required 42 adults (26 females, 16 males; Mage = 30, SD = 6 years) to recall their affective responses associated with two exercise conditions of differing intensity (low to moderate vs. high). Affect was recorded using the Feeling Scale and Felt Arousal Scale immediately before the trial commenced, and 5, 10, 15, & 20 min during the trial. Recall of affect was measured with the Global Affective Evaluation scale 1, 5, & 15 min, and 4 & 8 hours post exercise, as well as 1, 2, 7 & 14 days post exercise. Within-subject changes in recalled affective experience over time were examined using one-way repeated measures ANOVAs. The predictive values of anticipatory feelings immediately prior to exercise were examined using multiple regression analyses. **RESULTS:** Recalled affect significantly changed following the low intensity ( $p = 0.01$ ) and the high intensity ( $p = 0.03$ ) exercise trials. Follow-up pairwise analyses revealed significant differences between the 8 and 24 h post exercise measurement points in the low intensity ( $p < 0.01$ ) and high intensity ( $p < 0.05$ ) conditions. Anticipatory feelings measured before the second trial explained 38% of variance in the measurement points obtained during the exercise ( $p < 0.01$ ) and 77% of variance was explained by the recalled affect measurement collected after the exercise terminated ( $p < 0.01$ ). **DISCUSSION:** Recalled exercise-related affect fluctuates with a worsening of the affect recalled 24 h following exercise. Anticipatory feelings prior to exercise are guided by the affective recall of previous experiences. These findings raise important applied implications for professionals aiming to optimise the maintenance of exercise and training behaviours. Contact paul.davis@northumbria.ac.uk

**VALIDITY THRESHOLDS AND ERROR RATES FOR TEST MEASURES USED TO ASSESS INDIVIDUALS**

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A practical test may be used to assess individuals when a criterion or gold-standard test is expensive or inconvenient to administer. However, there has been little investigation of the effect of validity of the test (the correlation between practical-test and criterion-test measures) on accuracy of assessment. **PURPOSE:** To define magnitude thresholds for the validity correlation of a practical measure and to determine error rates when a cut score is used to pass or fail individuals. **METHODS:** Thresholds for magnitudes of the validity correlation were calculated by equating the usual standardized thresholds for a difference in means to twice the standard error of the estimate of the practical measure predicted by the criterion measure. Test-pass (false-positive) and test-fail (false-negative) error rates and their confidence limits were derived by simulation for a given validity correlation, a given threshold of the practical measure, and given uncertainty in the threshold. Error rates were also derived for a criterion with given reliability. Spreadsheets were developed for assessing specific tests. **RESULTS:** Thresholds for very poor, poor, good, very good and excellent validity correlations are 0.45, 0.70, 0.85, 0.95 and 0.995 respectively. For cut scores up to 1 SD from the mean, desirable test-pass and test-fail error rates (<5%) occur only for excellent validity. Thresholds and error rates with a criterion test are equivalent to those of a practical test with validity correlation equal to the square root of the test-retest reliability correlation. **CONCLUSION:** Validity correlations for a practical measure and reliability correlations for a criterion measure need to be much higher than generally recognized to achieve low errors of measurement and desirable error rates in diagnostic or competence testing.

**18:00 - 19:30****Oral presentations****OP-PM57 Substrate Oxidation, Blood and Steroids****FAT OXIDATION DURING DIFFERENT MODES OF EXERCISE IN UNTRAINED YOUNG AND MIDDLE-AGED MEN**

FRANSEN, J., BECK, N.T., LANGKILD, H.C., LARSEN, S., DELA, F., HELGE, W.J.

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**Introduction** A low fat oxidation during rest and exercise and aging per se are associated with a higher clustering of unfavourable metabolic syndrome risk factors. Interestingly, fat oxidation during exercise in middle-aged and elderly subjects has scarcely been studied, so the understanding of aging and fat oxidation is incomplete. The aim of this study was to investigate maximal fat oxidation in healthy untrained young and middle-aged subjects during cycle ergometer and treadmill exercise. We hypothesized that untrained middle-aged compared to young men would have a lower maximal fat oxidation (MFO) at a lower relative intensity (fatmax). **Method** Healthy untrained men, 8 young ( $46.5 \pm 1$  ml/min/kg,  $27 \pm 1$  yrs) and 10 middle-aged ( $36.8 \pm 2.3$  ml/min/kg,  $55 \pm 1$  yrs) underwent a treadmill and a cycle-ergometer incremental exercise test. Fat oxidation rate was determined by indirect calorimetry. Venous blood samples were collected at each step throughout the tests. A two-way ANOVA was applied to analyze differences in MFO and fatmax between groups and modes of exercise. A Pearson product-moment correlation analysis with MFO as the dependent variable was performed to reveal associations with  $\text{VO}_2\text{max}$  and fasting plasma glycerol concentrations. **Results** Lean Body mass ( $60.7 \pm 1.8$  vs.  $56.3 \pm 1.9$  kg) and BMI ( $24.4 \pm 0.4$  vs.  $23.4 \pm 0.4$ ) were not different between the young and middle-aged groups, respectively.  $\text{VO}_2\text{max}$  was lower (cycle:  $36.8 \pm 2.3$  vs.  $46.5 \pm 1$ ; Treadmill:  $40.4 \pm 1$  vs.  $48.6 \pm 1.2$  ml/min/kg) in middle-aged compared to young men, respectively. MFO was not significantly different during the graded cycle or the treadmill tests between the young and middle-aged group, respectively. Within the young group, MFO ( $0.462 \pm 0.04$  vs.  $0.396 \pm 0.05$  g/min) and fatmax ( $38.1 \pm 1.6$  vs.  $38.2 \pm 2.6\%$ ) were not different between cycle ergometer and treadmill exercise, respectively. Within the middle-aged group MFO ( $0.370 \pm 0.03$  vs.  $0.438 \pm 0.03$  g/min,  $P < 0.05$ ) and fatmax ( $40.3 \pm 1.3$  vs.  $45.7 \pm 2.3\%$ ,  $P < 0.05$ ) were lower during the cycle ergometer compared to the treadmill test, respectively. MFO was positively correlated to fasting plasma glycerol concentrations in the young group ( $r^2 = 0.393$ ,  $P < 0.05$ ) and to  $\text{VO}_2\text{max}$  in the middle-aged group ( $r^2 = 0.461$ ,  $P < 0.05$ ). **Conclusion** In contrast to our hypothesis, an age-related attenuation of maximal fat oxidation rate was not present during cycle ergometer exercise or treadmill exercise. In middle-aged men MFO and fatmax were higher during graded treadmill compared to cycling exercise and MFO was positively associated with  $\text{VO}_2\text{max}$ . In young men MFO was positively associated with fasting plasma glycerol concentrations. For further information, please contact Jacobf@sund.ku.dk

**IMPACT OF THE "SLEEP-LOW" STRATEGY ON SUBSTRATE UTILIZATION DURING EXERCISE**

MARQUET, L.A.1,2, TIOLLIER, E.2, HAWLEY, J.3, BURKE, L.4, BRISSWALTER, J.1, HAUSSWIRTH, C.2

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**Introduction** The "sleep-low" (SL) strategy consisted of the periodization of the carbohydrate (CHO) intake (1): a low-CHO recovery after a high-intensity training session (HIT) in the late afternoon followed by a low-intensity session (LIT) performed after an overnight fast. In a recent paper (2) we have observed that SL strategy improves performance during prolonged exercise associated with body composition changes. The aim of the study was to investigate the physiological mechanisms responsible for the observed improved performance. **Methods** 22 trained cyclists (age:  $31.6 \pm 7.2$  years; maximal oxygen uptake:  $64.3 \pm 5.9$  ml.min<sup>-1</sup>.kg<sup>-1</sup>) followed a standardized training program and specific nutritional guidelines during 1 week according to the group they were assigned. All participants performed the same standardized training program based on the SL strategy (6 sessions over 6 days). In the "sleep low" group (SL=12), no CHO intake was authorized for all HIT and LIT sessions. The diner was also CHO-free and the LIT sessions were performed after an overnight fast. The CHO availability was regularly maintained in the "sleep high" group (SH=10) by consuming sports drinks during training sessions and CHO at every meals. All groups ingested the same amount of CHO per day ( $6$  g.kg<sup>-1</sup>.d<sup>-1</sup>) but divided differently over the day. **Performances** in cycling (2h submaximal at 60% of maximal power output and 20km time-trial tests), perceived exertion, cycling efficiency and body

composition were recorded before and after the week of training. Fat metabolism was assessed from, expired gas, serum glycerol, and free fatty acids values sampled before, and during the submaximal test. Results All the participants of the SL group increased their performance during the time trial (-1min 7sec for the SL group,  $P < 0.05$ ) after the training week. No change was observed for the CON group (-24 sec). These changes in performance were associated with a 0.48% reduction in fat mass. Analyses of substrate utilization are still running, but preliminary results indicate a possible change in substrate utilization during cycling. Conclusion SL strategy induces an improvement in performance after 1 week of training. A shift in substrates utilization could explain this result with a higher fat oxidation leading to glycogen stores sparing, and consequently leading to a higher energetic availability. References 1. Lane SC, Camera DM, Lassiter DG, et al. Effects of sleeping with reduced carbohydrate availability on acute training responses. *Journal of Applied Physiology* 2015;jap.00857.2014. 2. Marquet L-A, Brisswalter J, Louis J, et al. Enhanced Endurance Performance by Periodization of CHO Intake: "Sleep Low" Strategy. *Med Sci Sports Exerc* 2016; Contact Laurie-anne.marquet@insep.fr

## INCREASED RATES OF FAT OXIDATION DURING GRADED EXERCISE AFTER A SHORT-TERM KETOGENIC DIET IN ENDURANCE-TRAINED MALES

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1Institute for Sport & Health, and 2Institute of Food & Health, School of Physiotherapy, Public Health and Sports Science, University College Dublin, Ireland Introduction The ketogenic diet (KD) is a low carbohydrate, high fat diet that is used widely as a weight loss strategy and as therapy for some diseases. The relative contribution of carbohydrate (CHO) and fat utilization to energy expenditure during exercise is dependent on variables including exercise intensity, mode and dietary intake, but few studies have examined the effects of KD on exercise metabolism in athletes. The present study investigated changes in body composition and patterns of substrate utilization before and after a short-term (7 day) KD. Methods Ten young, endurance-trained males (mean $\pm$ SD; age, 21.6 $\pm$ 2.0 y; height, 1.83 $\pm$ 0.10 m; body fat, 14.3 $\pm$ 4.1%) were assessed before and after seven days of KD (CHO:protein:fat, 10:20:70%). On each assessment day, participants arrived to the lab after an overnight fast after which body composition (DXA) was assessed. Next, each performed a continuous incremental exercise test to exhaustion known as the FATmax protocol (Achten et al., 2003) on an electronically-braked cycle ergometer beginning at 95 W and increasing 35 W per stage in 3 min stages. Expired air and heart rate were monitored continuously, and lactate and rate of perceived exertion were measured in the last 15 sec of each stage. Results Wmax (295 $\pm$ 28 vs. 293 $\pm$ 36 W) and VO<sub>2</sub>peak (4.18 $\pm$ 0.35 vs. 4.13 $\pm$ 0.41 L/min) were unchanged by KD. Body mass decreased by 2.3 $\pm$ 1.1 kg after KD (77.8 $\pm$ 13.2 vs. 75.5 $\pm$ 12.5 kg;  $p < 0.001$ ). Body fat, by 0.75 $\pm$ 0.41 kg ( $p < 0.001$ ), and fat-free mass (FFM), by 1.65 $\pm$ 1.68 kg ( $p = 0.013$ ), were decreased by KD. Despite similar oxygen consumption, the respiratory exchange ratio was lower and rates of fat oxidation (FATox) were higher after KD across a range of exercise intensities ( $p < 0.05$ ). FATox averaged 2.4-fold higher at ~65%VO<sub>2</sub>peak after KD ( $p < 0.001$ ), with peak FATox averaging 0.83 $\pm$ 0.23 g/min at this intensity. The crossover point for substrate utilization occurred at a higher relative exercise intensity after KD (48.8 $\pm$ 4.0 vs. 72.1 $\pm$ 3.6%VO<sub>2</sub>peak,  $p < 0.05$ ), which coincided with a rightward shift in the plasma lactate profile. Discussion A short-term KD results in rapid alterations in body composition comprising of loss of both body fat and FFM. Rates of fat oxidation are elevated after short-term KD concomitant with reduced reliance on CHO utilization for energy provision, even at moderate and high exercise intensities, analogous to findings from 'keto-adapted' ultra-endurance runners compared to habitual high CHO diet (Volek et al., 2016). Whether these adaptations to short-term KD or longer term keto-adaptation translate into performance benefits, particularly in high intensity sports, remains to be explored. References Achten J, et al. (2002) *Med Sci Sports Exerc.* 34(1):92-7. Volek JS, et al. (2016) *Metabolism.* 65(3):100-10. Contact brendan.egan@ucd.ie

## ANDROGEN RECEPTOR GENE POLYMORPHISMS AND MAXIMAL FAT OXIDATION IN MEN. A LONGITUDINAL STUDY.

PONCE-GONZÁLEZ, J.G.1,2, GUADALUPE-GRAU, A.1, RODRÍGUEZ-GONZÁLEZ, F.G.3,4, DORADO, C.1,2, DE TORRES-PERALTA, R.S.1,2, MORALES-ALAMO, D.1,2, RODRÍGUEZ-GARCÍA, L.1, DÍAZ-CHICO, B.N.3,4, CALBET, J.A.1,2

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Introduction. The aim of this longitudinal study was to evaluate if extreme CAG and GGN repeat polymorphisms of the androgen receptors (AR) influence body fat mass, its regional distribution, fat accumulation, basal metabolic rate, basal and maximal fat oxidation capacity (MFO), maximal oxygen uptake (VO<sub>2</sub>max), and serum concentration of leptin, free testosterone and osteocalcin. Methods. CAG and GGN repeats length were measured in 319 men (mean $\pm$ SD: 28.3 $\pm$ 7.6 years old). From these, we selected the subjects with extreme short (CAGS $\leq$ 19) and long (CAGL $\geq$ 24) CAG repeats, and the subjects with short (GGNS $\leq$ 22) and long (GGNL $\geq$ 25) GGN repeats. Results. The length of CAG repeats was not associated to fat mass. CAGS and CAGL subjects had similar basal metabolic rate and accumulated comparable amounts of fat tissue over 6.4  $\pm$  1.0 years of follow up. However, CAGL showed higher MFO and total lean mass than CAGS ( $p < 0.05$ ). Men with GGNS $\leq$ 22 accumulated greater amount of total fat mass than men with GGNL $\geq$ 25, particularly in the trunk region seven years later. This concurs with a trend for a greater MFO in the GGNL group ( $P = 0.06$ ), who accumulated less fat mass. Free testosterone was associated with MFO in absolute values ( $r = 0.45$ ;  $p < 0.05$ ) and MFO per kg of lower extremity lean mass per height squared ( $r = 0.35$ ;  $p < 0.05$ ). Conclusions. Longer CAG and GGN repeats polymorphism may increase fat oxidation capacity, which could reduce the accumulation of fat over the years.

## THE EFFECT OF 8-WEEK WALKING EXERCISES WITH DIFFERENT INTENSITY ON SERUM HEPcidIN, IL-6 LEVELS AND MARKERS OF IRON METABOLISM IN PRE-MENOPAUSAL WOMEN

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Introduction Exercise-induced iron deficiency is quite common in athletic population (Kong, et al.,2014). It has been suggested recently that hepcidin may be an important mediator in this process (Nemeth et al.,2006). Previous studies examined the effects of acute exercise on hepcidin and markers of iron metabolism (Peeling et al. 2009; Peeling et al., 2014). To our knowledge, there are no studies examining the chronic effects of walking exercises (WE) on these parameters. Therefore, the aim of this study is to examine the chronic effect of two different-intensity, eight-week WE on hepcidin, IL-6 and markers of iron metabolism in pre-menopausal women. Methods Exercise groups (EG) (moderate tempo walking group; MTWG; n=11; brisk walking group BWG; n=11) walked three days a week, starting from 30 minutes, gradually increasing up to 51 minutes. Control group (CG; n=8) did not participate in any exercise forms. BWG walked at ~70-



75% and MTWG at ~50-55 of HRRmax. Body mass index, body fat, VO<sub>2</sub>max, serum hepcidin, IL-6 levels and some iron metabolism markers [iron, total iron binding capacity (TIBC), transferrin, transferrin saturation (STR), ferritin, hemoglobin (Hb), red blood cells (RBC), hematocrit (Hct)] were determined before and after the intervention. Results VO<sub>2</sub>max increased in both EG significantly, favoring BWG. Hepcidin levels increased in BWG ( $p < 0.01$ ), MTWG ( $p = 0.05$ ), and CG ( $p < 0.05$ ). Serum IL-6 decreased in BWG and MTWG ( $p < 0.05$ ;  $p < 0.01$ , respectively). While serum iron levels did not change significantly in any groups, TIBC increased significantly only in BWG ( $p < 0.01$ ). There was a nearly significant increase in Hb levels of BWG ( $p = 0.061$ ) and Hct levels ( $p < 0.01$ ); RBC increased significantly only in BWG ( $p < 0.05$ ). We observed no statistical changes in ferritin, transferrin and transferrin STR levels of all study groups. Discussion Serum IL-6 decreased regardless of the exercise type; therefore both WE types may be useful to prevent inflammation. However, brisk walking is advisable due to the positive changes in VO<sub>2</sub>max and some iron metabolism parameters since they may contribute to prevent iron deficiency anemia. Despite the positive effects of the exercise programs on the reduction in serum IL-6 levels, the significant increase in hepcidin levels in EG remains unclear and necessitates further studies. References Kong WN, Gao G, Chang YZ (2014). *Cell & Bioscience*, 4:19 Nemeth E, Ganz T (2006). *Annu Rev Nutr*, 26, 323-42 Peeling P, Dawson B, Goodman C, et al. (2009). *Int J Sports Nutr Exerc Metab*, 19,583-97. Peeling P, Sim M, Badenhorst CE, et al. (2014) *PlosOne*, 9(3). Contact gurbuzbuyukyazi@gmail.com

## IMPACT OF THE UGT2B17 POLYMORPHISM ON THE STEROID PROFILE. RESULTS OF A CROSSOVER CLINICAL TRIAL IN A POPULATION OF ATHLETES SUBMITTED TO A TESTOSTERONE ADMINISTRATION STUDY.

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**Objective:** To study the genomic influence (UGT2B17 polymorphism) on the urinary steroid profile focused on the Testosterone/Epitestosterone ratio (T/E) during testosterone administration. **Methods:** A triple-blind randomized placebo-controlled crossover trial with healthy male athletes between the ages of 18 and 55 who had practiced sport for at least 3 to 5 years and worked out regularly. Each subject was administered a single dose of either Testex Elmu Prolongatum (250mg testosterone cypionate/testosterone ciclopentilpropionate) by intramuscular injection or Baxter (Clear-Flex) saline solution (9 mg/mg) in a single uniform dose of 2 ml. For each participant, a total of 40 samples of urine were collected for steroid profile measurement. The dependent variable of the study was the T/E ratio. **Results:** A total of 12 athletes, all male, were included in the study, with a mean age of 39.9 years (SD 11.2). The polymorphism was evenly distributed (4 volunteers of each genotype). The increased levels of T/E after administration of Testex Elmu Prolongatum presented statistical significance based on the presence of the polymorphism ( $p = 0.034$ ). Athletes in the wt-homozygous group presented mean relative increase of 30 (CI 95%: 25.2 to 36.7); the increase in the heterozygous mutant group was 19.8 (CI 95%:15.9 to 24.7); and the increase in the homozygous mutant group was 19.7 (CI 95% 14.9 to 26.2). **Conclusions:** Increased levels of T/E in urine were observed after administration of Testex Elmu Prolongatum that was not homogeneous in terms of the presence of the polymorphism. An intraindividual evaluation approach of results is more effective than an inter individual one.

## Oral presentations

### OP-PM43 Physiological Responses

#### DIFFERENCES IN GAS EXCHANGE KINETICS BETWEEN CYCLING AND WALKING

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**Introduction** Oxygen uptake (V'O<sub>2</sub>) kinetics allow an estimation of cardiovascular and respiratory regulatory processes to adequately adjust oxygen delivery to and extraction in the exercising muscles. It is well known that maximal V'O<sub>2</sub> differs between running and cycling. So far, V'O<sub>2</sub> kinetics were compared between cycle and treadmill exercise exclusively by applying square wave work rate (WR) protocols. No differences were observed for V'O<sub>2</sub> kinetics. Carbon dioxide (V'CO<sub>2</sub>) and ventilation (V'E) were not investigated, yet. It was hypothesised that V'O<sub>2</sub>, V'CO<sub>2</sub> and V'E kinetics would be similar for walking and cycling. **Methods** 19 active young subjects (age: 26±4 years; weight: 67.3±8.1 kg) were tested for gas exchange kinetics (V'O<sub>2</sub>, V'CO<sub>2</sub>, V'E) applying pseudo-random binary sequences (PRBS) on a treadmill (velocities of 3 km·h<sup>-1</sup> and 6 km·h<sup>-1</sup>) and cycle (WRs of 30 W and 80 W) ergometer in randomized order. The WR protocols were matched for similar absolute V'O<sub>2</sub>. Gas exchange kinetics were assessed applying cross-correlation functions (CCF) of WR with the mentioned parameters. Higher peaks in CCF (CCFmax) imply faster system responses (kinetics) (Hoffmann et al. 2013). Two-factorial ANOVA was applied to assess differences between kinetics responses and absolute values of V'O<sub>2</sub>, V'E and V'CO<sub>2</sub>. **Results** CCFmax(V'E) (walking vs. cycling: 0.34 ± 0.02 vs. 0.26 ± 0.02;  $P = 0.003$ ) and CCFmax(V'CO<sub>2</sub>) (0.33 ± 0.02 vs. 0.25 ± 0.01;  $P = 0.003$ ) were significantly higher for walking compared with cycling. CCFmax(V'O<sub>2</sub>) was not different (0.35 ± 0.01 vs. 0.35 ± 0.01;  $P = 0.014$ ). Absolute values of V'E were significantly higher during walking (6 km·h<sup>-1</sup>: 29.9 ± 4.1 vs. 80 W: 27.6 ± 3.0;  $P = 0.001$ ) whereas V'CO<sub>2</sub> was significantly lower (6 km·h<sup>-1</sup>: 0.99 ± 0.11 vs. 80 W: 1.12 ± 0.11) and V'O<sub>2</sub> was similar. **Discussion** The achievement of similar absolute V'O<sub>2</sub> values with similar kinetics responses for walking and cycling affords higher values of V'E for walking with a faster kinetics profile; but produces lower absolute values of V'CO<sub>2</sub> with a faster kinetics response. Therefore, the regulatory processes of V'E and V'CO<sub>2</sub> for the achievement of a similar V'O<sub>2</sub> response are different. These results should be considered comparing gas exchange kinetics between walking and cycling exercise. Since the determination of cardiorespiratory kinetics applying PRBS can be performed in a single test session this method seems promising for e.g. clinical diagnostics. **References** Hoffmann, U., Drescher, U., Benson, A. P., Rossiter, H. B., & Essfeld, D. (2013). *Eur J Appl Physiol*, 113(7), 1745–1754.

## EFFECT OF AEROBIC AND STRENGTH TRAINING ON GAS EXCHANGE KINETICS DURING MODERATE- AND HEAVY-INTENSITY EXERCISE IN ELDERLY

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**Introduction** Aerobic training accelerates Phase II of  $\dot{V}O_2$  kinetics at the onset of moderate intensity exercise (M) and decreases the amplitude of the slow component (A3) during heavy-intensity exercise (H). The physiological causes of the slow component are still matter of debate. The progressive recruitment of the less economical Type II muscle fibers during H (Jones et al., 2005) may be implied in its genesis. The increase of muscle strength caused by resistance training would decrease the number of Type II muscle fibers recruited during H at the same workload (WL), wherefrom a smaller A3 may derive. **Methods** 12 active older men ( $69.4 \pm 4.3$  yr;  $78.5 \pm 10.5$  kg;  $171.2 \pm 5.3$  cm;  $\dot{V}O_{2peak}$ :  $29.5 \pm 4.1$  mL/kg/min) were exposed to 8 weeks of: i) high intensity interval training (HIT), 7 2-minute cycling repetitions @90% of  $\dot{V}O_{2peak}$  ( $\dot{V}O_{2p}$ ), 3 times/week and, after 4 months, ii) isoinertial resistance training (IRT),  $4 \times 7$  maximal concentric-eccentric knee extensions, 3 times/week. Before and after trainings we measured: i)  $\dot{V}O_{2p}$  and gas exchange threshold (GET); ii) B-by-B  $\dot{V}O_2$  at the onset of: a) moderate intensity (M; @WL equal to 80 % of GET;  $n = 4$ ); and b) heavy-intensity exercise (H, @WL equal to 50% between GET and  $\dot{V}O_{2p}$  assessed before training;  $n = 3$ ); iii) isokinetic concentric torque (Tc) and isometric torque (Ti) of the limb extensors.  $\dot{V}O_2$  kinetics were modeled, after synchronization and averaging, by means of double or triple exponential functions. **Results** Only HIT led to a significant increase of absolute and relative  $\dot{V}O_{2p}$  ( $P < 0.05$ ). IRT brought about a significant increase of Tc and Ti ( $P > 0.05$ ). The time constant of Phase II of  $\dot{V}O_2$  kinetics ( $\tau_2$ ) during M was significantly faster only after HIT (19.5 vs. 27.3;  $P < 0.05$ ); the amplitude (A2) of  $\dot{V}O_2$  response during M was significantly lower at the end of IRT (-10%,  $P < 0.05$ ) than after HIT. After HIT, A3 was smaller than before training. Conversely, A3 was not affected by IRT. **Discussion** 8 weeks of HIT induced a significant acceleration of  $\dot{V}O_2$  kinetics during M and decreased the amplitude of A3 during H. On the contrary, IRT did not elicit any substantial effect on the characteristics of the slow component assessed during H. However, IRT resulted in a significant decrease of A2 during M, indicating an amelioration of the economy of exercise. These findings are in agreement with the ones obtained in young adults (Zoladz et al., 2012) and may suggest that IRT can have beneficial effects on performance of endurance events. **References** Jones AM, Pringle JSM, Carter H. (2005) Oxygen uptake kinetics in sport, exercise and medicine, 261-293, NY. Zoladz JA, Szkutnik Z, Majerczak J, Grandys M, Duda K, Grassi B. (2012) Eur J Appl Physiol 112, 4151–4161.

## COMPARISON OF GPS, ACCELEROMETRY, AND HEART RATE FOR ESTIMATING METABOLIC RATE DURING LEVEL AND UPHILL OUTDOOR WALKING

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**Introduction** Speed and grade are two powerful predictors of walking metabolic rate. The conventional use of accelerometry to measure such parameters in free-living environment is limited due to technical considerations. By directly measuring speed and altitude, Global Positioning System (GPS) receivers could be accurate for estimating outdoor walking metabolic rate. Moreover, no study compared GPS with other commonly used methods for estimating metabolic rate while walking. The aim of this study was to compare the accuracy of GPS, accelerometry, and heart rate (HR) monitoring, for estimating metabolic rate during level and uphill outdoor walking. **Methods** Thirty young adult subjects (NCT01805219) completed three 6-min outdoor walks (2.0, 3.5 & 5.0 km/h) in three randomized conditions: 1/ level walking (0.0% grade); 2/ uphill walking on a 3.4% mean grade; 3/ uphill walking on a 10.4% mean grade. Walking metabolic rate (in METs) was measured using a portable metabolic system (K4b2, Cosmed®). Subjects were equipped with i) a DG100 (GlobalSat®) GPS receiver (shoulder position, 1-Hz), ii) a wGT3X+ (ActiGraph™) accelerometer (hip position, 90-Hz), and iii) a Polar® HR monitor (chest position, 1-Hz). GPS grade (grade= $\Delta$  altitude/distance walked) was computed from two calculation methods using i) GPS uncorrected altitude data and ii) by correcting GPS altitude data using cartography software (CartoExploreur, Bayo Ltd). METs, GPS parameters, accelerometer outputs (counts/s, for vertical axis (V) and vector magnitude (VM)), and HR, were averaged over the last 3 min of each walking period. Linear mixed models were computed for METs and the different outputs of the sensors used. Accuracy of linear mixed models was tested using the leave-one-out cross-validation method and by computing root-mean squared errors (RMSE). **Results** The prediction models accuracy ranked as follow: GPS speed and corrected grade (RMSE = 0.84 MET;  $R^2 = 0.86$ ), GPS speed and uncorrected grade (RMSE = 1.03 MET;  $R^2 = 0.78$ ), VM-accelerometer counts/s (RMSE = 1.22 MET,  $R^2 = 0.64$ ), V-accelerometer counts/s (RMSE = 1.28 MET;  $R^2 = 0.59$ ), HR (RMSE = 1.61 MET;  $R^2 = 0.63$ ). **Discussion** GPS was accurate for predicting METs and more accurate than accelerometry and HR monitoring. Further studies are needed to assess GPS accuracy for predicting metabolic rate in environments with different obstruction levels.

## PERIODIC BREATHING PREDICTS EXCESSIVELY REDUCED EXERCISE TOLERANCE IN PATIENTS WITH CHRONIC HEART FAILURE

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**Introduction** Periodic breathing (PB) is evident during exercise in some patients with chronic heart failure (CHF) and is accompanied by hyperventilation. Aim to determine whether the presence of PB predicts excessive reduced exercise capacity in patients with severe CHF relative to patient with CHF of similar severity but with no PB. **Methods** Sixty one CHF patients underwent cardiopulmonary exercise from 2009 to 2011 as part of their evaluation for cardiac transplantation. From this data, we selected patients in which the term 'periodic breathing' appeared in their report. Matching patients with CHF without PB were identified from the same pool. **Results** Fifteen CHF patients with PB and 18 patients with CHF with similar ejection fraction but without PB (control) were identified from the pool of 61 patients. The PB group had a lower peak oxygen uptake related to body weight ( $\dot{V}O_{2/kg}$ ) and anaerobic threshold (AT) than the control group, by 3011 and 394%, respectively ( $p < 0.05$ ). The ventilatory equivalent for  $CO_2$  production ( $\dot{V}E/\dot{V}CO_2$ ) at the AT was higher and the end tidal pressure of  $CO_2$  ( $PETCO_2$ ) was lower in the control group as compared with PB group ( $p < 0.05$ ).  $\dot{V}E/\dot{V}CO_2$  at the AT was inversely correlated with peak  $\dot{V}O_{2/kg}$  ( $r = -0.45$ ,  $p < 0.05$ ). **Discussion** PB in patients with severe CHF is associated with excessively reduced exercise capacity. Increased ventilatory requirement may enhanced dyspnea and may add to exercise limitation in these patients. **Conclusion:** Periodic breathing reflects the severity of CHF and is associated with excessively reduced exercise tolerance in patients with CHF.

**EFFECTS OF HYPOVENTILATION TRAINING AT SUPRAMAXIMAL INTENSITY IN SWIMMING**

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EFFECTS OF HYPOVENTILATION TRAINING AT SUPRAMAXIMAL INTENSITY IN SWIMMING Woorons, X.1, Mucci, P.1, Richalet, J.P.2, Pichon, A.3  
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 Introduction Recently it was demonstrated that swimmers could train under hypoxic conditions at sea level through voluntary hypoventilation at low lung volume (VHL; i.e. the 'exhale-hold' technique) (Woorons et al., 2014). While intermittent hypoxic training carried out at moderate intensity does not seem to improve sea-level performance more than the same training in normoxia, it has been shown to be more effective when performed at high intensity (Faiss et al., 2013). The goal of the present study was therefore to assess the effects of VHL training at supramaximal intensity on swimming performance and to determine its physiological consequences. Methods Over a 5-week period, 16 well-trained triathletes were asked to include into their usual swimming session one set of 12 to 20 x 25 m (10-15 s recovery between reps) at supramaximal intensity, twice a week. The set was performed either with VHL (HYPO group, n = 8) or with normal breathing (NB group, n = 8). Before (Pre) and after (Post) training, all subjects performed all-out front crawl trials over 100, 200 and 400 m. Peak oxygen consumption (VO<sub>2peak</sub>), ventilation (VE), tidal volume (VT), breathing frequency (Bf), heart rate (HR), arterial oxygen saturation (SpO<sub>2</sub>), stroke distance (SD) and stroke rate (SR) were measured throughout some of the trials and maximal blood lactate concentration ([La]max) was assessed after each trial. Results In the HYPO group, performance was improved for the 100- (- 3.7 ± 3.7 s; - 4.4 %), 200- (- 6.9 ± 5.0 s; - 3.6 %) and 400-m (- 13.6 ± 6.1 s; - 3.5 %) trials whereas there was no change in NB. [La]max was higher at Post than at Pre after all trials in the HYPO group only (+ 2.35 ± 1.3 mmol.L<sup>-1</sup> on average). There was no change in VO<sub>2peak</sub>, VE, VT, Bf, SpO<sub>2</sub>, HR and SD in both groups at the end of the training period. On the other hand, SR was higher at Post compared to Pre in HYPO but was not different in NB. Discussion This study demonstrated that VHL training, when performed at supramaximal intensity, could improve swimming performance more than the same training carried out under normal breathing conditions for distances from 100 to 400 m. The increased [La]max in the HYPO group represents an interesting finding. In the absence of an additional aerobic, hydrodynamic or technical benefit, it suggests that performance improvement could be attributed, at least in part, to a greater activity of anaerobic glycolysis. This phenomenon was probably the consequence of the hypoxic as well as the hypercapnic effect of hypoventilation training. References Faiss R, Girard O, Millet GP. (2013). *Br J Sports Med.* 2013, 47, 45-50. Woorons X, Gamelin FX, Lamberto C, Pichon A, Richalet JP. (2014). *Respir Physiol Neurobiol*, 190, 33-39.

**Oral presentations****OP-BN17 Kinematic Analysis of selected Movements/ Sports****EVALUATION OF INERTIAL SENSOR CALIBRATION VARIABILITY AND ITS EFFECT ON 3D KNEE JOINT ANGLES ESTIMATION**

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Introduction Recent technological advances in MEMS allow considering the biomechanical evaluation of sports practitioners outside the laboratory, with more ecological conditions. To this end, inertial motion capture is promising but still requires a calibration procedure to estimate body segment rotation, generally based on static or dynamic tasks. These tasks give the opportunity to estimate segmental rotation axis, from which body-to-sensor rotations can be obtained. Within the context of sports monitoring, accuracy and repeatability of the calibration procedure is of major importance. Firstly, the aim of this study is to determine the variability of calibration procedures. Secondly, the influence of this variability on 3D knee joint rotations is evaluated during a cycling and gait task. Methods Fourteen subjects wore inertial sensors on thigh and shank. Three reflective markers were attached on each IMU and tracked using a Vicon optoelectronic system. Each subject performed five calibration tasks (based on static and dynamic calibration) (Palermo et al. 2014, Favre et al. 2009) which were randomly repeated four times. The combination of calibration tasks enabled defining different calibration methods (static-based, dynamic-based and static/dynamic-based methods). For each method, body-to-sensor rotation matrix was calculated, leading to 3D segmental body orientations. Variability of these orientations were quantified to compare calibration methods and both inertial and optical systems. Finally, variability effects on 3D knee joint angles were studied using simulated perturbation (Brennan et al., 2011) during cycling (2' at 90 rpm, 150W) and walking (8m). Results No significant difference was found between both systems except for thigh and shank rolling standard deviation (p<0.01 & p<0.05). Dynamic-based methods are more variable for thigh rolling determination (p<0.05) but the largest difference was quantified for shank heading with significant lower range and standard deviation (p<0.0001 range of variability=2.25° and SD=1.01°). Combined static/dynamic-based method presented smallest variability. Multi-simulation showed moderate error against non-perturbed angle (RMSE<2.3°). Discussion This study showed that combined static/dynamic based method engendered lower variability than the static based method. Simulation perturbation is useful to estimate confidence in knee joint angles based on inertial sensors. Future works will focus on the accuracy of the latter methods for outdoor ecological situations. References Palermo E, Rossi S, Larini F, Patanè F, Cappa P. (2014). *Measurement*, 52, 145-155. Brennan A, Deluzio K, Li Q. (2011). *Journal of Biomechanics*, 44, 2838-2842. Favre J, Aissaoui R, de Guise JA, Aminian. (2009). *Journal of Biomechanics*, 42, 2330-2335 Contact [sebastien.cordillet22@gmail.com]

**KINEMATIC CHARACTERISTICS OF THE BOBSLEIGH TEAM START**

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Victory in bobsleigh is considered highly influenced even pre-determined by engineering and technology. However, following the introduction of stringent technical rules that restricted the use of technological developments, such as structural damping and electronic control, the sport has become strongly dependent on the driver's skills and crew start time. The sport uses the so called flying start; time is taken after crossing a line that is away from the actual starting point. The start procedure is strictly regulated and is described below. The crew pushes the sled from a wooden start block that must be at least 150 cm long, 20 cm wide and 5 cm high from the surface of the ice.

The crew cannot pass the block or remove it prior to the start. Once the start is initiated the crew pushes the sled along the "push-off stretch" which is the part of the track between the start block (wooden board) and the first photoelectric cell. This stretch of the track is postulated to be 15 meters long with a gradient of 2%. As stipulated by the sport governing body FIBT (2014), after the first photoelectric cell (which represents the virtual start-line for the time-taking), the track must follow a straight path so that bobsleds starting off may reach a speed of 35 km/hr or 9.72 m/s. As a result the most important feature is to achieve maximum initial velocity of the sled rather than minimize the time from the start. This work considers the parameters that affect the start time and the initial velocity gained by the sled. The following four start phases were identified: Joint non-timed push-off, i.e. between the -15 to 0 m Driver loading Brakeman push phase Brakeman loading. To date specialists used timing gates and cameras to analyze the start. They provide valuable but insufficient information. We used accelerometers and force transducers to assess individual efforts and suggest optimal timing in the key points of the start. Based on the acceleration measurement the timing of the driver and brakeman loading (number of strides) were identified as the most important features in gaining and maintaining the maximum velocity. We have found that the necessary measurements to allow accurate a kinematic analysis are relative forces imparted by individual crew members (crucial for team selection), and sled's velocity and acceleration. It is shown that the fastest sprinters are not necessarily the best team contributors as running synergy is crucial for optimal velocity profile generation. We also illustrate that once the crew is selected just acceleration could be used to optimize the start routine. In particular we illustrate how just the change of run-up length by the driver could deliver 2.5% increase of the initial velocity which could result in more than 5% reduction in the total time. It is shown that athletes need to reach running speed of more than 10 m in order to achieve the desirable speed of 9.8 m/s. The relatively simple system is highly effective in immediate and quantifiable feedback and practical ways to improve performance are discussed.

### THROWING ARM ANGLE DETERMINES PROBABILISTIC STRUCTURE OF ERRORS IN PITCH LOCATION

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**Introduction** Although a baseball pitcher is an athlete who achieves the highest level of accuracy, pitch errors could never be zero. According to recent motor control studies, it is important to know probabilistic structure of his/her own motor errors to choose an optimal motor plan (i.e., where you aim at) to maximize the expected gain (Ota et al. 2015). In this study, we questioned what determines the probabilistic structure of pitching errors in baseball pitchers. **Methods** Eighteen healthy male collegiate baseball pitchers, including over-arm, sidearm and underarm left and right pitchers, participated in the study. The participants threw a baseball aiming at a target (diameter: 7.2 cm) located 15 m apart from the participant and 90 cm above the ground. Pitch location was captured by using a 60 fps digital video camera and throwing arm angle was filmed by using a 125 fps high-speed video camera. The participants threw 100 pitches in the experiment. Probabilistic structure of the pitch errors (i.e., shape and size of the pitch distribution) was evaluated by bivariate normal distribution fitting. **Results** In 17 out of 18 participants, the pitch errors distributed along an eccentric ellipse. The direction of the long axis was dependent on each participant's pitching form (e.g., right overarm pitchers pitched along a right-up-left-down ellipse and left overarm pitchers pitched along a left-up-right-down ellipse). This was confirmed by circular correlation analysis ( $p = 0.98$ ). **Discussion** The ellipsoidal pitch distribution indicates that if a pitcher, at least one who as skilled as our collegiate participants, throws a ball aiming at a target, the error from the target would likely be on a certain direction, not just a random direction. We confirmed that the direction (long axis of the ellipse) was determined by throwing arm angle. These results suggest that different mechanisms, potentially errors in pitching mechanics and errors in ball release timing (Hore et al. 1995, 1996), might contribute to errors along the long axis and those along the short axis. **References** Hore J., Watts S., Martin J., Miller B. (1995) Exp. Brain Res. 103:277-286. Hore J., Watts S., Tweed D. (1996b) J. Neurophysiol. 75:1013-1025. Ota K., Shinya M., Kudo K. (2015) Front Comput Neurosci. 2015 Jul 15;9:88. Contact Email: shinya.masahiro@gmail.com

### EFFECTS OF AN ACTIVE LOWER LIMB EXOSKELETON ON KINEMATICS IN LOADED GAIT

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**INTRODUCTION** New types of exoskeletons (ES) are becoming available nowadays. They provide capabilities for supporting and enhancing human physical performance. In addition to applications for medical and rehabilitative purposes they are applicable for occupational purposes like enhancing load carrying capacities or physical endurance (Mertz, 2012). In contrast to medical applications in which the ES are enabling a patients' locomotion, occupational uses require a proper support of existing body movements. In our study we focused on a knee-supporting ES prototype. A biomechanical gait analysis was performed for a loaded and unloaded condition in order to find effects and differences caused by the use of an ES. **METHODS** Gait on level ground of 10 participants was captured under four conditions. Kinematics of the lower extremities were recorded by 16 IR cameras (VICON, Oxford, UK) at 100 Hz. Reflective markers were applied on anatomical landmarks and their positions were used to drive an anatomical model. Carrying loads of 15.8 kg or 37.1 kg were used as experimental conditions. Gait of the participants with both loads were tested with and without the ES. Walking speed was 7.5 km/h in all conditions. The kinematics of knee and ankle joint were used for the statistical analysis. All parameters were normalised to stance phase. Statistical parameter mapping (SPM) was used for analysis of the joint angle curves. **RESULTS** Significant differences in knee flexion were found during the second half of the stance phase. Knee extension is reduced by about 3° in both loading conditions by wearing the ES. Knee-flexion in first half of stance phase of all conditions is about 20% higher than reported in normative data. No significant changes in kinematics of the ankle joint were found. **DISCUSSION** The identified changes in knee extension in second half of stance phase are considered to be relatively low. Thus, an increase of overall physical endurance is questionable. An explanation of this is insufficient anatomical fitting and control algorithms of the ES. This might result in hindered knee extension. The observed greater knee flexions in first half of stance phase can be explained by the given walking speed, which was faster than in normative data (e.g. Perry, 1992), and the additional loads of 18-43% of participants' mean body weight. No changes in ankle joint kinematics were observed due to the slight changes in knee kinematics. **REFERENCES** Mertz L (2012). IEEE Pulse (3)4, 56-61 Perry J (1992). Gait Analysis: Normal and Pathological Function. Slack Inc., New Jersey **CONTACT** christian.plegge@kie.fraunhofer.de



## ATYPICAL BUT HIGHLY SUCCESSFUL MOVEMENT PATTERNS OF THE DOUBLE SIDE KICK TECHNIQUE EXECUTION OF AN ELITE POINTFIGHTING KICKBOXER. A CASE STUDY.

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**INTRODUCTION** In Hölbling et al. (2014), technique execution of the double side kick of 44 pointfighting kickboxers, including 8 world champions, has been recorded and analysed using a Vicon 3D motion capturing system. 10 experts with long-term experience in coaching of international top athletes scored the competition techniques by assessing their chances of success (1-10) based on videos of the individual executions (ICC (3,1): 0.952). The mean scores were used to rank the participants. One "top five" participant, a multiple world champion, showed atypical movement patterns in qualitative video observation in contrast to most previous studies. The aim of this study was to determine and describe differences in technique execution of this special case participant (CP). **METHODS** From the qualitative observation of CP, biomechanical parameters for quantitative description of his special technique were identified. The initial movement (IM) defined as the last bounce before the kick was first qualitatively described, categorised and nominally quantified. 4 times of measurement were defined: the highest elevation of the knee before the first and the second kick (MT1, MT2) (Hölbling et al., 2014); and the knee extension maximum (KE1, KE2) at the end of both kicking phases. For these times of measurement, flexion, abduction and external rotation of the kicking leg's hip joint were determined for CP. These parameters were then compared to all other 43 participants. **RESULTS** Initial Movement (IM): CP was the only participant using a both legged bounce forward motion. Among all participants, the most used IM were rear or both foot closing bounces (25/6 participants), rear foot jump-in movements (7 participants) or just leaned back with or without bouncing movement (4/1 participants). Hip Joint Angles: Besides a high abduction, in every observed phase CP differed by a high flexion (FLX) combined with external rotation (ER) in MT1 (FLX:  $82.2 / 50.9 \pm 21.0$ ; ER:  $24.4 / 11.6 \pm 16.4$ )°, KE1 (FLX:  $88.2 / 34.5 \pm 18.9$ ; ER:  $24.6 / 6.4 \pm 18.3$ )° and MT2 (FLX:  $112 / 45.7 \pm 26.5$ ; ER:  $49.1 / 7.8 \pm 3.2$ )°, compared to all other 43 participants. **DISCUSSION** The initial movement of CP allows to reduce distance to the opponent without revealing the technique. The flexion and external rotation in hip joint enables a high first kick without further reclining of the upper body. For the second kick the external rotation in hip joint decreases, so he is able to use his hip joint to gain maximum force into the punching bag. **REFERENCES** Hölbling, D., Preuschl, E., Baca, A. (2014): A kinematic analysis of the double- side kick in point-fighting. In: Book of Abstracts of the 19th Annual Congress of the European College of Sport Science in Amsterdam.

## LOWER LIMB JOINT STIFFNESS DIFFERS BETWEEN REACTIVE AND PRE-PLANNED CHANGE OF DIRECTION TASKS

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**Introduction** Research has indicated that increased vertical and joint stiffness can improve sprint running and jumping performance (Butler et al., 2003), with researchers also reporting an increase in knee joint stiffness with an increase in running speed (Houghton et al., 2013; Kuitunen et al., 2002). However, despite a possible link between joint stiffness and CoD ability, analysis of the interaction between these data presented rarely in the scientific literature. The purpose of this investigation was to determine the effect of the presence of a decision making task on lower limb joint stiffness during a simple change of direction (CoD) tasks. **Methods** Lower limb kinetics and kinematics were collected using a high speed (500 Hz) motion capture system linked to two force platforms (2000 Hz) from ten amateur football players ( $20.9 \pm 4.09$  years) during a series of pre-planned and reactive CoD tasks. Testing followed standard reactive agility test protocols (Veale et al., 2010) with the CoD angle set at  $135^\circ$ . Inverse dynamics procedures were used to calculate ankle, knee and hip joint stiffness during the CoD step, with these data compared with three-dimensional kinematics of the centre of mass, ground contact times, and ground reaction forces for six trials at each test condition. **Results** Ground contact times were shorter for the pre-planned CoD test than for the reactive CoD test. Knee joint stiffness was the greatest during the pre-planned CoD test and recorded a moderate correlation with linear running velocity. Conversely, hip stiffness increased significantly during the reactive CoD test and demonstrated a moderate correlation with the ability to produce lateral forces during the CoD tasks. Ankle stiffness did not vary significantly across either test condition, but was correlated moderately with the ability to produce vertical force during the CoD tasks. **Discussion** This is one of the first studies to investigate the importance of joint stiffness during reactive and pre-planned CoD tasks. Results indicate that the inclusion of a decision making component had a clear impact on knee and hip joint stiffness during the CoD foot plant. In addition, increased knee joint stiffness appeared associated with superior performance during these tasks. These results highlight the importance of including decision making elements in both CoD testing and training. **References** Butler RJ, Crowell HP, Davis IM. (2003). Clin Biomech, 18(6), 511-517. Houghton LA, Dawson BT, Rubenson J. (2013). J Strength Cond Res, 27(4), 1036-1046. Kuitunen S, Komi PV, Kyröläinen H. (2002). Med Sci Sports Exerc, 34(1), 166-173. Veale JP, Pearce AJ, Carlson JS. (2010). Int J Sports Physiol Perform, 5(2), 239-248. Contact msayers@usc.edu.au

## Oral presentations

### OP-BN20 Motor Learning & Coordination

## INTERNAL VS. EXTERNAL FOCUS OF ATTENTION INSTRUCTION FOR THE IMPROVEMENT AND RETENTION OF BALANCE FOLLOWING A 6-WEEK EXERCISE TRAINING PROGRAM.

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**Do not insert authors** **Introduction:** It is not clear whether balance training which incorporates an external focus of attention (EFA) is superior to training using an internal focus of attention (IFA) for improving balance and following a 6-week balance exercise program. Current theory suggests EFA instruction leads to better motor skill outcomes than IFA instruction during motor learning and retention, however, most research has focused on immediate learning and not on motor skill retention. The purpose of this study was to examine if subjects receiving EFA vs. IFA instruction during a 6-week balance exercise training program would exhibit differences in outcomes at both short and long-term follow-up. **Methods:** 63 healthy active college-aged subjects were randomly assigned to receive EFA or IFA instruction during a 6-week balance exercise training program consisting of 8 rotating stations of progressive balance exercises, per-

formed twice a week for six-weeks. Outcome measures included the Bess Test and Y-balance Test, whose baseline scores were compared between groups at 3-week, 6-week, 3-month and 6-month intervals. Separate ANOVA's were used for the dependent variables assessed using an alpha level of .05. Results: Sixty-three subjects, mean age 24.4 (SD 3.2, 65% female), satisfied the eligibility criteria and gave consent to participate. Thirty-three patients were included in the IFA instruction group; 30 subjects in the EFA group. At baseline, the IFA group had significantly higher scores (better balance) for both outcome measures ( $P < .05$ ). Subjects receiving IFA instruction compared to EFA instruction had significantly greater Y-balance scores at 3-week, 6-week, and 3 month time intervals, and significantly lower scores (improved balance) for the Bess test at the 6-week and 3-month intervals, but not at long-term (6-month) follow-up. The EFA group, however, experienced the greatest rate of change (improvement in balance) at the 3-week interval (for Bess test), and 6-week, 3-month and 6-month time intervals (for Y-balance and Bess tests), when compared to baseline measures. Discussion: The results showed that, in healthy college-aged subjects, the greatest rate of change in balance following a 6-week exercise training program occurred when EFA instruction was provided and that motor skill retention of balance skills was greater in the EFA vs. IFA instruction group. Clinicians should consider using EFA vs. IFA instruction to improve motor skill learning and retention. Further study is needed to determine if similar results occur in injured or disabled populations.ere

## CHANGES OF ATTRACTER LAYOUT IN LEARNING A WHOLE BODY MOTOR SKILL

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Introduction: Based on the dynamic theory, motor learning occurs as the interaction of intrinsic dynamic of system organization and its relevant information that attracts the movement dynamics toward the task goal (Kelso, 1995). The changing nature of attractor was approved by learning the coordination patterns of finger oscillation by Zanone and colleagues (1992). To investigate the evolution of attractor layout of learning the multi-segmental movement skills, the presented study examined the change of behavior dynamics in the process of learning a novel cycling task. Methods: Nine male college students participated as the learners to ride the bike, which with the independently crank, on a roller training plate. As they could ride successfully for at least 10 seconds, the goal relative phase (GRP) between right and left pedal of 180, 90, 270 and 0 degrees were required sequentially in practice sessions under the criterion of each GRP was successfully performed for 5 consecutive trials. There were 20 trials within each 20 seconds in one practice session and totally 8 sessions. Before and after each practice session, the probed tests of 12 trials (3 for each GRP) were implemented. Results: 1. A significant Tests $\times$ GRPs interaction was observed. Simple main effect showed that the learners had higher error in the pre test than did in the post test for 90 degree GRP. Furthermore, the effect of GRPs was only found in the pre test in which the errors in 180 and 0 degrees RP were lower than those in 270 and 90 degrees RP respectively. 2. Three groups of learners could be classified according to their GRP's accomplishment. In all, as a new goal was accomplished, the higher r-square value of exponential function fitting could be found. Moreover, most of the learners emerged the 180 degrees RP tendency at the beginning and modified their pedaling movement smoothly as the goal information of 180 was implemented. In contrast, two of the learners revealed the tendency of 90 degrees RP at the beginning of practice and showed the conversely results. 3. Three components could explain approximately all of the variances in which the first component primarily reflected the motion of lower body in vertical direction, the second component reflected the motion in forward-backward direction. The third component revealed the minor motion for balancing. The individual difference in whole body movement coordination in learning process was found in the third component. Discussion: Individual difference in learning whole body movement coordination skill was found and could be explained by the mechanism of cooperation/competition effect (Zanone, et. al., 1992). The examination of learning curve showed that the exponential function was found and accompanied with the better performance in GRP suggesting the dynamics of system toward or around its attractor (Newell, et. al., 2001). The coordination patterns of pedaling and balance construct the motion of whole body segments. Changes of coordination were found in the coordination pattern for balancing.

## STRENGTH TRAINING AFFECTS MUSCLE COORDINATION DURING BENCH PRESS – A RANDOMISED CONTROLLED STUDY

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INTRODUCTION Strength increase during the initial phase of a strength training program is primarily due to neural adaptations. Extraction of muscle synergies addresses aspects of muscle coordination. The aim of this randomised controlled study was to evaluate training induced adaptations in muscle synergies during bench press. METHODS Thirty untrained subjects were randomly allocated to either a training (TRA) (N=17, age 25.6 $\pm$ 4.9 years, body mass 77.2 $\pm$ 16.2 kg) or control group (CON) (N=13, age 22.9 $\pm$ 2.7 years, body mass 77.2 $\pm$ 11.1 kg). The pre- and post-test were separated by five weeks and consisted of performing 3 sets of 8 repetitions at 60% of 3 repetition maximum (3RM) in bench press. Between test sessions, TRA performed supervised upper body strength training, 3 times a week, while CON did not train. Muscle synergies were extracted from surface electromyographic data of 13 muscles using non-negative matrix factorization [1]. A muscle synergy consists of a synergy activation coefficient and muscle synergy vectors. The synergy activation coefficient represents the relative contribution of the muscle synergy to the overall muscle activity pattern, while the muscle synergy vector represents the relative weighting of each muscle within each synergy. We performed a cross-validation analysis to evaluate changes in muscle synergy vectors and synergy activation coefficients [1]. In this iterative procedure, the muscle synergy vectors extracted in the pre-test were recomputed, using the fixed synergy activation coefficients from the post-test, and vice versa. A similar procedure was performed for the muscle synergy vectors. RESULTS AND DISCUSSION As expected, TRA became significantly stronger (3RM Pre=56.5 $\pm$ 19.6 kg, 3RM Post=65.7 $\pm$ 19.7 kg,  $p=0.001$ ), while no changes occurred in CON (3RM Pre=55.2 $\pm$ 12.6 kg, 3RM Post=55.0 $\pm$ 12.2 kg,  $p=0.546$ ). Two muscle synergies accounted for >90% of the variance accounted for. For TRA, the similarities between pre- and post-values of muscle synergy vectors 1, 2, and synergy activation coefficient 2 were significantly lower than the similarities between the recomputed and original synergy parameters ( $p=0.05$ ). However, this was not the case in CON. The modulation of muscle synergies during bench press by a five week strength training program can likely be explained by changes in efferent neural drive. CONCLUSIONS The present findings revealed that strength training cause changes in muscle synergies concomitantly with an increase in strength. REFERENCES [1] Frère J & Hug F, 2012, Front Comput Neurosci 6: 99 CONTACT mvk@hst.aau.dk

## EFFECTS OF FATIGUE ON TEMPORAL VARIABLES AND THEIR VARIABILITY DURING A REPETITIVE KARATE EXERCISE

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**INTRODUCTION** Despite the differential training approach has been successfully applied to improve skills by introducing variability, repetitive training approaches are still common in most sports (e.g., karate). Increased variability has been reported with fatigue accumulation during repetitive endurance training (Cignetti et al., 2009). Thus, skill acquisition by repeating could be attributed to fatigue-induced variability. Accordingly, our aim was to analyze temporal variables and their variability in karate during a fatiguing exercise based on repetitions. **METHODS** Sixteen healthy adults (5 women, 11 men) practicing karate with black and brown belts performed 9 sets of 60 mae-geri kicks (i.e., frontal kick) at submaximal intensity (alternating subsets of ten repetitions with right and left leg) with 90-seconds of rest period between sets. All kicks were performed at a frequency of 1 kick/2 seconds without impacting a target. Kinematic data were captured by 10 Oqus 310 infrared cameras (Qualisys AB, Sweden, 333 Hz) employing passive markers. Total kick time duration was divided into 2 phases (phase 1 from the start of the kicking foot movement until maximum knee flexion; phase 2 from this moment until full knee extension). Means and standard deviations (as a measure of variability) of the kick durations, peak angular velocities occurrence (of the hip, knee, ankle), and peak linear velocities of the kicking area of the foot (metatarsal heads) were compared within (between subsets of 10 repetitions) and between sets by means of Friedman ANOVA. **RESULTS** Kicks had a statistically significant increase with fatigue accumulation within sets in total duration and phase 1 duration (mainly between the first subset of 10 repetitions and the rest); furthermore, peak velocities occurred later (mainly of the feet). Regarding variability, significant differences were found for duration (phase 1 and 2) within the last set, and for peak velocities occurrence of the foot and joints between different sets. **DISCUSSION** With fatigue accumulation kick duration increases (phase 1 is much more affected than phase 2) and peak velocities of the feet occur later within sets. Moreover, the effects of fatigue are clearly manifested after the first subset of 10 repetitions, considering that subset 2 and 3 are not significantly different. Nevertheless, a 90-seconds rest period seems to be enough in order to produce previous values. Results demand further differentiated research related to absolute and relative variability and more variables should be considered to fully understand the effect of fatigue accumulation on variability during repetitive training. **REFERENCES** Cignetti F, Schena B, Rouard A (2009). *JBiomechanics*, 42, 1452-1459. **CONTACT** daragone@uni-mainz.de

## MULTIVARIATE ANALYSES OF THROWING PERFORMANCE: THE EFFECT OF EXPERIENCE

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**Introduction** Movement outcomes are the consequences of the coordination among the body segments under the influence of the gravitational field. Movement experience shapes the intrinsic dynamics of the individual that influences the coordination patterns she or he produces. In this study, we show that the outcome of a simple 2-joint throwing movement that can be well described by a mechanical model and differentially links to the coordination patterns of learners with different throwing experience. **Methods** 24 college students participated in the study. Half of them were elite basketball players and the others had no sport training experiences. All the participants practiced 50 trials a day for 3 days. The task goal was to throw a ball to a target. The ball was placed in a cup attached to the dominant wrist of the participant. A high-speed camera and Kwon 2D motion analysis system were used to capture 2-d kinematics of the hip, shoulder, elbow, wrist, and the ball. Throwing outcomes, ball and throwing arms' release angles and velocities were used in modeling projectile motion, linear discriminant analyses, and canonical correlation analyses (CCA). **Results** We used the ball release angle (BA), velocity (BV), and height from the data to model the projectile motion of the ball, and the prediction of the hit rate was close to 98%. For basketball players, the "discriminant index" (DI) based on the shoulder angle (SA), shoulder velocities (SV), elbow angle (EA), and elbow velocity (EV) at ball release to differentiate "hit" or "miss" of the throws increased over 3 days from .62 to .78 ( $r^2 = .94$ ) whereas the non-basketball players had a similar DI range between .70 and .78 without significant trend ( $r^2 = .16$ ). The basketball players had large coefficient for all 4 variables whereas the non-basketball players tended to concentrate on the SA and EA. The canonical correlation analysis, which was used to examine the relation between the movement (SA, SV, EA, and EV) and the projectile motion (BA and BV) showed that joint angles, especially SA, and BA tended to have higher coefficients whereas the coefficients of SV, EV, and BV were relatively small. **Discussion** The throwing outcomes are determined by the ball release kinematics through the projectile motion equation. The results from CCA indicated that only BA was directly influenced by SA. The BV, on the other hand, did not show a linear relation with respect to any of the movement parameters. This indicates the nature of movement degeneracy in producing performance outcome. With an extended experience in basketball throwing, the basketball players explored all the available movement parameters over the 3 days of practice. The non-basketball players, however, mainly used the proximal SA to control the throwing movement. Movements of multi-segment coordination patterns require the multivariate analyses to fully examine the performance of different levels. Future research will continue to employ other multivariate methods in studying movement coordination issues.

## THE RELATIVE IMPORTANCE OF INTER- AND INTRA-INDIVIDUAL PATTERNS DURING ANTICIPATION

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**Introduction** In complex, time constrained environments anticipation is critical to successful performance. When anticipating in sport, perception of postural cues (intra-individual patterns; Diaz, Fajen, & Phillips, 2012) and relations between players (inter-individual patterns; Williams, North, & Hope, 2012) have been proposed as important perceptual-cognitive processes. Dittrich's (1999) interactive encoding hypothesis proposes that skilled performers perceive meaning by extracting relative motion between features to inform their actions. We examined the relative importance of intra- or inter-individual patterns during anticipation and how this varied as a function of task constraints. **Methods** Skilled and less-skilled soccer players completed anticipation paradigms in video-film and point-light display (PLD) format. Sequences were classified as either far or near based on how close the ball was to the participant when making the judgement. **Results** Skilled players ( $M = 58.33\%$ ,  $SD = 18.20$ ) were more accurate than less-skilled players ( $M = 36.11\%$ ,  $SD = 10.36$ ). There was a Skill x Display interaction. Skilled players had a greater advantage over less-skilled players in the video-film ( $M = 69.10\%$ ,  $SD = 13.57$  vs.  $M = 38.54\%$ ,  $SD = 9.77$ ) relative to the PLD condition ( $M = 47.57\%$ ,  $SD = 15.83$  vs.  $M = 33.68\%$ ,  $SD = 10.56$ ). Finally, there was a Display x Distance interaction. For video-film clips, there was no difference in accuracy between far and near tasks ( $M = 56.60\%$ ,  $SD = 21.28$  vs.  $M = 51.04\%$ ,  $SD = 17.26$ ), whereas, on the PLD clips, judgements were more accurate for the far than near task ( $M = 49.31\%$ ,  $SD = 14.31$  vs.  $M = 31.95\%$ ,  $SD = 10.03$ ). **Discussion** The skill advantage across conditions suggests skilled players can utilise information conveyed by inter-individual patterns during anticipation. However, intra-individual information from postural cues is important when

available to enhance anticipation. Anticipation is complex and made up of a number of different perceptual-cognitive skills. As proposed by Dittrich (1999), skilled performers extract relative motion information to perceive meaning, however whether this is processed locally (intra-individual relations between postural cues) or globally (inter-individual relations between players) is dependent on the task constraints under which anticipation occurs. References Diaz, G. J., Fajen, B. R., Phillips, F. (2012). *Journal of Experimental Psychology: Human Perception and Performance*, 38, 848-864. Dittrich, W. H. (1999). In, *Gesture-Based Communication in Human-Computer Interaction* (pp 3-22). Berlin, Heidelberg: Springer-Verlag. Williams, A. M., North, J. S., Hope, E. (2012). *The Quarterly Journal of Experimental Psychology*, 65, 1975-1992. Contact jamie.north@stmarys.ac.uk

## Oral presentations

### OP-PM17 Running Performance

#### EFFECTS OF STRENGTH, EXPLOSIVE AND PLYOMETRIC TRAINING PROTOCOL ON ENERGY COST OF RUNNING IN HIGH-LEVEL ULTRA-MARATHONERS

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**Introduction** Effects of strength, explosive and plyometric (SEP) training on endurance performance have been studied in different sport situations but there is a lack of information related to the effects of SEP training on ultra-marathoners. Thus, the aim of this study was to evaluate the effects of a 12-week SEP training protocol on the cost of running (Cr) in high-level ultra-marathoners and to define the causes of an eventual change in Cr. **Methods** Twenty-five male runners (38.2±7.1 years; BMI: 23.0±1.1 kg·m<sup>-2</sup>; VO<sub>2</sub>max: 55.4±4.0 mlO<sub>2</sub>·kg<sup>-1</sup>·min<sup>-1</sup>) were divided into an exercise (EG=13) and control group (CG=12). Before and after a 12-week SEP training protocol, Cr and spring-mass model parameters at 8, 10, 12, 14 km·h<sup>-1</sup> were calculated. Maximal muscle power of the lower limbs (MMP), morphological properties of the gastrocnemius medialis (GM) and triceps surae tendon stiffness (ktendon) were measured. **Results** In EG, Cr decreased significantly (p<0.05) at all tested running speeds by mean -4.2±1.5%, contact time (tc) increased at 8, 10 and 12 km·h<sup>-1</sup> by mean 4.4±0.1% and aerial time decreased by -25.6% at 8 km·h<sup>-1</sup> (p<0.05). Further, inverse relationships between changes in Cr and MMP at 10 (p=0.013; r=-0.67) and 12 km·h<sup>-1</sup> (p<0.001; r=-0.86) were shown. Conversely, no differences were detected in the morphological properties of the GM and ktendon. In CG no differences were shown in any of the studied parameters. **Discussion** 12-week SEP training program lower the Cr in high-level ultra-marathoners at submaximal speeds. For these athletes the small improvement in Cr (~4%) can lead to an important step forward in the rankings. In the present study stride length and stride frequency did not change after the training protocol, but tc increased, as shown by Ferrauti et al.(2010). According to the cost of generating force hypothesis (Kram and Taylor 1990), running with longer tc should be more economical, since it requires slower and less expensive fibers and the force is applied in a longer period of time. In agreement with this hypothesis the increased tc could in part explain the lower Cr. Further, an inverse relationship between changes in MMP and changes in Cr at 10 and 12 km·h<sup>-1</sup> suggests that athletes who slightly improved their MMP also decreased their Cr at submaximal speeds suggesting that MMP is an important parameter in determining Cr, as previously shown (Lazzer et al. 2015). **In conclusion**, we suggest to add at least three sessions per week of SEP exercises in the normal endurance-training program. **References** Ferrauti A, Bergemann M, Fernandez-Fernandez J (2010). *J Strength Cond Res*, 24, 2770-2778 Kram R, Taylor CR (1990). *Nature*, 346, 265-267 Lazzer S, Salvadeo D, Taboga P, Rejc E, Giovanelli N, di Prampero PE (2015). *Int J Sports Physiol Perform*, 10, 238-247 Contact nicola.giovanelli@uniud.it

#### THE BETTER THE DISTANCE RUNNER, THE MORE SLOW-TWITCH MUSCLE TYPOLOGY?

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**Introduction** Classical studies on histological analyses of muscle biopsies of elite athletes have revealed that sprint-type disciplines require a predominant fast-twitch (FT) muscle fiber type composition (MFTC), whereas athletes in endurance-type disciplines thrive on largely slow-twitch (ST) muscles. However, 1) this fundamental element in exercise physiology is in present day hardly used in scientific guidance of athletes, and 2) many questions still remain unanswered regarding optimal MFTC for different sport events. Both these limitations relate to the invasive nature of the muscle biopsy, making it inapplicable in elite sports. Recently, muscle carnosine quantification by proton magnetic resonance spectroscopy (1H-MRS) was developed as a new noninvasive method to estimate MFTC (Baguet et al., 2011). By applying this technology to a large group of elite athletes, we aim to answer unresolved questions such as 'Do short-distance swimmers need a predominant fast MFTC?' and 'Do international-caliber distance runners have a slower MFTC than national-level runners?'. **Methods** A total of 111 elite Belgian athletes (74 runners, 7 triathletes, 11 swimmers, 14 cyclists and 5 kayakers) were recruited to measure muscle carnosine content in gastrocnemius and deltoid muscle by 1H-MRS on a 3T scanner. Carnosine is a typical FT metabolite and high concentrations of carnosine correspond to a fast MFTC. Athletes were compared to a gender- and age-matched reference population (n=188). **Results** Across the different sports disciplines, carnosine content showed the strongest significant correlation with cyclic movement frequency (R = 0.86, P = 0.001), though no significant correlation was found between the carnosine content and performance duration (R = -0.58, P = 0.06). Thus, swimmers—even those who compete in short events—have a more ST muscle typology than corresponding runners and cyclists. Interestingly, there was no difference in carnosine content between the international- and the national-level endurance runners (P = 0.89). The opposite was found in sprinters, as international-level athletes were characterized with higher carnosine levels than national-level athletes (P = 0.05). **Discussion** Cyclic movement frequency, rather than exercise duration came out as a factor best related to the optimal estimated MFTC in elite athletes. A more extreme MFTC seems more important to excel in sprint running than in endurance running. Our findings suggest that MR-based non-invasive estimation of MFTC can have important applications in elite sports. **References** Baguet A, Everaert I, Hespel P, Petrovic M, Achten E, Derave W. (2011). *PLoS ONE*, 6, e21956 Contact E-mail: elielieve.lievens@ugent.be



## PACE VERSUS PREDICTION: IMPLICATIONS OF AGE, EXPERIENCE AND SEX ON MARATHON RACE PERFORMANCE

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**PURPOSE:** Pacing strategies during exercise are attributed to optimizing the balance between the artifacts of fatigue and regulation of substrate metabolism. Pace judgement is set within a continuum of information from the ability to anticipate metabolic demands and select an appropriate strategy through to the accumulation of prior experience for completion of such a task that has a known end-point. Therefore the purpose of this study was evaluate the factors which contribute to successfully regulating pace and attaining a predicted end time during a marathon. **METHOD:** Following local institutional ethical approval n= 777 runners competing in the 2015 London Marathon of which n= 393 were females and n= 384 were males participated. Using an on-line survey and opportunistic questionnaires at a pre-marathon event participants were asked to predict their race time. Athlete experience (EXP) was established based on the number of previously completed marathons using a Likert scale from 0 to greater than 10 with increments of 1 race. Age was stratified according to those adopted by the marathon organizers: 18-39yrs, 40-49yrs, 50-59yrs and >60yrs. 5Km split times were converted to speed and normalized (%) to the final split time/speed (m.s<sup>-1</sup>). Prediction time (PT) was used a proxy for end-point and compared to finish time (FT). **RESULTS:** FT for whole group (WG) was 15479 ± 3311s compared to the group PT 15003 ± 2972s a significant difference of 476s (P= 0.0001). An R<sup>2</sup> of 0.863 observed for WG compared to 0.799 (0-EXP) and 0.852 (EXP-5) when comparing FT to PT. 0-EXP showed significant difference across all split times apart from 35-40 km (P=0.0001) with a decrease in normalized speed from 5km (109.0 ± 7.6) – 40km (89.9 ± 7.4%). The 5-EXP group showed significant changes in pace between 25-30 km (P= 0.001) (ES =0.35), 30-35 km (P= 0.0001) (ES= 0.44) and 35-40 km (P= 0.0001), decrease in pace from 5km (105.0 ± 5.7%) to 40km (93.7 ± 5.6%). Large effect sizes (ES) observed for 18-39yrs at 30-35km (r= 0.370), 40-49yrs at 30-35km (r= 0.337), 50-59yrs at 25-30km (r= 0.368) and 30-35km (r= 0.418) and >60yrs at 30-35km (r= 0.527). A significant difference (P= 0.0001) of 476s was observed between PT and FT for the whole group compared to differences of 531 s (p= 0.000) and 419s (P= 0.000) for the males and females respectively. **CONCLUSIONS:** These data suggest that successful marathon pacing is dependent on the experience of the athlete reflecting the development of the pacing template. Additionally experience is associated with better attainment of prediction time suggesting that less experienced runners should run with more experienced athletes with similar end-point targets.

## LACTATE MINIMUM OF THE HEART RATE-BASED LACTATE MINIMUM TEST HIGHLY PREDICTS 10K AND HALF-MARATHON RUNNING PERFORMANCE IN MEN AND WOMEN

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**Introduction** Some years ago, the so-called heart rate-based lactate minimum test (LMT-HR) developed at our institute (Strupler et al., 2009) revealed a high correlation between lactate minimum (LM) and the maximal lactate steady-state (MLSS) in wheelchair racing (Perret et al., 2012), which makes this test feasible to determine individual training intensity zones. However, it remains still unclear, if this test is also suitable to estimate endurance race performance in able-bodied sports such as running. Thus, the aim of the present study was to investigate, whether 10k and half-marathon performance can be predicted based on a LMT-HR in male and female runners over a wide range of performance levels. **Methods** 30 participants (13 male / 17 female) performed a LMT-HR on a treadmill according to the protocol of Strupler et al. (2009). Additionally, they completed a 10k and a half-marathon race at the highest possible pace on a flat track on two separate occasions at least 5 days apart. During these races, runners were regularly informed about the distance covered, but were not aware of race pace or heart rate. For statistical analysis Spearman correlations for speed data at LM versus average speeds during the 10k and half-marathon run were calculated for male and female runners separately. **Results** The present study included 13 men (age: median [minimum; maximum] 38y [25;47]; height: 181cm [170;186]; body mass: 75.0kg [63.0;86.0]; VO<sub>2</sub>peak: 54.1ml/min/kg [42.3;66.0]) and 17 women (age: 33y [24;44]; height: 167cm [161;180]; body mass: 58.0kg [50.0;70.0]; VO<sub>2</sub>peak: 51.4ml/min/kg [41.1;61.2]). Race times for the 10k ranged between 36:02min and 56:36min and for the half-marathon between 79:36min and 128:59min, respectively. Highly significant correlations between speed at LM vs. 10k speed in men (r=0.875; p<0.001) and women (r=0.916, p<0.001) as well as between speed at LM vs. half-marathon speed (men: r=0.873, p<0.001; women: r=0.924, p<0.001) were found. **Conclusions** Results of the LMT-HR allow an accurate prediction of 10k and half-marathon race performance in male and female runners based on a single exercise test. Thus, in daily clinical practice the LMT-HR seems to be a very useful tool for sport scientists and coaches not only to determine individual training intensity zones but also to estimate the actual athletes' running performance potential over a wide range of fitness levels. **References** Perret C, Labruyère R, Mueller G, Strupler M. (2012). Correlation of heart rate at lactate minimum and maximal lactate steady state in wheelchair-racing athletes. *Spinal Cord* 50: 33-36. Strupler M, Mueller G, Perret C. (2009). Heart rate-based lactate minimum test - a reproducible method. *Br J Sports Med* 43: 432-436.

## QUALITATIVE RESPONSES TO ANAEROBIC EXERCISE BOUTS

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**Introduction** Qualitative measures such as Rate of Perceived Exertion (RPE) and questionnaires can be quick and inexpensive methods to monitor training load and training load responses<sup>1</sup>. This study aimed to report the difference in RPE response to a low, moderate and high anaerobic exercise bout and to assess if responses to a modified neuromuscular fatigue questionnaire (NMFQ)<sup>2</sup> change over time dependent on different anaerobic loads. **Methods** Recreationally trained participants (n=6; 23.2±1.2y; 1.71±0.07m; 71.5±9.7kg) completed in a low (2sets), moderate (4sets) and high (6sets) load repeat sprinting protocol. Participants completed the load trials in randomised order with a minimum of 96h between trials. Following a standardised warm-up the repeat sprint running protocol consisted of multiple sets of 10x20m sprints on a 20s cycle, each with a 180s inter-set rest period. At the completion of each set participants provided an RPE score using the Borg CR10 rating scale. The NMFQ was completed prior to and then at 3, 6, 24 and 48h post trial. RPE and NMFQ scores were analysed using individual one-way repeated (conditions or time) measures ANOVA with LSD post hoc. A Pearson's correlation was used to examine the relationship between RPE and NMFQ. Due to the small sample size level and to avoid a type I error significance was accepted at p≤0.1. **Results** A significant interaction effect was observed between conditions (p=0.009) for RPE, with post hoc tests indicating a significant difference between low (p=0.003) and moderate (p=0.022) with the high condition. A significant interaction was observed for NMFQ over time in all conditions (low p=0.093; mod p=0.024; high p=0.046). Pre NMFQ scores ranged between 0-4, 1-7, and 0-5 for low, moderate and high respectively. Mean (min-max) peak NMFQ scores following low were 14 (0-14) at 48h post, while moder-

ate (13; 5-13) and high (19; 4-19) both occurred 24h following the exercise protocol. Post hoc testing revealed a significant increase in NMfQ scores from the pre time point, furthermore in high condition NMfQ scores continued to increase significantly from 3h to 24h. There was no significant relationship between RPE and NMfQ responses for low ( $r=-0.5-0.1$ ) moderate ( $r=0.3-0.6$ ) and high ( $r=-0.2-0.4$ ). Discussion The results suggest that RPE measures are sensitive to changes in anaerobic loads resulting from repeat sprints. The observation that there was no correlation between RPE and the NMfQ score over time suggests a modified NMfQ has the potential to be a useful tool to monitor neuromuscular fatigue responses to training up to 48h post exercise. References 1. Coutts, A. J., et. al., (2007). J of Sci Med Sport 2. Perica, S., et. al., (2011). J Neurol Res

## Oral presentations

### OP-PM64 Cardiovascular Pathologies

#### EFFECTS OF POST-EXERCISE COOLING ON HEART RATE RECOVERY IN NORMOTENSIVE AND HYPERTENSIVE MEN

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**Introduction** Post-exercise heart rate recovery (HRR) is regulated by several mechanisms, including thermoregulation. The exercise-induced increase in core temperature (Tc) is partly responsible for the maintenance of elevated heart rate during recovery. Hence, strategies able to reduce Tc after exercise might be effective in accelerating HRR. This effect is particularly relevant for subjects with hypertension who have delayed HRR. Thus, this study aimed to verify the effects of post-exercise cooling on HRR after exercise in normotensive (NT) and hypertensive (HT) men. **Methods** 25 NT (43±8 years, 28.6±2.7 kg/m<sup>2</sup>, 114±4/77±2 mmHg) and 23 HT (45±8 yrs, 29.4±3.6 kg/m<sup>2</sup>, 142±8/96±3 mmHg) men randomly underwent 2 exercise sessions (30 min cycling at 70% VO<sub>2peak</sub>) followed by 15 min of recovery. In one session, a fan was turned on in front of the subjects during the recovery period (cooling session), while in the other session, no cooling was performed (control session). ECG, photoplethysmographic blood pressure and Tc (ingestible pills) were recorded. HRR was assessed by: heart rate reduction after 60 (HRR60s) and 300s (HRR300s) of recovery, the short-term time constant of HRR (T30), and the time constant of the HRR after exponential fitting (HRR<sub>t</sub>). Heart rate variability (HRV) was assessed in the first 5 min of recovery by time-domain indices (RMS and RMSSD), at rest and 10-15 min of recovery by spectral analysis (low and high frequency components; LF and HF). Spontaneous baroreflex sensitivity (BRS, sequence technique) was also assessed at rest and during recovery. Two- (group vs. session) and three-way (group vs. session vs. time) ANOVAs were employed ( $p \leq 0.05$ ). **Results** There were no differences between groups for any of the main outcomes. In both groups, post-exercise cooling reduced Tc (37.5±0.3 vs. 37.6±0.3 °C,  $p<0.05$ ). HRR300s was higher (39±12 vs. 36±10 bpm,  $p<0.05$ ) and T30 was lower (213±85 vs. 284±135 s,  $p<0.05$ ) in the cooling session. With respect to the HRV indices, RMS, RMSSD and HF were higher (2.6±0.6 vs. 2.4±0.6 ms, 1.8±0.7 vs. 1.6±0.7 ms, 16.2±17.1 vs. 11.0±7.5 nu, respectively,  $p<0.05$ ) and LF was lower (82.6±14.4 vs. 86.1±10.8 nu,  $p<0.05$ ) in the cooling session. **Conclusion** In NT and HT men, post-exercise cooling with a fan decreases Tc and accelerates HRR. This HRR response is accompanied by an acceleration of parasympathetic reactivation and sympathetic withdrawal during the recovery period. **Funding:** FAPESP 2013/04997-0, 2013/05519-4, 2015/15466-0.

#### QTC INTERVAL IN ADOLESCENTS AND YOUNG ATHLETES: METHODOLOGICAL CONSIDERATIONS AND INFLUENCE OF CORRECTION FORMULAS

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**BACKGROUND.** A challenging problem in the pre-participation screening of young athletes is the finding of rate-corrected QT interval (QTc) at the upper limits in the electrocardiogram. Regardless factors potentially able to influence this parameter (age, sex, electrolytes, conduction abnormalities etc.), several authors underlined how often correction formulas fail to properly correct QT interval, especially for upper normal limits (440-460 msec). Furthermore, from literature review, it seems that different formulas comply differently depending on populations analyzed (pediatric, heart patients etc). Our goal was to identify the most reliable rate-correction formula and relative reference values (RV) for adolescents and young, healthy, male athletes. **METHODS.** Rest-ECG of 701 healthy elite male athletes (aged 9-35) were analyzed. QTc was calculated with the most utilized formulas (Bazett, Fridericia, Framingham, Hodges). Regression analysis (Slope), correlation coefficients (R) of QTc/heart rate (HR) and RV for each formula were calculated and compared overall (TOT) and considering 3 different age groups (A: 9-12, B: 13-17, C: 18-35). **RESULTS.** R values were: Bazett 0.56(TOT), 0.52(A), 0.60(B), 0.34(C); Fridericia 0.02(TOT), 0.03(A), 0.12(B), -0.13(C); Framingham -0.78(TOT), -0.74(A), -0.74(B), -0.72(C); Hodges -0.10(TOT), 0.08(A), -0.01(B), -0.33(C). Slopes were: Bazett 1.04(TOT), 0.98(A), 1.23(B), 0.83(C); Fridericia 0.02(TOT), 0.52(A), 0.20(B), -0.31(C); Framingham -1.91(TOT), -1.63(A), -1.77(B), -2.62(C); Hodges -0.16(TOT), 0.11(A), -0.02(B), -0.87(C). RV were: Bazett 358-455msec; Fridericia 364-439msec; Framingham 336-455msec; Hodges 366-442msec. **CONCLUSIONS.** Fridericia's formula seems to be the most reliable and the less influenced by age ( $p<0.05$ ) for QT rate-correction in young male athletes (RV 360-440 msec), and should be routinely used in this population. QTc values obtained with the Bazett's formula appear considerably dependent by HR (even in the "optimal range" of 60-90 bpm), overestimated at higher HR (5% of QTc>440 msec, of which 96% at HR>60 bpm, 84%>70 bpm) and underestimated at lower ones. Framingham's formula shows similar limits, but in an inverse way. Hodges' formula offers a good overall performance, but shows significant dependence from age. **REFERENCES** Luo S et al. A comparison of commonly used QT correction formulae: The effect of heart rate on the QTc of normal ECGs. J Electrocardiol. 2004;37:81-90 Rautaharju PM et al. New age- and sex-specific criteria for QT prolongation based on rate correction formulas that minimize bias at the upper normal limits. Int J Cardiol. 2014 Jul 1;174(3):535-40 Phan DQ et al. Comparison of formulas for calculation of the corrected QT interval in infants and young children. J Pediatr. 2015 Apr;166(4):960-4 Chiladakis J et al. Heart rate-dependence of QTc intervals assessed by different correction methods in patients with normal or prolonged repolarization. Pacing Clin Electrophysiol. 2010 May;33(5):553-60

## ARE AEROBIC INTERVAL TRAINING AND CONTINUOUS TRAINING ISOCALORIC IN CORONARY ARTERY DISEASE PATIENTS?

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**BACKGROUND:** Aerobic interval training (IT) seems to be superior to continuous training (CT) in improving exercise capacity (peak VO<sub>2</sub>) in coronary artery disease (CAD) patients in some, but not in all studies. Based on theoretical calculations, these comparative studies stated that the energy expenditure (EE) of both programs is similar. To date, the calorificity of both programs has never been objectively measured. Therefore, our aim was to objectively measure the EE of the IT and CT programs described in the protocol of the SAINTEX-CAD study (based on Wisloff et al.; ITw - CTw), and the actually performed training intensities in the SAINTEX-CAD study by Conraads et al. (ITc - CTC). Wisloff et al. found a superior effect of IT, while the SAINTEX-CAD study by Conraads et al. reported that IT and CT were equally effective. **METHODS:** Eighteen male CAD patients (mean age 62.4±6.1 years) performed a two week run-in period with three IT and three CT training sessions on a cycle ergometer. The IT session included a 10 min warm-up, 4 bouts of 4 min at a higher intensity, alternated by 4 periods of 3 min at a lower intensity (total exercise time 38 min). The CT session included a 5 min warm-up, a 37 min bout at a constant intensity, and a 5 min cool-down (total exercise time 47 min). After the familiarisation period, 4 training sessions were performed in random order: an ITw (90-95% of peak heart rate (HR)), CTw (70-75% peak HR), ITc (88% of peak HR) and CTC (80% of peak HR) test. The EE was assessed by indirect calorimetry using gas exchange measures obtained with the Oxycon™ mobile. **RESULTS:** We found a higher EE for CTC compared to ITc (352±90.8 kcal versus 269±70.7 kcal; p=0.026), while CTw and ITw seemed to be isocaloric (317±85.2 kcal versus 273±65.3 kcal; p=0.42). Higher lactate levels were reached after IT sessions (ITw 5.42±1.42 mmol/l, ITc 5.05±1.38 mmol/l) compared to CT sessions (CTw 2.45±1.04 mmol/l, CTC 3.41±1.44 mmol/l) (p<0.01). Lactate levels during the training session increased above baseline levels (1.91±0.34 mmol/l) except for the CTw session. **CONCLUSION:** CTC expended significantly more energy than ITc, showing that the programs used in the SAINTEX-CAD study were not isocaloric. In contrast, isocaloricity was met for CTw and ITw. In the SAINTEX-CAD study, both programs were equally effective in increasing peak VO<sub>2</sub>, but it seems that a lower EE was needed with IT in order to achieve similar improvements as CT. We can thus suggest that the efficacy of IT is higher than CT.

## ASSESSING FREE-LIVING WALKING IMPAIRMENT IN PERIPHERAL ARTERY DISEASE PATIENTS BY OBJECTIVELY QUANTIFYING WALKING PAIN OCCURRENCE: DEFINITION OF A METHODOLOGY USING PHYSICAL ACTIVITY MONITORS

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**Introduction** A high proportion (~50 to 80%) of peripheral artery disease (PAD) patients experience ischemic pain in the lower extremities whilst walking, which forced them to stop in most cases. Although walking pain occurrence can be objectively assessed in laboratory during a treadmill test, no objective free-living assessment has been yet performed. Using physical activity (PA) monitors, our aim was to develop a method to objectively quantify in free-living conditions walking pain occurrences and stops induced by ischemic pain in PAD patients. **Methods** Fifteen PAD patients (defined by an ankle-brachial index ≤0.90) limited by ischemic walking pain wore a wGT3X+ accelerometer and a Micro Motion logger watch for 7 days (NCT02041169). Patients had to push a button on the watch (marker event) to report the onset of walking pain and the stop induced by the pain. In addition, patients completed a PA diary on a daily basis. We have developed an algorithm to appropriately assign to each recorded marker event the following: i) walking pain occurrence; ii) stop induced by walking pain; iii) inconsistent event (error). For this purpose, downloaded data from the wGT3x+ were analyzed using conventional handling procedure (Choi et al., 2011) and then used to discriminate walking and sedentary periods. Consistent marker events were assigned to walking pain occurrences or stops induced by walking pain using the number of counts/sec (Vector Magnitude). Diaries were scored with the Compendium of PAs and used to identify indoor/outdoor conditions. **Results** The algorithm developed allows quantifying walking pain occurrences and stops induced by walking pain in outdoor conditions. However it didn't allow distinguishing walking pain from walking stop in indoor conditions because of the intermittent nature of the walk with very short bouts. When applying this algorithm among the 15 PAD patients, we highlighted that, on average, patients experienced pain six times per week in outdoor conditions and this pain led the patients to stop in half of the cases. In indoor conditions, on average 6 marker events per week were recorded. **Discussion** The objective assessment of walking pain occurrences and walking stops induced by ischemia in free-living environment could provide interesting clinical information on patients' walking impairment. **References** Choi L (2011). *Medicine and Science in Sports and Exercise*, 43(2), 357–364. Contact segolenechaudru@wanadoo.fr Authors thank the University of Rennes which granted a funding (CORECT) and the "Region Bretagne, bourse ARED.

## Oral presentations

### OP-PM23 Performance Testing

#### INTERNAL- AND EXTERNAL-TRAINING LOAD MEASURES DURING VARIOUS CRICKET TRAINING MODALITIES

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**Introduction** The use of session rating of perceived exertion (sRPE) has become common practice in recent years to monitor the training load (TL) of elite athletes and teams. However, as noted by Weaving et al. (2014) the monitoring of TL in team sports can be difficult due to the various training forms and modes undertaken. Training within cricket typically involves net-based and conditioning sessions, though more recently, game-based scenarios are increasingly prevalent. Given the lack of information regarding the monitoring of TL amongst cricket players, this study aimed to examine the relationship between measures of TL and the training mode used within a cohort of elite cricket fast bowlers. **Methods** Following net-based cricket (n=51), game-simulated centre-wicket (n=16) and conditioning sessions (n= 27) in eleven elite, fast bowlers (23.3 ± 4.8 y; 1.88 ± 0.08 m; 85.6 ± 8.34 kg), TL was calculated by multiplying rating of perceived exertion (RPE: CR-10) by the session duration (in minutes). Internal-TL was further quantified using heart rate devices (HRmean, TRIMP), whilst exter-

nal-TL was quantified via 10 Hz GPS devices, along with the number of balls bowled per session using video analysis. Pearson's product moment correlations were calculated between sRPE and measures of internal- and external-TL for each training mode. Results A small correlation ( $r = -0.29$ ) existed between mean heart rate and sRPE during net-based sessions, however no other significant ( $P > 0.05$ ) correlations were reported between sRPE and other internal measures of TL (HRmean, TRIMP) across any training mode. Large to almost perfect correlations were evident between sRPE and GPS-based measure of external-TL, particularly total overall distance covered ( $r = 0.87-0.91$ ) and distance at low-intensity ( $r = 0.87-0.93$ ). A significant correlation ( $P > 0.05$ ,  $r = 0.68$ ) between the number of balls bowled and sRPE existed, but only during net-based training. Discussion The results suggest that a similar relationship between both internal- and external-TL exists across the various cricket training modes for fast bowlers. Regardless, internal measures of TL displayed a small or non-significant associations with sRPE, which may result from the activity pattern of fast bowling. Small variations in GPS-derived measures of external-TL were noted across all training modes, suggesting sRPE is a valid measure for monitoring the workload of cricket fast bowlers across a range of cricket training modes. References Weaving D, Marshall P, Earle K, Nevill A, Abt G (2014) Int J Sports Physiol Perform, 9, 905-912. Contact Dr Will Vickery [will.vickery@northumbria.ac.uk]

## PHYSIOLOGICAL AND PERCEPTUAL RESPONSES TO COMBINED ARM-LEG ERGOMETRY AT SELF-ED AND IMPOSED WORKLOADS

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Introduction For the same relative exercise intensity, combined arm-leg ergometry appears to be more readily tolerated than arm or leg training alone, likely due to the greater active muscle mass. The addition of arm crank ergometry (ACE) to cycling (CYC) increases oxygen uptake with no greater cardiovascular or subjective strain (Gutin et al. 1988) however, specific mechanisms are as yet unknown. To clarify our understanding of the physiological and subjective responses to work of this type, we compared exercise responses during self-selected (SS) and imposed (IMP) workloads. Methods A pilot group of five males initially undertook incremental exercise tests to volitional exhaustion for ACE ( $133 \pm 23$  W) and CYC ( $232 \pm 32$  W) to determine peak minute power (WPEAK). Subsequent tests involved 20-min combined ACE+CYC trials at SS and IMP intensities. During IMP, intensity was set at 40% of each ergometer-specific WPEAK. Participants were asked to maintain a cadence of 70 rev·min<sup>-1</sup> for both the arms and legs as for the preliminary tests. During SS, participants were asked to self-select cadence and adjusted workload every 5 min to achieve an exercising heart rate of  $\sim 160$  beats·min<sup>-1</sup>. All participants were fully familiarised to A+L exercise. Heart rate (HR), oxygen uptake (VO<sub>2</sub>), minute ventilation (VE) and central ratings of perceived exertion (RPE) were recorded continuously. Results Despite similar power outputs during SS (ACE;  $39 \pm 8$ , CYC;  $88 \pm 14$  W) and IMP (ACE;  $48 \pm 9$ , CYC;  $94 \pm 15$  W) trials, physiological responses were generally greater for IMP (HR;  $172 \pm 4$  beats·min<sup>-1</sup>, VO<sub>2</sub>;  $2.14 \pm 0.41$  L·min<sup>-1</sup> and VE;  $71.0 \pm 9.85$  L·min<sup>-1</sup>) compared to SS (HR;  $163 \pm 4$  beats·min<sup>-1</sup>, VO<sub>2</sub>;  $1.95 \pm 0.32$  L·min<sup>-1</sup> and VE;  $60.9 \pm 9.84$  L·min<sup>-1</sup>). Central RPE was similar between trials (SS;  $12 \pm 2$ , IMP;  $13 \pm 2$ ). For the SS trial, relative VO<sub>2</sub> was  $73 \pm 11$  % and  $62 \pm 7$  % of the VO<sub>2</sub>peak achieved during maximal arm and leg tests, respectively. Similarly, relative HR was  $91 \pm 2$  % and  $82 \pm 2$  % of HRMAX achieved during incremental arm and leg trials, respectively. For the final SS intensity, cadence was  $60 \pm 5$  and  $64 \pm 5$  rev·min<sup>-1</sup> for ACE and CYC, respectively. Load was increased by  $\sim 0.2$  Kg for CYC and reduced by  $\sim 0.1$  Kg for ACE. Discussion The results indicate that when participants self-select exercise intensity during combined arm-leg ergometry, they chose work rates eliciting metabolic and cardiovascular stimuli which are within the moderate range of ACSM guidelines for lower limb exercise. During SS there was a preference to reduce cadence. This study provides evidence that individuals are able to self-select a combined arm-leg training intensity that not only feels comfortable, but also falls within the training range which is expected to improve cardiovascular conditioning.

## EFFECTS OF SHORT-WAVE LIGHT ON ANAEROBIC PERFORMANCE

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Overview Short-wavelength light (450-495nm) is perceived by humans as blue and is known to stimulate biological functions. Blue light interventions enhance cognitive function and reaction times (Beaven & Ekström, 2013) and affect brain areas associated with arousal and circadian rhythmicity (Rautkylä, Puolakka, & Halonen, 2011). Exposure to short-wavelength light has been reported elevate testosterone and increase lean muscle mass (Cao et al., 2008). Testosterone has been suggested to be acutely linked to power production (Crewther, Cook, Cardinale, Weatherby, & Lowe, 2011). Hence, we investigated whether exposure to short-wavelength light could impact performance in an anaerobic power test. Methods 21 healthy volunteers performed a 30s Wingate test on a Monark friction-braked ergometer against a resistance of 0.075kg/kgBW immediately following a 60min exposure to either a blue LED light source (470 nm) or a white light alternative. Relative peak, average, and minimum power data was collected, as well as percentage power decrease. Results There were no differences between the peak power or average power but the minimum power was clearly higher in the blue light condition (5.53 vs. 4.99W/kg; Effect Size: 0.49±0.59). As a result, the power decrease was lesser in the blue light condition (50.7 vs. 55.6%; Effect Size: 0.39±0.59). Conclusions It was apparent that the 60min exposure to blue LED lighting was capable of improving fatigue resistance exercise performance in a test of anaerobic power. While the mechanism is unclear, there is potential for short-wavelength light to manipulate athletic performance via direct visual input to the limbic and arousal system. Beaven, C. M., & Ekström, J. G. (2013). A comparison of blue light and caffeine effects on cognitive function and alertness in humans. PLoS One, 8(10), e76707. Cao, J., Liu, W., Wang, Z., Xie, D., Jia, L., & Chen, Y. (2008). Green and blue monochromatic lights promote growth and development of broilers via stimulating testosterone secretion and myofiber growth. The Journal of Applied Poultry Research, 17(2), 211-218. Crewther, B. T., Cook, C., Cardinale, M., Weatherby, R. P., & Lowe, T. (2011). Two emerging concepts for elite athletes: the short-term effects of testosterone and cortisol on the neuromuscular system and the dose-response training role of these endogenous hormones. Sports Medicine (Auckland, NZ), 41(2), 103-123. Rautkylä, E., Puolakka, M., & Halonen, L. (2011). Alerting effects of daytime light exposure – a proposed link between light exposure and brain mechanisms. Lighting Research and Technology, 44(2), 238-252.

## MATCHING OF OXYGEN DELIVERY AND UTILIZATION DURING INCREMENTAL CYCLING EXERCISE

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Introduction The ratio of relative changes in deoxygenated hemoglobin and oxygen uptake ( $\Delta\text{HHb}/\Delta\text{VO}_2$ ) has recently been used as a marker for the dynamic balance of microvascular matching of oxygen delivery and utilization (DeLorey et al., 2004; Murias et al., 2010).



Low values therefore indicate a good matching of oxygen delivery and utilization.  $\Delta\text{HHb}/\Delta\text{VO}_2$  showed to be primarily dependent on microvascular perfusion, which in turn is dependent on local vasodilation. The aim of this study was to examine the matching of oxygen delivery and utilization in relation to exercise intensity during incremental cycling exercise. Methods 20 men ( $\text{VO}_2\text{peak}$   $50.3 \pm 5.7 \text{ ml} \cdot \text{kg}^{-1} \cdot \text{min}^{-1}$ ) participated in the study. The experimental session consisted of an incremental exercise test to exhaustion on a cycle ergometer (Lode Excalibur, Groeningen, NL) starting with 60W and increasing intensity by 10 W every minute. Relative changes in HHb were measured noninvasively with a continuous wave near-infrared-spectroscopy (NIRS) device (portamon, Artinis, Zetten, NL), placed on the vastus lateralis muscle.  $\text{VO}_2$  was measured using a metabolic cart (ZAN 600USB; Nspire Health, Oberthulba, Germany).  $\Delta\text{HHb}/\Delta\text{VO}_2$  ratio was calculated for the exercise intensities corresponding to 40%, 50%, 60%, 70%, 80% and 90%  $\text{VO}_2\text{peak}$ . A repeated-measures-design ANOVA was used to compare the effects of the various intensities on  $\Delta\text{HHb}/\Delta\text{VO}_2$  ratio. Results ANOVA reported a significant main effect ( $P = 0.004$ ). Post hoc tests showed a significantly rising  $\Delta\text{HHb}/\Delta\text{VO}_2$  ratio from 40% to 60%  $\text{VO}_2\text{peak}$  ( $P \leq 0.03$ ) while no further change could be observed above 60%  $\text{VO}_2\text{peak}$ . Discussion These results suggest that the matching of oxygen delivery and utilization gets impaired from 40% to 60%  $\text{VO}_2\text{peak}$  but remains stable thereafter. Apparently, local muscle perfusion counteracts the increased metabolic demand more effectively above 60%  $\text{VO}_2\text{peak}$ . References Delorey DS, Kowalchuk JM, Paterson DH. Effect of age on  $\text{O}_2$  uptake kinetics and the adaptation of muscle deoxygenation at the onset of moderate-intensity cycling exercise. *Journal of Applied Physiology* (2004); 97: 165–172. Murias JM, Kowalchuk JM, Paterson DH. Speeding of  $\text{VO}_2$  kinetics with endurance training in old and young men is associated with improved matching of local  $\text{O}_2$  delivery to muscle  $\text{O}_2$  utilization. *Journal of Applied Physiology* (2010); 108: 913–922. Contact fabian.stoecker@tum.de

## HEART RATE RECOVERY AFTER A 60M SPRINT TEST IS FASTER WHEN $\text{VO}_2\text{PEAK}$ IS HIGH

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Introduction The quick recovery of many physiological parameters is an important determinant of cardiorespiratory fitness (Coote, 2009). Particularly, oxygen consumption kinetics at the start and after intense dynamic exercise have been well explored (Borresen & Lambert, 2008), often in relation with the maximum aerobic power ( $\text{VO}_2\text{peak}$ ). Less attention has been given so far to heart rate (HR) kinetics after maximal effort. We here use a simple test, a short sprint running, suitable to check the relationship between a speed index of heart rate recovery, namely the time interval to reach 50% of the difference with the basal HR ( $\text{toff-HR}_{\text{sprint}}$ , s) and  $\text{VO}_2\text{peak}$  in active and sedentary subjects. Methods Sixteen individuals subdivided in sedentary (SED,  $n=8$ ;  $26.3 \pm 8.0$  years,  $72.1 \pm 12.6$  kg,  $174.0 \pm 12.5$  cm) and active (ACT,  $n=8$ ;  $25.4 \pm 3.5$  years,  $68.5 \pm 6.0$  kg,  $178.0 \pm 7.2$  cm) undertook both a 60-m sprint test on firm terrain to obtain  $\text{toff-HR}_{\text{sprint}}$  by sampling HR recovery in orthostatism and, after 10 min rest, an incremental cardiopulmonary test on a treadmill to determine the  $\text{VO}_2\text{peak}$  and  $\text{VO}_2$  off kinetics ( $\text{toff-VO}_2$ , s) defined similarly as for HR. A Student's  $t$  test checked differences in SED and ACT groups among  $\text{toff-HR}_{\text{sprint}}$ ,  $\text{toff-VO}_2$  and  $\text{VO}_2\text{peak}$ . A Pearson's product-moment test was used to assess correlation between variables. Results When compared to SED, ACT group presented significantly higher values for  $\text{VO}_2\text{peak}$  ( $p < 0.001$ ) and lowered for  $\text{toff-HR}_{\text{sprint}}$  ( $p = 0.006$ ), whereas  $\text{toff-VO}_2$  was similar in the two groups ( $p = 0.702$ ). When considered separately SED and ACT groups did not show significant pairwise correlations among  $\text{toff-HR}_{\text{sprint}}$ ,  $\text{toff-VO}_2$  and  $\text{VO}_2\text{peak}$ . Differently, when pooling all subjects,  $\text{toff-HR}_{\text{sprint}}$  and  $\text{VO}_2\text{peak}$  showed a significant correlation ( $r = -0.64$ ,  $p = 0.008$ ). Discussion  $\text{toff-VO}_2$  was similar between groups despite of different training levels, although  $\text{toff-VO}_2$  depends on several factors, as mitochondrial density, oxidative enzyme activity and lactate removal, which are likely affected by training (Dupont et al., 2010). The  $\text{toff-HR}_{\text{sprint}}$  and  $\text{VO}_2\text{peak}$  did show significant (negative) correlation only when all subjects data were pooled, indicating that HR variability needs a high sample size to reveal reliable relationships with  $\text{VO}_2\text{peak}$ . The present analysis of HR recovery has the potential to indirectly estimate individual  $\text{VO}_2\text{peak}$ . Further studies involving different sample sizes, heart rate off-kinetics at shorter maximal tests, as well as other groups of subjects, could check the stability of the obtained parameters and refine its applied physiological relevance. References Borresen J, Lambert MI. *Sports Med* 38: 633–646, 2008. Coote JH. *Exp Physiol* 95: 431–440, 2009. Dupont G, McCall A, Prieur F, Millet GP, Berthoin S. *Eur J Appl Physiol* 110: 627–634, 2010.

## Oral presentations

### OP-PM44 Inflammation & Stress Response

#### INFLAMMATORY BALANCE OF CYTOKINES: RESPONSES TO EXERCISE IN MASTER ATHLETES

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The kinetics of cytokine production may be changed by exhaustive exercise. Exercise stimulates moderate to large increases in circulating concentrations of interleukin (IL)-6, IL-8, IL-10, IL-1ra, G-CSF, and smaller increases in TNF- $\alpha$ , MCP-1, IL-1beta, BDNF, IL-12p35/p40 and IL-15 (Peake, 2015). Aging is often associated with low-grade systemic inflammation predisposing older individuals to an increased risk of chronic diseases. The aim of this study was to compare the cytokine production and the influence of aging in the pro and anti-inflammatory cytokine balance. Participants ( $n = 38$ ) were divided into 3 groups: Young ( $n = 8$ ), Old ( $n = 10$ ) and Master athletes ( $n = 20$ ). The young and old groups were not involved in any systematic exercise practice, while the inclusion criteria for the Master athletes was a minimum of 20 years in competitive sport. All subjects performed a maximal incremental test in a cycle ergometer. Blood samples were obtained before (PRE), 10 minutes into recovery (POST) and 1 hour after the test (1HR).  $\text{VO}_2\text{max}$  levels were similar for Master athletes and the Young group, both groups showing the highest values (absolute and relative) when compared to the Old group. Cytokine concentrations of IL-1ra, IL-1beta and IL-8 were higher at all times for the Master group (compared to the Young and Old groups,  $P < 0.05$ ). For the anti-inflammatory cytokine IL-10, the highest values were observed for the Young group at all times (compared to Masters and Old groups,  $P < 0.05$ ) with the Old group showing the lowest values. The pro-inflammatory cytokines IL-1beta, IL-6 and IL-8 decreased during recovery (1HR), with reductions for all pro-inflammatory cytokines in the Masters ( $P < 0.05$ ) and for IL-8 in the other groups ( $P < 0.05$ ). Only the anti-inflammatory cytokines (IL-1ra and IL-10) increased following the exercise with post hoc tests showing statistically significant differences to the Old group. In the Young, IL-1beta and IL-8 increased ( $P < 0.05$ ) immediately after exercise. In conclusion, long life training does not seem to have deleterious effects in the balance of pro- and anti-inflammatory cytokines with IL-10 levels very close to those found in the young adults.

## THE EFFECTS OF HIGH INTENSITY TAEKWONDO TRAINING ON BLOOD TESTOSTERONE, CORTISOL AND LACTATE IN SOUTH AFRICAN MALE TAEKWONDO ATHLETES

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**Introduction** Various training protocols have been used in combat sports including Taekwondo to improve the individual performance by balancing the exercise intensity and the athletes' metabolic tolerance and hormonal response (Melhim 2001, Pilz-Burstein et al 2010). Cortisol and testosterone are essential for muscle adaptation during exercise and training (Kraemer et al 2005). Post-exercise blood lactate is an indicator of the glycolysis rate induced by exercise (Obminski et al 2010). The aim of the study was to investigate the effects of high intensity intermittent Taekwondo training on blood testosterone, cortisol and lactate. **Methods** 14 male South African Taekwondo (TKD) athletes aged 20-26years, BMI=23.7±2.9 were subjected to 4 weeks of TKD training divided in two groups: experimental (n=7) performing high intensity intermittent (85-90% VO<sub>2</sub>max) TKD training and control (n=7) performing interval TKD training of lower intensity (70-75% VO<sub>2</sub>max). A structured Taekwondo tasks (sTT) test was conducted before and after the training period. Blood samples for measurements of cortisol, testosterone and lactate were taken at rest 30 min pre- and post-sTT test. Student paired t-test was used for statistical analysis. Results In the experimental group after 4 weeks of high intensity intermittent Taekwondo (HITKD) training period, post-sTT test total testosterone was higher (p<0.05) by 21.7% compared to pre-sTT test values. No differences between groups were found in free testosterone, testosterone-binding globulin and cortisol. Post-sTT test cortisol/total testosterone (C/T) ratio decreased by 13.3% in the experimental group and increased by 18.5% in controls (p<0.05) after the training period. No differences were observed at the beginning of the training period. When comparing lactate changes in response to sTT test applied before and after the training period we observed that after 4 weeks lactate post-sTT levels were higher (p<0.05) by 46.2% in the experimental group and by 30.6% in the controls. **Discussion and Conclusion** Intermittent physical events may produce great strength and muscle power demands on both upper and lower body with high anaerobic energy demand (Passelergue & Lac, 2012) and simultaneously lead to changes in both anabolic and catabolic hormones (Pesce et al., 2015). The data of this study support the importance of testosterone cortisol interactions and lactate in evaluating the effectiveness of different protocols and training responses. Our findings based on higher post-sTT test total blood testosterone and decreased C/T ratio suggest that 4 weeks of HITKD stimulated an anabolic type hormonal response in the experimental group. **References** Melhim (2001). Br J Sports Med, 35, 231-234, Pilz-Burstein et al (2010). Eur J Appl Physiol, 110, 1283-1290, Kraemer et al. (2005). Sports Med, 35, 339-361, Obminski et al (2010). J Combat Sports & Martial Arts, 1, 31-36, Passelergue & Lac (2012). J Strength Cond Research, 26, 3049-3058, Pesce et al (2015). Brain Behavior & Immunity, 47, 239-248. Contact: drdjaro@yaho.co.uk

## IMPACT OF A MOUNTAIN ULTRA-MARATHON ON CARDIAC BIOMARKERS

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**Objectives.** While moderate exercise has beneficial effects on the cardiovascular system, consequences of a supra-physiological effort are not clear yet. In particular, the physiological consequences of ultramarathons need to be further documented. The aim of the study was to assess the changes of various cardiac biomarkers after a mountain ultra-marathon. **Material and methods.** Blood and urine samples were collected on 28 runners (17 men) participating to the Ultra-Trail du Mont Blanc (105 km, total positive elevation: 5600 m) at 3 different times: before the race (Pre), within 1 h after the finish (Post) and 7 days after the finish (D+7). Several biomarkers involved in heart disease (coronary syndrome, heart failure and fibrosis) and in inflammation were assayed on different analyzers such a COBAS® (for CKMB, TnT, NT-proBNP, H-FABP and CRPs) and KRYPTOR® (for Copeptin). ST2 was measured manually with the Presage kit from CRITICAL DIAGNOSTIC®. **Results.** Plasma levels of cardiac markers (CKMB, TnT, NT-proBNP, copeptin, H-FABP, ST2) and inflammation (CRPs) increased significantly at Post. Means values increased from Pre to Post as follows: 2.3 to 91.9 U/L for CKMB (p<0.0001); 7.6 to 31.7 ng/L for TnT (p<0.0001); 41.7 to 1190.5 ng/L for NT-proBNP, 4.2 to 22.9 pmol/L for copeptin (p=0.001); 3.6 to 107.8 ng/mL for H-FABP (p<0.0001), 29.7 to 126.2 ng/mL for ST2 (p<0.0001); 0.5 to 29.1 mg/L for CRPs (p<0.0001). With the exception of a few (H-FABP, ST2, CRPs) biomarkers in some subjects, all values were back to Pre values at D+7. **Discussion-conclusion.** Prolonged strenuous running exercise caused an elevation in cardiac biomarkers. Elevation in CK-MB levels lacks specificity for cardiac damage as runners have increased CK-MB from skeletal muscles as well. Previous studies suggested that exercise induced TnT elevation is a benign reversible physiologic phenomenon but this parameter, as well as H-FABP, could be a sign of ischemia. Different phenomena occurred such as stretch of myocytes causing an increase in pressure or volume and neurohormonal activation which can explain the Copeptin and NT-proBNP increase, while ST2 is a biomarker of cardiac remodeling and fibrosis. CRP is an acute phase compound that tends to increase following a strenuous and prolonged bout of exercise and/or muscular injury. As the values tended to return within the normal reference range values within 7 days after the race, our study suggests that there is no permanent structural damage at the myocardium level.

## HORMONAL AND ANTI-INFLAMMATORY EFFECTS OF GLUCOCORTICOID

COLLOMP, K.1,3, ZORGATI, H.1,2, COTTIN, F.1,2, DO, M.C.1,2, LABSY, Z.1,2, GAGEY, O.1,2, LASNE, F.3, PRIEUR, F.1,2, COLLOMP, R.4

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**Introduction** The aim of the study was to elucidate the time-course effects of short-term glucocorticoid administration on hormonal and inflammatory responses at rest and during exercise. The study focused on the sex (DHEA, DHEA-S, testosterone) and mineral (aldosterone) steroids, as well as on pro- and anti-inflammatory cytokines (IL-6, IL-10). **Methods** According to a double-blind and randomized protocol, blood samples were taken from 12 healthy recreationally-trained males after placebo or prednisone (GC, 60 mg/day/7days) ingestion, at rest and after resistance exercise. Each subject performed the trials four times on the 2nd (acute) and 7th (short-term) day of each treatment period, 3 hours after capsule ingestion. Enzyme-linked immunosorbent assays (ELISA) were used for the analyses. **Results** A significant decrease in DHEA, DHEA-S, without change in aldosterone or testosterone was demonstrated after acute GC intake. A significant increment in IL-10 and a significant decrement in IL-6 were also observed with GC both at rest and during exercise. Continued GC treatment led to another significant decrease in both DHEA and DHEA-S, whereas no change in the inflammatory markers was observed between days 2 and 7. **Discussion** Hypothalamic-pituitary axis is altered after short-term systemic GC intake through negative feedback, with marked decreases in cortisol and ACTH and works were extended to define the time required for return to the pretreatment hormone values after this therapy (Carella et al., 1993; Streck et al., 1979). However, to our knowledge, only one study examined the onset and time-course of hormonal response during short-term GC intake, and the study was limited to resting saliva cortisol and DHEA

investigation (Jollin et al., 2010). Our data demonstrate that the anti-inflammatory effects of GC were maximal and stable from the beginning of treatment, both in rest and exercise conditions. However, hormonal concentrations continued to decline during short-term intake. Further studies are needed to determine the effects of hormonal time-course alterations with longer GC treatment and the clinical consequences. References Carella MJ, Srivastava LS, Gossain VV, Rovner DR (1993). *J Clin Endocrinol Metab*, 76: 1188-1191. Jollin L, Thomasson R, Le Panse B, Baillet A, Vibarel-Rebot N, Lecoq AM, Amiot V, De Ceaurriz J, Collomp K (2010). *Eur J Clin Invest*, 40: 183-186. Streck WF, Lockwood DH (1979). *Am J Med*, 66: 910-914.

## INCREASING HEAT STORAGE DURING UPPER BODY EXERCISE UPREGULATES HEAT SHOCK PROTEIN 70 BUT DOES NOT MODIFY THE INFLAMMATORY RESPONSE

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**Introduction:** Heat shock protein (HSP) concentrations rise during heat stress (Whitham et al., 2007), and HSP can independently induce the production of cytokines (Wallin et al., 2002). Upper body exercise normally results in very modest body temperature elevations. The aim of this study was to investigate the impacts of additional clothing on the temperature, cytokine and HSP responses during this exercise modality. **Methods:** Thirteen moderately trained male individuals performed 45-min constant load arm cranking at 63% of their maximum aerobic power ( $62 \pm 7\% \text{VO}_{2\text{peak}}$ ). Exercise was performed in either a non-breathable whole body suit (intervention, INT) or shorts and T-shirt (control, CON). Core ( $T_c$ ) and skin ( $T_s$ ) temperatures and subjective feeling (indicated from -5, very bad, to +5, very good) were monitored during exercise, and venous blood was collected pre, post and 2h post exercise. **Results:** Exercise resulted in a significant increase of IL-6 and IL-1ra plasma concentrations ( $P < 0.001$ ), with no difference between conditions ( $P > 0.19$ ). The increase in HSP70 from pre to post was only significant for INT ( $0.12 \pm 0.11 \text{ ng/mL}$ ,  $P < 0.01$ ; vs  $0.04 \pm 0.18 \text{ ng/mL}$ ,  $P = 0.77$ ). Exercise significantly elevated  $T_c$  by  $0.46 \pm 0.29$  (INT) and  $0.37 \pm 0.23^\circ\text{C}$  (CON), respectively ( $P < 0.01$ ), with no difference between conditions ( $P = 0.16$ ). The rise in mean  $T_s$  ( $2.88 \pm 0.50$  and  $0.30 \pm 0.89^\circ\text{C}$ , respectively) and maximum heat storage ( $3.24 \pm 1.08$  and  $1.20 \pm 1.04 \text{ J/g}$ , respectively) were significantly higher during INT ( $P < 0.01$ ). Participants' feeling during INT was worse ( $-4.0 \pm 1.2$ ) when compared with CON ( $1.3 \pm 1.9$ ,  $P < 0.01$ ). **Discussion:** Despite large differences in heat storage between conditions, the elevations in HSP70 during INT, even though significant, were very modest. Possibly, the  $T_c$  elevations were too low to induce a more pronounced HSP response that could ultimately affect cytokine production, as passive elevation of  $T_c$  of  $\sim 2^\circ\text{C}$  has the potential to increase cytokine plasma concentrations (Leicht et al., 2015). Alternative methods to elevate  $T_c$  during exercise should be explored, as further increasing heat stress using additional clothing may be perceived as too uncomfortable to be of practical value. **References** Leicht CA, Kouda K, Umemoto Y, Banno M, Kinoshita T, Moriki T, Nakamura T, Bishop NC, Goosey-Tolfrey VL, Tajima F (2015). *Eur J Appl Physiol*. 115: 2243-2252. Wallin RP, Lundqvist A, More SH, von Bonin A, Kiessling R, Ljunggren HG (2002). *Trends Immunol*. 23: 130-135. Whitham M, Laing SJ, Jackson A, Maassen N, Walsh NP (2007). *J Appl Physiol*. 103: 1251-1256. Contact c.a.leicht@lboro.ac.uk

## TIME-DEPENDENT EXPRESSION OF IL-6, IRISIN AND BDNF IN RESPONSE TO EXERCISE IN RATS

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**Time-dependent expression of IL-6, Irisin and BDNF in response to exercise in rats** **Introduction** Irisin, BDNF and IL-6 are exercise-induced myokines which exert their effects in driving brown-fat-like development (Irisin) and regulating fat oxidation (BDNF and IL-6) (Bostrom et al. 2012; Pedersen et al. 2012). However, their dynamic expression in response to exercise is not fully known. Here we examined the level of Irisin, BDNF and IL-6 as well as the activation of AMPK and AKT at different time points following exercise, in order to explore the pattern of their expression and biological functions. **Methods** Sprague-dawley rats were subjected to downhill running at 17m/min for 90 minutes. Serum creatine kinase activity was tested at day 1, 3, 5, 7, and 14 following exercise to evaluate skeletal muscle injury. The serum level and skeletal expression of BDNF, IL-6 and Irisin were measured by ELISA and real-time RT-PCR, respectively. The activation of AMPK and AKT signaling pathway was confirmed by Western Blot. To compare the difference between two groups, t-test was employed using SPSS software and  $p < 0.05$  was considered statistically significant. **Results** An increase of CK activity was observed at day 3 and day 5 following exercise, confirming exercise-related skeletal muscle injury. We didn't find any increase of IL-6 in the rats following exercise compared to sedentary group, although it is reported that IL-6 level is elevated dramatically during exercise. The level of Irisin and BDNF was increased both in the serum and in the skeletal muscle in day 1 and day 3 following downhill running; then, while Irisin level returned to the baseline, serum BDNF level was continuously elevated. Besides, AMPK activation was found at day 1 and day 3, but AKT was kept activated over all the time points. **Discussion** Although IL-6, Irisin and BDNF are all exercise-induced myokines, their expression is regulated differently. Irisin and BDNF are both reported to be involved in the activation of AMPK signaling pathway. However, we found that the increase of Irisin was in accordance with AMPK activation, while BDNF increase is in accordance with AKT activation. Our results suggest that BDNF may participate in skeletal muscle regeneration via AKT-mediated pathway in addition to fat oxidation. Therefore, exercise-induced myokines are regulated precisely and sequentially, which in turn exert different functions at different time following exercise. **References** Bostrom, P., et al. (2012). 'A PGC1-alpha-dependent myokine that drives brown-fat-like development of white fat and thermogenesis.' *Nature* 481(7382): 463-468. Pedersen, B. K., et al. (2012). 'Muscles, exercise and obesity: skeletal muscle as a secretory organ.' *Nat Rev Endocrinol* 8(8): 457-465.

## Oral presentations

### OP-PM35 Concurrent Training

#### QUANTIFYING ENERGY SYSTEM CAPACITY CHANGES IN CYCLING FROM 7 DAYS ISCHEMIC LEG PRECONDITIONING

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**Introduction** A single session of ischemic preconditioning has been shown to acutely improve exercise performance in several sports including swimming (Jean-St-Michel et al., 2011), cycling (de Groot et al., 2010) and running (Bailey et al., 2012) but not repeated sprint ability (Gibson et al., 2015). Interestingly, the immediate and retained benefits of continued ischemic preconditioning as a training tool remain un-investigated. Therefore, the aim of this study was to quantify changes in capacity of both the aerobic and anaerobic energy systems from using ischemic leg preconditioning over seven consecutive days. **Methods** We conducted a randomized, controlled, single-blinded experiment with 18 recreationally active adults ( $23.2 \pm 7.1$  years; Relative  $\text{VO}_2\text{max}$   $38.6 \pm 5.9$  ml.kg<sup>-1</sup>.min<sup>-1</sup>). The intervention consisted of a 220 mmHg with 4 x 5-min ischemia and 4 x 5-min reperfusion per leg, conducted once a day for 7 consecutive days (days 3 – 9). The control condition used the same protocol with 20 mmHg. Cycling  $\text{VO}_2\text{max}$  (day 1, 11, 18) and 30-s Wingate tests (day 2 and 10) were performed pre and post intervention. **Results** Ischemic preconditioning had a large ( $p < 0.01$ ,  $d = 0.91$ ) effect on increasing maximal aerobic capacity by 9.5% immediately post intervention, and increased further to 12.8% seven days post ( $39.1 \pm 5.4$  to  $42.8 \pm 5.7$  to  $44.1 \pm 6.2$  ml.kg<sup>-1</sup>.min<sup>-1</sup>). There was a moderate ( $p < 0.01$ ,  $d = 0.46$ ) effect on increasing maximal aerobic power by 18.5% immediately post intervention which dropped slightly to 16.1% seven days post ( $268.9 \pm 92.7$  to  $318.6 \pm 121.3$  to  $312.2 \pm 125.5$  W). There was no aerobic improvement in the control group ( $p > 0.05$ ), and no improvement was evident in either group for anaerobic fitness measures ( $p > 0.05$ ). No significant differences were found at any time point in fatigue or lactate measurements between groups. **Discussion** Seven days ischemic preconditioning resulted in substantially improved aerobic but not anaerobic measures, at least with recreationally active adults. The absence of differences in lactate and fatigue measures indicates energy system differences were unlikely from increased neural drive or enhanced muscle recruitment which has previously been suggested (Bailey et al., 2012). Further mechanistic investigations are recommended as well as determining the effectiveness of the intervention for more highly trained populations. **References** Bailey T, Jones H, Gregson W, Atkinson G, Cable N, Thijssen D. (2012). *Med Sci Sports Exerc*, 44(11), 2084-2089. de Groot P, Thijssen D, Sanchez M, Ellenkamp R, Hopman R. (2010). *Eur J Appl Physiol*, 108, 141-146. Jean-St-Michel E, Manlihot C, Li J, Tropak M, Michelsen M, Schmid M, McCrindle B, Wells G, Redington A. (2011). *Med Sci Sports Exerc*, 43(7), 1280-1286. Gibson N, Mahony B, Tracey C, Fawckner S, Murray A. (2015). *J Sports Sci*, 33(11), 1182-1188.

#### RE WARM-UP PRIOR TO FOOTBALL MATCHES: IS IT BENEFICIAL FOR PHYSICAL PERFORMANCE?

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**Introduction** Warm-up (WU) routines are widely explored and commonly accepted for optimizing performance and preventing injury. However, official international pre-match protocols may require players to passively rest for approximately 15 minutes in the time-course between WU and the beginning of the match. Therefore, the aim of this study was to assess the contribution of different re warm-up (re-WU) strategies on the physical performance of football players. **Methods** Twenty-two Portuguese elite under-19 football players participated in the study conducted during the competitive season. 4 protocols (WU + re-WU) were tested in 4 consecutive days. The protocols differed only in the re-WU strategy applied after the standardized WU: without re-WU (CON), eccentric re-WU (ECC), plyometric re-WU (PLY) and repeated changes of direction re-WU (RCOD). Vertical jump (counter movement, CMJ; and abalakov, AJ) and Sprint capacity (10-m and 20-m) were tested immediately after WU and 12 minutes after WU. The re-WU strategies were performed 6 minutes after WU. Magnitude-based inferences and precision of estimation were employed in data analysis. **Results** Both CMJ and AJ performances presented a likely/very likely improvement after PLY intervention ( $\sim 3.8\%$  in CMJ and  $\sim 4.8\%$  in AJ) when compared to CON. PLY also showed a moderate very likely beneficial effect in 10-m (Cohen d;  $\pm 90\% \text{CL}$ ,  $-0.7$ ;  $\pm 0.3$ ) and a moderate most likely beneficial effect in 20-m ( $\text{ES} = -0.9$ ;  $\pm 0.3$ ) performances. The RCOD presented a likely/possible beneficial effect to CMJ and AJ, and a moderate likely/most likely beneficial effect to 10-m and 20-m sprint performances. Different practical implications may be taken from the ECC since there was a  $-5.1 \pm 5.6\%$  decrease in CMJ height from post-WU to re-WU which suggests a possible harmful effect when compared to CON. **Discussion** The absence of re-WU activities in the time-course between the WU and the beginning of the match may be detrimental to players' physical performance. However, the inclusion of re-WU exercises prior to match is a very delicate issue, since the manipulation of volume, intensity and recovery may positively or negatively affect the subsequent performance (Robbins, 2005). In fact, our research shows that eccentric exercise prior a football match may be harmful for physical performance. However, plyometric and repeated changes of direction exercises seem to be efficient active strategies to attenuate losses in vertical jump and sprint capacity after WU. **References** Robbins, D. W. (2005). *J Strength Cond Res*, 19(2), 453-458. Contact eabade@ismai.pt

#### EFFECTS OF COMBINED STRENGTH AND AEROBIC TRAINING ON MIDDLE AND LONG-DISTANCE PERFORMANCE: A META-ANALYSIS

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1. Sports Studies Department, Bishop's University, Canada 2. Institut national du sport du Québec, Canada 3. Department of Physiology, Faculty of Medicine and Odontology, University of the Basque Country, Basque Country 4. Faculty of sports sciences, University of Poitiers, France **INTRODUCTION:** Combined strength and aerobic training is an appropriate strategy to decrease the energy cost of locomotion (ECL), improve aerobic endurance (AE) and may enhance performance in middle and long distance events (1, 2). The aim of this study was to assess the effects of strength training on middle and long-distance performance through a meta-analysis of the available literature. **METHODS:** Articles were included in this meta-analysis if they met these criteria: 1) combined strength and aerobic training; 2) performance outcomes (official or simulated competition, maximal oxygen uptake -  $\text{VO}_2\text{max}$ , ECL or AE) related to middle and long-distance events in cross country skiing, running, triathlon, swimming, cycling, rowing and biathlon; 3) details about the training load; 4) sufficient



information to calculate effect size. Thirty-seven articles were included. Statistical analyses were presented in detail in a previous article from members of our laboratory (3). RESULTS: Combined strength and aerobic training provides a moderate beneficial effect on middle and long-distance performance (SMD [95% CI] = 0.61 [0.43 to 0.79],  $P < 0.01$ ). Combined training with a focus on maximal strength (0.26 [0.10 to 0.42],  $P < 0.01$ ) or sub-maximal strength (0.57 [0.10 to 1.03],  $P < 0.01$ ) had beneficial effects on VO<sub>2</sub>max. AE was also improved after implementation of sub-maximal strength training (2.8 [1.85 to 3.77],  $P < 0.01$ ). Moreover, it was shown that ECL was significantly decreased (-0.75 [0.45 to 1.04],  $P < 0.01$ ). A meta-regression analysis revealed that changes in middle and long-distance performance were associated with changes in VO<sub>2</sub>max (slope: 0.52,  $P < 0.05$ ), AE (slope: 0.50,  $P < 0.01$ ) and ECL (slope: = 0.58,  $P < 0.01$ ). DISCUSSION: These results provide a framework that support the implementation of strength training in addition to normal aerobic training to improve middle and long-distance performance and associated aerobic characteristics. REFERENCES 1. Berryman N, Maurel D, Bosquet L. Effect of plyometric vs. dynamic weight training on the energy cost of running. *J Strength Cond Res.* 2010 Jul;24(7):1818-25. 2. Ronnestad BR, Mujika I. Optimizing strength training for running and cycling endurance performance: A review. *Scand J Med Sci Sports.* 2014 Aug;24(4):603-12. 3. Bosquet L, Berryman N, Dupuy O, Mekary S, Arvaisis D, Bherer L, et al. Effect of training cessation on muscular performance: A meta-analysis. *Scand J Med Sci Sports.* 2013 Jun;23(3):e140-9. Contact: nicolas.berryman@ubishops.ca

## Oral presentations

### OP-PM39 Bone Health

#### IMPACT BETWEEN MEDICATION USAGE, PHYSICAL ACTIVITY, NUTRITIONAL STATUS AND OSTEOMUSCULAR HEALTH IN MALE AND FEMALE ADULTS AGED 40-65 YEARS IN KOSOVA

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**Introduction:** This observational, cross-sectional study investigates the general health condition, drug consumption and the possible effects of certain medications in osteo-muscular systems amongst males and females aged 40-65, in the population of a developing, low income country such as Kosova. Many studies have been performed worldwide regarding the possible side effects of medications in our body, but very few published studies were carried out in Kosova. **Methodology:** Bone Mineral Density (BMD) and T-score at distal forearm regions (with DEXA scan), together with the isometric strength (Handgrip) were evaluated in a total of 162 subjects, out of which 53 Males (average age 55.15±7.12) and 109 Females (54.27±5.1). Additionally, a group of 4 questionnaires regarding general health, Brief Medication Questionnaire 1 (BMQ1), self-administered Nutritional Standard Questionnaire (NSQ) and International Physical Activity Questionnaire (IPAQ) were filled. **Results:** Significant differences were found in Body Mass Index (BMI), Physical Activity (PA), BMD and T-score between genders. When comparing the total subject's BMD and T-score based on the PA levels (1, 2, 3), significant differences were found between subject groups PA1 and PA3 as well as PA2 and PA3, but not between PA1 and PA2. This situation accounted also in both genders. Similar results were encountered when comparing the total subject's Handgrip isometric strength with significant differences between PA1 and PA3, but not between PA1 and PA2, PA2 and PA3. One difference though was encountered in females between PA2 and PA3 ( $p < 0.05$ ) which was not the case when comparing in total subjects. When evaluating the possible effect of specific medication on BMD, T-score, and Handgrip, no differences were observed in N05B, C07A and M01A. No differences were observed in total subjects in the group A02BC as well, whereas significant differences between female consumers and no consumers were found in all the variables. Meanwhile, significant differences were observed in H02AB and M05BA in all the variables, while in N02BE significant differences were observed in BMD and T-score, but not on handgrip. This study showed the 42% of total participants were diagnosed with Osteopenia, out of which 6.8% are on the verge of getting Osteoporosis (with T-score below -2). No one was diagnosed with Osteoporosis. **Conclusion:** This study describes the occurrence of age related conditions such as Osteoporosis and Osteopenia, prevalence of medication usage and their possible side effects in osteo-muscular system of mature adults in a developing, post conflict country such as Kosova. In addition to that, important data regarding the general health, nutritional status and physical activity levels amongst the studied population were given. To our knowledge, this is one of the few studies where the effects of the above mentioned medication groups were compared and evaluated in the bone and muscular health within a study population.

#### COMBINED RESISTANCE AND SPRINT TRAINING HAS A POSITIVE AFFECT ON BONE MINERAL CONTENT IN VETERAN ENDURANCE CYCLISTS

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**Introduction** The importance of regular exercise on bone health during aging is widely acknowledged (Gomez-Cabello, et al., 2012). However, these effects appear dependent on the mode, intensity and duration of exercise training (Nichols et al., 2011). Previous research has shown that high-impact and resistance training exercises increases bone mineral content (BMC) in older athletes (Nowak et al, 2010). In contrast, long duration non-weight bearing aerobic exercise such as cycling and swimming may lead to decreases in BMC in aging athletes (Velez et al, 2008). Thus, for endurance-trained cyclists, high intensity resistance exercises may be important to reduce age-related declines in BMC. The purpose of the present study was to examine the effects of 12-weeks of combined high-intensity resistance and sprint cycle training (HIRST) and high-intensity sprint cycle training (ST) on BMC in veteran endurance cyclists. **Methods** Twenty seven male veteran endurance cyclists (55.0±8.3 yr) were divided into three age-matched groups - controls (n=10) who maintained normal endurance training (~ 8 hours per week) and two intervention groups (ST: n=7; HIRST: n=10). Sprint group. ST replaced four of their usual weekly endurance cycling training sessions with four group track sprint cycling training sessions designed in consultation with an accredited track cycling coach. Post warm-up, subjects performed 1-3 sets x 1-3 repetitions of maximal effort sprints (65-330 m). Sprint and mixed-methods resistance group. HIRST replaced four of their usual weekly endurance cycling training sessions with two group track sprint cycling training sessions similar to the ST group and two group gym-based mixed-methods resistance training sessions per week. Progressive overload was applied by completing 3 sets of every exercise but manipulating the number of repetitions (4-12) and resistance (>70% 1 RM). The overall training adherence rate, with no statistical differences between groups, was 87 ± 4%. Pre- and post-training, subjects undertook Hologic 'Discovery W' dual-energy X-ray absorptiometry whole body scans analyzed using APEX 4.0 software. **Results** There were no differences in baseline BMC between groups. A paired-sample t-test revealed an increase in BMC following 12-weeks of

HIRST ( $2850 \pm 31.9$  g vs  $2907 \pm 32.4$  g) ( $t(9) = -3.94$ ,  $p = 0.004$ ). No significant changes were observed in the control or ST groups. Discussion The results suggest that 12-weeks of HIRST can increase BMC in veteran endurance cyclists. It appears that in veteran athletes aging bone remains dynamic and that HIRST needs to be included in veteran endurance cyclist training programs to maintain BMC into older age. References Gomez-Cabello et al., (2012). *Sports Med*, 42(4), 301-325. Nichols et al, (2011). *J Strength Cond Res*, 25(3), 727-734. Nowak et al, (2010). *Aging Male*, 13(2), 133-141. Velez et al, (2008). *Osteoporos Int*, 19(10), 1457-1464. Contact p.reaburn@cqu.edu.au

### A COMPARISON OF BONE MINERAL DENSITY IN MALE AMATEUR BOXERS AND ACTIVE NON-BOXERS

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Introduction As a health promotion strategy, boxing training, which can be undertaken as a general fitness activity, presents itself as a potentially attractive method of upper limb impact-loading exercise. However, the influence of boxing on upper limb bone mineral density has yet to be explored. The aim of this study was to compare the forearm and arm bone mineral density of male boxers to that of active age-matched non-boxing controls. Methods A cross-sectional study was performed with 30 amateur male boxers (aged 18-44 years,  $6 \pm 4$  years boxing experience,  $4 \pm 2$  boxing sessions per week) and 32 age-matched, non-boxing, active controls. Participants had their regional and whole body bone mineral density assessed by dual-energy x-ray absorptiometry. Isometric hand grip strength, testosterone, oestradiol, sex hormone-binding globulin, vitamin D, lean and fat mass, and past and current physical activity were also assessed. Results Forearm and arm bone mineral density were 1.5-2.2% higher in boxers than the control group, although this was not statistically significant ( $p = 0.29-0.48$ ). There were no differences between groups for spine, hip, or whole body bone mineral density ( $-1.3-0.6\%$ ), or for body composition or hormone status (all  $p > 0.05$ ). Within the arms, lean mass was associated with bone mineral density in both boxers and the control group ( $r = 0.60-0.76$ ,  $p < 0.001$ ). Discussion There were no significant differences between amateur boxers and the control group for upper limb bone mineral density. Muscle mass appears to be particularly important to bone health of the upper limbs. Repeated impacts from boxing do not provide an osteogenic benefit to the upper extremities above and beyond general resistance training. Contact t.skinner@uq.edu.au

### NO ASSOCIATION BETWEEN VITAMIN D STATUS AND MARKERS OF BONE HEALTH IN NON-WEIGHT BEARING ATHLETES

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Introduction: To examine the relationship between serum 25(OH)D levels and markers of bone health, bone mineral density (BMD) & T score in a non-weight bearing, Arabic athletic population. Methods: One hundred and two male athletes registered with the Qatar Olympic Committee (QOC) originating from the Gulf Cooperation Council ( $n = 93$ ) and the Middle Eastern ( $n = 9$ ), presented for pre-competition medical assessment in Aspetar. All athletes participated in non-load bearing sports (archery, billiards bowling, cycling, diving, equestrian, racing, rowing, sailing, shooting, snooker, swimming and water polo). All undertook bone densitometry, body composition analysis by Dual-energy X-ray absorptiometry (DXA) and serum 25(OH)D evaluation. Results: From 102 athletes, 29.4% ( $n = 30$ ) demonstrated severe deficiency, 40.2% ( $n = 41$ ) deficiency, 23.57% ( $n = 24$ ) insufficiency and 6.8% ( $n = 7$ ) sufficiency. No difference in serum 25(OH)D was observed between athletes with clinically normal T-scores ( $n = 76$ ) and those presenting with osteopenia ( $-1$  to  $-2.5$  SD) ( $n = 20$ ) or osteoporosis ( $< -2.5$  SD) ( $n = 6$ ) in any locations (neck, hip, spine or total). Cyclists had higher serum 25(OH)D compared to equestrian, and other indoor athletes ( $P < 0.006$ ). No significant associations were observed between anthropometric measures and serum 25(OH)D, age, BMI, body fat %, calcium, PTH and skin exposure across sporting types. Mean body mass was lower ( $p < 0.05$ ) in athletes with a T-score suggestive of osteopenia or osteoporosis. Conclusion: No association was observed between serum 25(OH)D levels and markers of bone health in non-weight bearing athletes. Lower body weight was associated with osteopenia or osteoporosis regardless of serum 25(OH)D level. These findings support that maintaining normocalcemia has priority over skeletal integrity.

### PREVALENCE OF LOW RESTING METABOLIC RATE AND ASSOCIATED HEALTH CONSEQUENCES AMONG WELL-TRAINED MALE NORWEGIAN ENDURANCE ATHLETES

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Introduction Female athletes in leanness sports are reported to have high prevalence of reduced energy intake (EI), associated with low resting metabolic rate (RMR), reproductive dysfunction, and other severe physiological consequences such as low bone mineral density (BMD) (Nattiv et al., 2007). However, these associations are not well investigated in male athletes. Therefore, the aim of this study was to investigate the prevalence of low RMR and associated health consequences in male endurance athletes. Methods Forty-one well-trained cyclists ( $n = 21$ ) and long-distance runners ( $n = 20$ ) [age;  $37.0$  ( $28.5-44.5$ ) yrs, body mass index (BMI);  $23.3$  ( $21.3-24.2$ ) kg/m<sup>2</sup>, body fat;  $9.4$  ( $6.5-11.4$ ) %, training volume;  $12.0$  ( $8.3-18.3$ ) h/week presented as median and interquartile range ( $25-75$ )] were included, and divided in two subgroups according to RMR-ratio (predicted RMR/measured RMR); low ( $< 0.85$ ) and high ( $\geq 0.85$ ). Protocols included assessment of body composition, RMR, EI and energy exercise expenditure (4 days), hormonal- and metabolic biomarkers, and blood lipids. Results Nine subjects (22%) had low BMD (Z-score  $< -1$ ) in either hip ( $n = 2$ ) or L1-L4 ( $n = 7$ ), seven (14%) had high levels of cortisol, nine (22%) had hypercholesterolemia, and 19 (46%) had low RMR-ratio. EI correlated well with RMR-ratio ( $r = 0.77$ ;  $p < 0.001$ ). EI as well as triiodothyronine (T3) and insulin were significantly lower ( $p < 0.05$ ), while hip BMD was significantly higher ( $p < 0.05$ ) in the low compared to the high RMR-ratio group. Discussion We found a high prevalence of low BMD in this group of well-trained male endurance athletes, although not linked to low RMR-ratio or EI as earlier findings have hypothesized (Barry & Kohrt, 2008). EI correlated well with RMR-ratio, and low RMR-ratio was associated with lower levels of T3 and insulin. Furthermore, hypercholesterolemia and high levels of cortisol was common in this group of male athletes as earlier reported in female endurance athletes with energy deficiency (Melin et al., 2015) but none of these findings were linked to low RMR-ratio. Contact thoms14@student.uia.no Barry, D. W., & Kohrt, W. M. (2008). BMD decreases over the course of a year in competitive male cyclists. *J Bone Miner Res*, 23(4), 484-491. Melin, A., Tornberg, A. B., Skouby, S., et al. (2015). Energy availability and the female athlete triad in elite endurance athletes. *Scand J Med Sci Sports*, 25(5), 610-622. Nattiv, A., Loucks, A. B., Manore M., et al. (2007). American College of Sports Medicine position stand. The female athlete triad. *Med Sci Sports Exerc*, 39(10), 1867-1882.

## Oral presentations

### OP-PM72 Coaching: Soccer

#### PASSING AND SHOOTING IN FOOTBALL: PLAYING WITH THE BALL... AND THE OTHERS

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**INTRODUCTION** Winning in football is about scoring more goals than the opponent. To do so, players must master a set technologies that, together with other technical, tactical, psychological and physiological (among others) factors will allow them to be successful. Although it is common to believe that in football the key is to play with the ball, master the ball at high speeds and in small spaces, studies that we have been developing in recent years on isolated situations (e.g. Vicente et al. 2015) showed that there is time relations with the opponents that players must not ignore to succeed. The aim of this study was to verify whether a correlation exists between the velocity of the stimulus in passing and shooting situations in football and the attacking and defending player's responses. **METHODS** We've used a software (MeSiR2.2) designed to measure the relation between the velocity of the stimulus and the time to respond it. Four tests were used: Test 1 had a goalkeeper that moved from the center of the goal to each side (left or right) at different velocities (1 and 3 m/s) randomly; Test 2 had a striker that kicked a ball from the penalty kick spot to each side of the goal (left or right) at different ball velocities ( $\pm 40$ km/h and  $\pm 90$  km/h) randomly; Test 3 consisted on a defender that moved 3 meters in a real football field to each side (left or right) at different velocities (5 and 1 m/s) randomly; Test 4 consisted on a player with a ball that kicked it to the left or right at different ball velocities ( $\pm 10$ km/h and  $\pm 50$  km/h) randomly. 40 university football players and 25 semi-professional footballers had to perform each test for 20 trials and respond to each situation by moving their body towards the ball side (tests 2 and 4) or shooting a ball in the opposite direction to the movement of the player (tests 1 and 3). **RESULTS** From the 5200 trials performed from the 4 tests, results showed that players took the right decision in 83% of the situations. Data also showed that for the fastest stimulus in tests 2 and 4 the average response time was also higher (test 2=378ms / test 4=399ms) than the slowest stimulus situations (test 2=427ms / test 4=473ms). The same trend was obtained on tests 1 and 3. Participants tended to kick the ball at lower speeds in response to slower opponents movements (73% in test 1 and 68% in test 3) than in higher opponents movements. **DISCUSSION** Data showed that the stimulus velocity tend to influenced the response and the time to respond. As the stimulus was faster or slower the response was also faster or slower. The results tend to corroborate previous studies and other ecological studies we're still performing. This suggest that in passing and shooting situations in football, where players are permanently exchanging stimulus with opponents and teammates, players must be prepared to relate with the opponents and teammates being aware that they can influence their actions and response times to take advantage and increase success chances. **REFERENCES** Vicente A., Fernando C., Lopes H. (2015). 20th ECSS, Malmö.

#### AN ANALYSIS OF THE COMMUNICATION SKILLS OF COACHES ACCORDING TO THE PERCEPTION OF ATHLETES WHO PARTICIPATED IN INTERCOLLEGIATE FOOTBALL COMPETITION

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**Introduction** Football clubs are a part of system of communication and interaction. The qualification of the athletes are parallel with the trainers qualification. According to this fact, it is very important that trainers to improve their communication skills which are basics of learning and teaching process. The purpose of the study is determined to communication skills of trainers according to athletes perspective who have participated intercollegiate football tournament. **Methods** The sampling of the study is made of 117 football players who are attended to intercollegiate football tournament during 30 April-4 May 2013. In investigation random sampling method was used. During the study basic personal information form was utilized. In addition to this Trainer communication skill survey' which was developed by Yılmaz (2008). The Levene test was used to figure out normalization of data. During the analyze of data independent T test and one way Anova test were used besides descriptive statistical techniques. SPSS 16.0 statistic program were used to analyze to data. **Results** According to study there were no significant differences between trainers communication skills and training age, position on field, educational department of football players. However, football players thoughts towards trainers communication skills are that their skills are effective but need improvement. **Discussion** In the study of Yılmaz, et.al. which was researched on 739 athletes showed that individual sport trainers have more effective communication skills than team sports trainers. But also team sports trainers have sufficient communication skills however they need to work on their communication skills. Bayrak and Nacar studied on 209 athletes and they investigated trainers communication skills and results were that trainers mostly have adequately communication skills. According to Chih-Ming Yu (2016) in the organizations which have positive organizational climate, effects the communication skills of trainers. In contrary trainers should spend more time to develop on their communications skills. **References** i., Yılmaz, Z., Çimen, F., Bektaş (2009) Comparison Of Communication Skill Levels Of Individual And Team Sports Trainers: Perceptions Of Athletes, Atatürk University, Journal of Physical Education and Sport Science 4(45-58). Chih-Ming Yu (2016) A Study of Relationship between Coaches' Communication Behavior and Sports School Teams' Organizational/Atmosphere in Keelung Elementary Schools E. Bayrak, E. Nacar (2015) Investigating Communication Skill Levels Of Trainers Who Working In The Professional Team Sports The Journal of Academic Social Science, Volume: 3, 14(391-405), June 2015,

#### SOCCER PLAYERS AND COACHES' PERSPECTIVES TOWARDS ERGOGENIC AIDS AND SUPPLEMENT USE IN THE ETHEKWINI REGION

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**Introduction:** Doping is regarded as a form of cheating where athletes use substances that are on the prohibited list, predominantly for gaining an edge over their competitors. Where sports participation was previously seen as recreational activity, it is now an intense environment for the adolescent athlete, placing high demands for performance in order to get drafted into professional sports. There is increased pressure on athletes to perform. This leads to increase use of performance enhancing substances and supplements to achieve increased performance levels and cope with the heavy demands that are placed on the player. **Aim:** The aim of this study was to determine the perspectives of U-19 soccer players and their coaches towards the use of ergogenic aids and supplements in the

eThekweni region, KwaZulu-Natal. Methodology: The study was a mixed-methods design. Both quantitative and qualitative designs were employed. The sample comprised of participants playing first team U-19 soccer from clubs in the eThekweni region and their respective coaches. A questionnaire was administered to players to assess the knowledge, attitudes and practices towards doping in sport, to determine their source of information and to determine which supplement was most frequently used. An interview was conducted with the coaches to assess his/her knowledge, attitude and beliefs about supplementation, and where do they get their information from about supplements. Both descriptive and inferential statistics were employed to analyse and report the data. Results: The U-19 soccer players and coaches believed that consuming prohibited substances in sport is unethical. Majority of the U-19 soccer players (73.9% either agreed or strongly agree) and coaches believed that doping in soccer is on the increase. Almost a quarter (24.7%) of the U-19 soccer players consumed performance enhancing substances (PES), cannabis, alcohol and/or smoke. Coaches believed that there players do not consume PES or substances. Majority (84.4%) of the U-19 soccer players and majority of coaches stated that educational programmes are needed. Conclusion: The U-19 soccer players and coaches believe that doping is prevalent in soccer. Players and coaches believe that sport organisations need to implement more educational programmes about doping and on how to consume PES.

### **HIGH POTENTIAL IN BALL SPORTS FROM THE PERSPECTIVE OF ELITE PLAYERS AND THEIR YOUTH TRAINERS: A QUALITATIVE STUDY**

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**Introduction** Many sports associations use talent development programs for identifying young high potential players and to support children aiming to become elite players. Selection criteria to participate in such programs are often based on performance results, coach's judgments, physical appearance, perceptuo-motor tests for speed, agility and coordination, motivation, self-efficacy and parental support. However, identifying young children with the potential to become a world class player is a challenge, since the key factors for future success remain ambiguous. This qualitative study attempts to get a grip on what is meant by 'high potential' in elite ball sports from the perspectives of world-class players and the trainers of their formative years. **Methods** Semi-structured interviews were conducted in elite players (n=14; football, basketball, (beach-)volleyball, tennis, table tennis, squash, waterpolo, field-hockey) and their trainers (n=14) to unravel the multi-dimensional concept of 'high potential'. After transcribing the interviews, open and axial coding was carried out by three independent coders using an inductive approach. Consecutively, all authors were involved in the peer debriefing process. Datasaturation was established. **Results** The coded fragments of all interviews were reduced to seven interrelated themes describing the perspectives of the elite players and trainers with regard to high potential: 'early exposure', 'deliberate play', 'fit to the sport', 'learn fast', 'taking the next step', 'constant competition' and 'reaching the top of the world'. Each theme shows that high potential of a player can only be described in terms of the triptych: the player, the task (sport) and the environment. **Discussion** The results of this study are consistent with the ecological-dynamic approach (Newell, 1986). Based on the results is 'change over time' was added as an extra dimension to the model (Elferink-Gemser & Visscher, 2012). In addition, the results give direction to future studies that focus on the measurement of potential in young players within the framework of talent identification and development.

## **Oral presentations**

### **OP-SH14 Physical Education, Health & Students Perspectives**

#### **TEACHING HEALTH FOR UNDERSTANDING: A CASE STUDY OF STUDENTS' REASONING ABOUT AEROBIC FITNESS AND HEALTH**

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**Introduction** The interfaces between health, physical education and schooling have a long history. At present, critical questions are being raised about the enforcement of a particular health in school physical education, in Sweden called physical education and health (PEH). The starting point of this article is a case study from a practice based research project. The case study aimed to explore within the context of a period of lab work how upper secondary school students reason about aerobic fitness and how this influences their health. The pedagogical model was based on health literacy as a framework for learning outcomes. **Method and Results** A phenomenographic approach has been used when analyzing the student reports in order to identify and distinguish students' ways of reasoning about and understanding the learning object in focus. Three categories of reasoning emerged: (i) students only repeating basic facts, (ii) students integrating knowledge with a simple way of reasoning about/assessing their own outcomes, and (iii) students reasoning about aerobic fitness and health relating to changing conditions and context. When distinguishing pupils' ways of reasoning, the focus of almost all reports was on measurable results and expectations of improved fitness results. Only a few reports revealed an ability to transform understanding and experiences of what influences health into a process of coherence and relationships. **Discussion** The performance expectations created tensions, and even conflicts, between what the student assignments aimed to achieve and physical education traditions. The existing different ontological paradigms in physical education were difficult for the students to use. The findings also indicate the absence of other dimensions of health related to a moving body. From this follows that steering documents and physical education teachers have to consider what different perspectives on health that PEH should, could or ought to provide. Future studies are needed to increase knowledge of how to move away from 'teaching to be healthy' in PEH towards different ways of how students 'do health and make sense of themselves as healthy'. This may offer new educational perspectives on (physical) health.



## ADOLESCENTS PARTICIPATING IN PHYSICAL EDUCATION FOCUSING ON PLAY AND HEALTH, OR SPORTS; WHO IS MOST ACTIVE?

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**Introduction** Physical education (PE) in schools can play an important role in both improvement of movements' skills and health promotion. However, content and design of PE programs may influence adherence to PE class and learning outcomes. The aim of the present study was to compare objectively recorded light-, moderate-to-vigorous intensity physical activity (MVPA), walking steps and sedentary time in adolescents participating in either PE focusing on play, health and facilitating positive experience (Play and Health), or sports skills, technique and improvement of physical performance (Sports). **Methods** A total of 181 first year students (141 girls) attending to vocational studies of Restaurant and Food Processing (n = 58), Design, Arts and Crafts (n = 60) or Healthcare, Childhood and Youth Development (n = 102) from two high schools in Kristiansand, Norway, participated in a new PE program. 101 (24 boys) students (17yrs old (standard deviation 2.4)) wearing an activity monitor (SenseWear™ Armband Mini, BodyMedia Inc., Pittsburgh, Pennsylvania, USA and analysed with SenseWear™ Professional Research Software Version 8.1, BodyMedia Inc) were included in the analysis. Cut-point defining MVPA was Metabolic Equivalents above 3. Differences in MVPA and steps between students in the two PE groups were assessed by analysis of covariance adjusting for days of activity recordings, age, sex and parental education. **Results** Students participating in PE focusing on Sports were walking significantly ( $p < 0.001$ ) more steps/day compared to the group focusing on Play and Health (mean  $\pm$  95% confidence intervals; 9167 (7945, 10390) vs. 6661 (5514, 7808) steps/day). There was a tendency ( $p = 0.145$ ) that students choosing PE focusing on Sports participated in more MVPA (48 (31, 65) vs. 34 (18, 50) min/day). Neither light PA, sedentary time nor sleep hours were significantly different between the two groups of students. **Discussion** The results of the present study indicate adolescents choosing PE focusing on Sports tend to be more physically active than students choosing PE focusing on Play and Health. When designing PE programs students' preferences and physical activity experiences has to be kept in mind since these factors may influence adherence to PE class and learning outcomes. Contact: sveinung.berntsen@uia.no

## SPORT-RELATED HEALTH COMPETENCE: A COMPETENCE MODEL AND TEST INSTRUMENT FOR PHYSICAL EDUCATION

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**Introduction** In the context of an increasing focus on learning outcomes in the German educational system, sport pedagogy has been challenged in terms of measuring pupils' competence in physical education at school (Gogoll, 2014). Focussing on competence-related aspects of health promotion in physical education, first of all, a theoretical model of sport-related health competence was derived (Gogoll, 2014; Sørensen et al., 2012; Töpfer & Sygusch, 2014). On this basis the following study aims on the development of a test instrument measuring sport-related health competence. **Methods** A paper and pencil test was designed to assess sport-related health competence, targeting pupils in classes 7 to 10 in German schools. A combination of quantitative and qualitative methods were used to develop the test. Items were developed and selected on the basis of three pretests with pupils (N = 312), and three expert ratings involving sports scientists, students and teachers (N = 38). Final testing of the instrument included a sample of 670 pupils aged 12 to 17 (mean = 14.4). The test consisted of 33 items representing the three dimensions of the competence model. Item selection and test scaling utilised statistical methods based on both classical test theory and item response theory. **Results** Selected results based in particular on item response theory are summarised as follows. The mean value for item difficulty overall (item parameter  $a_i$ ) is intermediate (mean = 0.09; SD = 1.36; Min = -2.36; Max = 3.49). The applicability of the Rasch model (Partial Credit Model) was successfully proved for a subset of 25 items (LR-test:  $\chi^2 = 50.81$ ; df = 40;  $p = 0.118$ ). The test exhibits an acceptable level of reliability (EAP/PV = 0.79). All items show good values for item fit based on weighted mean square (WMNSQ) within the range 0.8-1.2. **Discussion** The study was successful in developing a comprehensive test measuring sport-related health competence. As some items were found unsuitable during the process of item development, it would be valuable to expand the pool of test items in order to cover the broad range of health-related topics in physical education. In addition, the scope of the test should be extended so it can be used with younger and older pupils to assess progress in sport-related health competence at school. **References** Gogoll, A. (2014). Das Modell der sport- und bewegungskulturellen Kompetenz und seine Implikationen für die Aufgabenkultur im Sportunterricht. In M. Pfitzner (Hrsg.), Aufgabenkultur im Sportunterricht. (S. 93-110). Wiesbaden: Springer VS. Sørensen, K., Van den Broucke, S., Fullam, J., Doyle, G., Pelikan, J., Slonska, Z. & Brand, H. (2012). Health literacy and public health: a systematic review and integration of definitions and models. BMC Public Health, 12, 80. Töpfer, C. & Sygusch, R. (2014). Gesundheitskompetenz im Sportunterricht. In S. Becker (Hrsg.), Aktiv und Gesund? Interdisziplinäre Perspektiven auf den Zusammenhang zwischen Sport und Gesundheit (S. 153-179). Wiesbaden: Springer VS. Contact clemens.toepfer@fau.de

## WHAT CHILDREN DO AND DON'T LIKE ABOUT TAKING PART IN SPORT: USING FOCUS GROUPS TO INVESTIGATE EXPERIENCES OF CHILDREN WITH HEARING LOSS

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**Introduction** Limited participation in physical activity and sport has been linked to poorer mental and physical health in children (Bailey 2006). For children in particular, participation in sport can help to develop social skills, communication and improved self-confidence resulting in an improved quality of life (Janssen & LeBlanc 2010). Children with hearing loss should have the same opportunities to participate in sport and receive the benefits as their hearing peers. Anecdotal evidence suggests this isn't always the case. This is concerning given there are 45,000 children in the UK with permanent hearing loss. The aim of this study was to understand what encourages or discourages children with hearing loss to take part in sports. **Methods** Ethical approval for the study was obtained from the University of Nottingham School of Medicine ethics committee. We conducted eight focus groups with children with hearing loss aged 10 to 15 years. A total of 45 children (19 male, 26 female) recruited from local schools and sports clubs took part. Information was gathered on the children's thoughts and feelings about participation in sport. The focus groups included an activity to facilitate discussion about sports. This included whether they played sports and who with, whether they did or did not like sport, and why they got involved in sport. Focus groups were audio recorded and transcribed. Transcripts were analysed using thematic analysis. **Results** Several key themes were identified as being associated with levels of sports participation. These included friendships, family and communication. Children with hearing loss with active siblings had participated in more sports. Communication was a common theme throughout regardless of the type of hearing-assistive technology a child used. Children found communication easier during sport if they were allowed to use their

technology and had particular difficulty during sports such as swimming. Children expressed a desire not to have to identify themselves at a club as having a hearing loss. This affected their confidence when participating in sport. Discussion Not surprisingly, children with hearing loss are more likely to participate in sport if they have a good support network of parents, coaches and friends. Key barriers to participation for these children are communication, lack of visual information, lack of opportunity and a lack of awareness. By addressing these issues more children with hearing loss will take part in sport and will continue their participation. References Bailey R. (2006). *Journal of School Health*, 76 (8), 395-401 Janssen I and LeBlanc A. (2010). *International Journal of Behaviour Nutrition and Physical activity*, 7(40), 1-16 Contact sarah.somerset@nottingham.ac.uk

## Oral presentations

### OP-PM38 Cognitive Function

#### EFFECTS OF THREE-MONTH AEROBIC-STRENGTH TRAINING ON COGNITIVE FUNCTIONS AND METABOLISM IN SENIORS WITH MILD COGNITIVE IMPAIRMENT.

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**Introduction:** Mild cognitive impairment (MCI) is accelerated cognitive decline associated with an increased risk of Alzheimer's disease. Prevalence of MCI increases in elderly (>65yrs of age). Regular physical exercise is physiological and effective means of preserving or improving cognitive functions, especially at early stages of cognitive decline. **Methods:** Cognitive healthy seniors (n=6/6, M/F, 65.2±2.2yrs) and seniors with amnesic MCI (aMCI, n=3/11, M/F; 72.7±1.8yrs) were recruited. Phenotyping before/after 3-month intervention included cognitive tests (Addenbrooke's Cognitive Examination, ACE-R; Mini Mental State, MMSE; computerized test MemTrax), assessment of resting metabolic rate (RMR, indirect calorimetry), body composition (quadrupedal bioimpedance), glucose metabolism (oral glucose tolerance test, oGTT) and physical activity (questionnaires & accelerometers). Individual cognitive domains of ACE-R were evaluated. Physical fitness (Rockport Walking Test), muscle strength (dynamometry) and motor functions (10-Meter Walk Test, 10-MWT; Chair Stand Test, CST) were assessed. Exercise intervention consisted of supervised progressive aerobic-strength training: 1h 3x/w, 60-70% VO2max or 60-70% 1RM, resp. **Results:** Three-month training improved cognitive functions in MCI individuals (ACE-R: p=0.009), modulating specifically short-term memory (p<0.001). Body composition, BMI, glucose metabolism and RMR did not change with training (p>0.05). However, 2h insulinemia (oGTT) was negatively associated with verbal fluency (r=-0.32, p=0.03) and attention/orientation (r=-0.32, p=0.02). MemTrax score did not change with training (p>0.05), however, reaction time improved in both control (by 41%) and MCI (by 50%) groups (p<0.0001). Short term memory performance (ACE-R) correlated negatively with serum lactate in baseline fasting state (r=-0.40, p=0.05), immediately after 45min bicycling (r=-0.49, p=0.01) and after 1h recovery (r=-0.69, p=0.001). MMSE score was associated with maximal force of knee extension, walking speed and CST (p<0.05 for all). **Discussion:** Three-months supervised aerobic-strength training improved cognitive and muscle functions in seniors with MCI. Our results indicate the importance of metabolic health and physical fitness for cognitive performance. Grant support: SAS-NSC Joint Research Cooperation grant, VEGA 2/0191/15

#### EFFECT OF "EXERCISE PROGRAM" APPLIED TO ALZHEIMER'S PATIENTS ON COGNITIVE FUNCTIONS AND QUALITY OF LIFE

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**Introduction:** Alzheimer's disease is a progressive neurodegenerative disorder that causes various neuropsychiatric behavioral disorders and dysfunctions in activities of daily living together with intellectual retardation (Arent and Lutz 2015). Exercises done by Alzheimer's patients are very important in improving the quality of life of older people and increasing cognitive function or preserving the existing wellbeing. **Objective:** The aim of this study was to investigate the effect of an 'Exercise Program' applied to patients with moderate Alzheimer's disease on their cognitive functions and quality of life. **Methods:** The study was experimental with a pretest-posttest control group. The experimental group included 60 Alzheimer's patients (30 in the experimental group, 30 in the control group) who were determined by physicians, who were diagnosed with Alzheimer's, who were in the moderate stage of the disease (SMMSE score: 13-22), and who were allowed to do physical activity practice. The elderly people in the experimental group were administered an exercise program during a total of six weeks as determined by experts. The exercise program consisted of 30-minute walks and 30-minute regular rhythmic exercises three days per week. The control group were not administered any exercise. Before starting and at the end of the exercise program, the patients were administered the Standardized Mini Mental State Examination (SMMSE) and the Quality of Life Scale in Alzheimer's patients. Data were analyzed using Mann-Whitney and the Wilcoxon test. **Results:** The mean age of the experimental group was 76.62±4.74 and that of the control group was 77.26±6.84. The pre-exercise SMMSE mean score of the patients in the experimental group (16.34±4.57) increased significantly (19.26.3±5.74) after the application (z=3.164;p=0.00). However, there was no significant difference between the pre-test and post-test mean scores in the control group (p>0.05). Similarly, the quality of life mean score of the patients in the experimental group increased from 20.06±3.24 before the exercise program to 26.75±4.72 following the program (z=0.623;p=0.00). A comparison of the post-test mean scores received by the experimental and control groups on the SMMSE and the Quality of Life Scale in Alzheimer's patients showed that the experimental group received significantly higher scores than the control group (p<0.05). **Discussion:** The exercise program, which was administered three days per week throughout six weeks, improved the cognitive functions and quality of life of the Alzheimer's patients in this study (Arent and Lutz 2015; Scarmes et al., 2009). References Arent, SM, Lutz RS. (2015). *The Psychology of Supplementation in Sport and Exercise: Motivational Antecedents and Biobehavioral Outcomes. In Nutritional Supplements in Sports and Exercise* (pp. 23-48). Springer International Publishing. Scarmes N, Luchsinger JA, Schupf, N, Brickman AM, Cosentino, S, Tang MX, & Stern Y (2009). Physical activity, diet, and risk of Alzheimer disease. *Jama*, 302(6), 627-637. Contact: sefalok@gmail.com

## INDEPENDENT AND COMBINED INFLUENCE OF SALIVARY TESTOSTERONE AND DHEA IN THE COGNITIVE ABILITY TESTS OF INSTITUTIONALIZED ELDERLY WOMEN WITH LOW LEVELS OF PHYSICAL ACTIVITY

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**Introduction:** Aging has been associated with cognitive decline in longitudinal studies of elderly individuals (Williams et al., 2010) with strong evidence linking this cognitive decline with low levels of physical activity (LPA) (Robitaille et al., 2014). Some studies explored the hypothesis that these associations may be mediated by hormonal biomarkers and cognitive abilities (Hogervorst et al., 2012). The aim of this study was to investigate the independent and combined influence of salivary Cortisol (sCOR), Testosterone (sTES) and DHEA levels in the cognitive abilities of elderly woman with low LPA. **Methods:** A cross-sectional with 102 women (age =  $82 \pm 7.30$  years) recruited from four social and health care elderly centres was done using Mini-mental State Exam (MMSE), Symbol Modalities Test (SMT), Hopkins Verbal Learning Test (HVLT), Verbal Fluency Test (VFT) and Digital Span Test (DST) to characterize their cognitive abilities. Salivary levels of COR, TES and DHEA were measured by ELISA. The International Physical Activity Questionnaire was used to stratify the participants by LPA. Descriptive statistic, Pearson's correlation coefficient and multiple linear regression were used to verify the association between variables. **Results:** There was a significant inverse correlation between cognitive HVLT and SMT tasks with sTES and DHEA levels ( $p < 0.05$ ). Correlations between PAL and MMSEA, HVLT and VFT were also found. A linear regression showed that in subjects with mild/moderate cognitive impairment, sTES significantly influenced the cognitive profile in MMSE and SMT. **Discussion:** Our results show that salivary hormone levels of testosterone and DHEA were associated with cognitive performance and the later associated with physical activity levels. **References:** Eef Hogervorst, Angela Clifford, Jennifer Stock, X. X. and S. B. (2012). Exercise to Prevent Cognitive Decline and Alzheimer's disease: For Whom, When, What, and (most importantly) How Much? *Journal of Alzheimers Disease & Parkinsonism*, 2(3), 1000e117. Robitaille, A., Muniz, G., Lindwall, M., Piccinin, A. M., Hoffman, L., Johansson, B., & Hofer, S. M. (2014). Physical activity and cognitive functioning in the oldest old: within- and between-person cognitive activity and psychosocial mediators. *European Journal of Ageing*, 11(4), 333–347. Williams, J. W., Plassman, B. L., Burke, J., & Benjamin, S. (2010). Preventing Alzheimer's disease and cognitive decline. *Evidence Report/technology Assessment*, (193), 1–727. Contact ateixeira@fcdcf.uc.pt

## RELIABILITY OF A COMPUTERIZED BASKETBALL-SPECIFIC COGNITIVE ASSESSMENT

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For many athletes, especially team sport athletes, optimal performance involves more than just physical skill; it also requires high-functioning cognition. A reliable measurement of cognitive performance is needed for talent identification/development and to determine the efficacy of nutritional interventions. However, the ability to reliably measure cognitive performance depends strongly on the type of assessment being used. It is generally agreed that the best measure of cognition in team sport athletes involves an assessment that simulates the specific sport directly. Yet, very little information is available on cognitive performance tests specific to basketball athletes, particularly where reliability has been assessed. **Purpose:** To determine the reliability of a basketball-specific cognitive assessment protocol during a simulated basketball game with youth athletes. **Methods:** Seventeen competitive, male basketball players ( $17 \pm 1$  y,  $72.6 \pm 11.9$  kg,  $184.0 \pm 8.8$  cm) completed a familiarization visit followed by two identical experimental trials. Prior to each trial, subjects ate a consistent 24 h diet and were asked to only consume a 500 ml bolus of water and a provided granola bar in the 3 h period prior to the trial start time. The basketball protocol consisted of four ~20-min quarters (including rest breaks), in which subjects performed basketball drills on a court (involving sprinting, jumping, shooting, dribbling, and passing). Heart rate (HR; Polar Electro, Kempele, Finland) was measured continuously throughout the trial. At the beginning of each trial, subjects were given a brief mock scouting report consisting of a video (~7 min) with a voice-over informing the subjects of the fictitious team they will be playing. The scouting report included key skills and weaknesses of the opponents as well as the coach's key offensive and defensive strategies. At the end of each quarter the subjects were asked to answer four questions based on the scouting report. Paired samples t-tests, coefficient of variation (CV), and intraclass correlation (ICC) were used to assess the reliability of the athlete's cognitive performance between the two experimental trials. **Results:** Mean HR was not different between trials ( $160 \pm 11$  bpm vs.  $161 \pm 10$  bpm,  $p = 0.77$ ). There was no difference between trials in the mean number of questions answered correctly per quarter ( $3.2 \pm 0.4$  vs.  $3.3 \pm 0.5$  correct answers,  $p = 0.21$ ). The CV and ICC for the mean number of correct answers per quarter was 8.8% and 0.759 ( $p = 0.003$ ), respectively. **Conclusion:** This novel basketball-specific, cognitive assessment is reliable in 14-19 y old basketball players, and may be a useful tool to assess cognition for talent identification or development purposes, as well as to determine the efficacy of nutritional interventions.

## DOES MENTAL IMAGERY HAVE A POSITIVE EFFECT ON CLOSED MOTOR SKILLS IN TENNIS, FIELD HOCKEY AND SOCCER?

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**Introduction** Research has shown that preparatory imagery, or using imagery immediately before a performance, can improve performance in strength tasks and muscular endurance tasks (Vealey & Greenleaf, 2006). In addition, combining imagery with relaxation is more effective. Few studies have addressed the efficacy of mental imagery to improve precision on closed motor skills (Coelho et al., 2007; Hegazy, 2012). Therefore, the aim of this study was to analyze the effects of mental training on precision in tennis serve, field hockey hit and soccer penalty kick. **Methods** The intervention used an experimental design with a pre- and posttest. The experimental groups received both technical practice and mental training units including imagery and relaxation exercises on the court for a total of four weeks. The control groups received only technical practice for the same time period. A total of 156 subjects from Germany and Switzerland, aged between 14 and 35, were divided into 60 in tennis (35 male, 25 female), 54 soccer male and 42 field hockey male and one female all amateur athletes with a high skill level. The dependent variable was measured by a hit ratio of a precision test for tennis serve, field hockey hit and soccer penalty kick. In this test, each player played 20 attempt aimed at a target area. **Results** The results of ANOVA with repeated measurements showed a highly significant interaction effect between time and group in tennis ( $F_1, 55 = 22.6$ ;  $\eta^2 = .29$ ) and field hockey ( $F_1, 41 = 19.9$ ;  $\eta^2 = .33$ ). However, in soccer the interaction effect was not significant ( $F_1, 52 = 3.71$ ;  $\eta^2 = .67$ ). **Discussion** This improvement of precision, in the intervention group in comparison to the control group, demonstrates the effectiveness of posi-

tive imagery on closed motor skills in tennis and field hockey. The effect of the intervention can be seen as large (Cohen's  $d > 1.00$ ) in both games. For tennis, the intervention group improved their performance in the precision task by 4.1 hits in 20 trials, whereas, the control group improved only by 1.0 hits. For field hockey, the intervention group improved their performance in the precision task by 2.7 hits in 20 trials, whereas the control group decreased their performance by 0.4 hits in 20 trials. However, in soccer, the difference between the intervention and the control group was not significant. References Coelho RW et al. (2007). Perceptual and motor skills, 105(2): 458-468. Hegazy K (2012). Diss, Uni Konstanz Vealey RS, Greenleaf CA (2006). Applied sport psychology: Personal growth to peak performance 5th ed., 306-348. New York: McGraw-Hill. Contact khaled.hegazy@kit.edu

## Oral presentations

### OP-SH16 Physical Activity in Children

#### INTERVENTIONS IN OUTDOOR PLAY AREAS OF KINDERGARTEN AND EFFECTS ON USAGE PATTERNS AND PA OF GIRLS AND BOYS

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Introduction Results in the HAPPY-study indicate that preschool children spend 85% of waking time being sedentary (Hinkley et al., 2012), and less than 50% of the children meets physical activity (PA) guidelines and recommendations (Tucker, 2008; Nicaise et al., 2011). The findings of the baseline study (E1) in the "KinderGarten"-project (8 kindergartens,  $n=333$  children; Dikettmueller et al., 2014) showed significant differences in PA-levels between girls and boys, esp. of boys with migrant background (highest proportions of time in MVPA). Whereas the offer of specific physical activity programs was associated with higher PA levels of both sexes, large-sized outdoor areas did not automatically lead to higher levels of PA. So the intervention focused on spatial changes, regulations of using the spaces as well as pedagogical concepts. Methods In the evaluation study (E2) of the project physical activity behavior of children in 4 kindergartens (2,5-6yrs) was collected on three time-points during outdoor play time through direct observation, where types of activity of girls and boys were identified and integrated into maps of activities. In addition, PA was measured by accelerometer ( $n=140$ ). The results (maps of activity) and the accelerometer data were compared with the findings of the baseline study. Results Based on a methodological triangulation, the comparison of the findings of the baseline and evaluation study (E1, E2) illustrates changes in PA behavior due to spatial, organizational and pedagogical changes: markings led to less conflicts between children, to larger -scaled activities in the outdoor area and to a significant increase of steps of girls. Changes in regulations, like the allowance of using secluded or "hidden" spaces (e.g. behind trees, bushes, ...) empowered the children to explore new spaces, enlarged the number of activity patterns and significantly the amount of PA of girls and boys. Discussion The discussion of the results with kindergarten teachers show who important the discussion and visualization of results in activity maps of each kindergarten and the accelerometer-derived physical activity data were to ensure awareness of kindergarten teachers. References Dikettmueller R, et al (2014). Physical activity of girls and boys in outdoor play areas of Kindergarten. ECSS Book of abstracts Amsterdam. Hinkley T, et al (2012). The HAPPY Study. JSMS 15, 407-417. Nicaise V, Kahan D, Sallis J. (2011). Correlates of MVPA among preschoolers during unstructured outdoor play periods. PrevMed 53, 309-315. Tucker P (2008). The physical activity levels of preschool-aged-children: a systematic review. Early Childhood Res Q, 23(4), 547-558.

#### EVALUATION OF BASIC MOTOR COMPETENCIES IN PRIMARY SCHOOL CHILDREN – VALIDITY OF THE MOBAK-1 TEST INSTRUMENT

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Introduction A central aim of physical education (PE) is the promotion of basic motor competencies (in German: Motorische Basiskompetenzen; MOBAK) which are prerequisites for children's active participation in sports culture. While instruments for measuring motor abilities in schoolchildren have been developed, less is known about the measurement of MOBAK. We introduce a newly developed measure of MOBAK for children aged six to eight years (first and second grade) made up of eight dichotomous items (e.g., throwing, catching, rolling, jumping; see Herrmann, Gerlach & Seelig, 2015). Methods  $N=1099$  primary school children (493 girls,  $M=6.9$  years,  $SD=0.52$ ) took part in a study focused primarily on construct validity of the test instrument. In addition, we investigated the relationship between MOBAK and motor abilities such as strength and demographic and individual differences variables BMI, sex and age. Confirmatory factor analyses (CFA) and structural equation models (SEM) were performed using MPlus. Results We found two factors consisting of four items each, confirming results of previous studies (Herrmann et al. 2015). The first factor "Locomotion" included the items throwing, catching, bouncing and dribbling, the second factor "Object-Control" included the items balancing, rolling, jumping, and moving variably. CFA revealed good model fit indices ( $CFI=.95$ ;  $RMSEA=.044$ ). Adding the motor ability tests long-jumping and sprinting into the model with the eight MOBAK-items did not result in a change of the MOBAK factor structure. Instead, motor abilities formed a separate factor "strength", which had a significant influence ( $CFI=.97$ ;  $RMSEA=.030$ ) on the factors "Locomotion" ( $\beta = .60$ ) and "Object-control" ( $\beta = .50$ ). An additional model including the variables BMI, sex and age as covariates of "Locomotion" and "Object-Control" indicates a satisfactory model fit ( $CFI=.90$ ;  $RMSEA=.036$ ). As expected older pupils achieve better results than younger pupils in both "Locomotion" ( $\beta = .09$ ) and "Object-Control" ( $\beta = .24$ ), whereas we found mixed results for BMI (pupils with high BMI achieved lesser results only for "Locomotion" ( $\beta = -.35$ ) but not for "Object-Control") and sex (boys being better in "Object-Control" ( $\beta = -.46$ ) whereas girls achieved higher results in "Locomotion" ( $\beta = .07$ )). Discussion The developed MOBAK test instrument meets psychometric validity demands, i.e. factorial, prognostic and discriminant validity. The eight-item test instrument is suitable for the evaluation of effects of PE. References Herrmann C, Gerlach E, Seelig H. (2015b). Measurement in Physical Education and Exercise Science, 19(2), 80-90. Contact c.heim@sport.uni-frankfurt.de



## INCREASING PHYSICAL ACTIVITY LEVELS IN PRIMARY SCHOOL PHYSICAL EDUCATION: THE SHARP PRINCIPLES MODEL

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**INTRODUCTION** There is limited evidence of effective physical education (PE) interventions in England to increase children's moderate to vigorous physical activity (MVPA) (Lonsdale et al., 2013). Thus the main aim was to implement and evaluate the effectiveness of a one-year intervention, to increase children's MVPA levels during primary school PE. **METHODS** A quasi-experimental non-equivalent groups design was employed, involving four classes (children aged 7 to 9 years: baseline, n=111; post intervention, n=95) from two primary schools in the West Midlands, England. In March 2014 schools were purposefully selected according to size and demographics. The intervention was grounded in the Self Determination Theory (SDT) (Ryan and Deci, 2000), the Social Ecological Model (SEM) (Mc Leroy, 1988) and three 'active ingredients' from the Behaviour Change Taxonomy (BCT) (Michie et al., 2011). The intervention included: the development of a new PE school policy; the creation of a new curriculum map; providing on going support; and developing teachers' awareness of children's PA in PE. Children's MVPA in PE was assessed at baseline and post intervention, using the System for Observing Fitness and Instruction Time (SOFIT); a total of 28 PE lessons were observed. Four teacher interviews were conducted with the intervention school, to explore teachers' perceptions of the intervention. **RESULTS** A two-way ANOVA indicated large interaction effect sizes for time spent in MVPA ( $F(1, 27) = 11.07, p=0.003, \eta^2=.316$ ) and VPA ( $F(1,27)=8.557, p=.007, \eta^2=.263$ ). MVPA in the intervention school increased significantly (42-72%) whereas in the control school MVPA remained constant (42-45%). The qualitative findings revealed two main emergent themes: a paradigm shift and teachers' advanced pedagogical understanding. **DISCUSSION** As the intervention was successful in increasing MVPA in PE, a 'SHARP Principles Model' was created with the following pedagogical principles at its core: Stretching whilst moving; High repetition of motor skills; Accessibility through differentiation; Reducing sitting and standing; and Promoting in class PA. The application of the SHARP principles could be seen as the first step towards improving pedagogical practice in PE when used with a curriculum focused school programme, having the potential to improve the quality of PE in primary schools in England. **REFERENCES** Lonsdale C, Rosenkranz RR, Peralta LR, Bennie A, Fahey P, Lubans DR (2013). *Prev Med*, 56(2), 152 -161. Mc Leroy K, Bibeau D, Steckler A, Glanz K (1988). *Health Educ Quart*, 15, 351-377. Michie S, Ashford S, Sniehotta FF, Dombrowski SU, Bishop A, French DP (2011). *Psychol. Health* 26 (11), 1479-98. Ryan RM, Deci EL (2000). *Am. Psychol.* 55 (1), 68 – 78. CONTACT e.powell@newman.ac.uk

## EFFECTS OF A 5-DAY OUTDOOR SPORTS INTERVENTION ON ENVIRONMENTAL ATTITUDES IN CHILDREN

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**Introduction:** The ability of environmental education programs is shown to influence environmental attitudes positively (Kruse and Card, 2004; Johnson and Manoli, 2011). But there is not much about the effect of outdoor sport programs on environmental attitudes. The present study examines the impact of 5-day extra-curricular outdoor sport interventions on environmental attitudes in 11-14 years old children. **Methods:** 288 students completed the intervention (male: n=157, 12.1±1.2 years; female: n=131, 11.9±1.1 years). To measure students' environmental attitudes, we administered the "Two-Major-Environmental-Values-Scale" (2-MEV) developed by Bogner and Wiseman (2006). The 2-MEV consists of two higher order factors: utilization and preservation of nature. A pre-, post- and retention-test design was used. For further analyses students were assigned to the type of their secondary school (secondary general school (GEN; n=41), intermediate secondary school (INT; n=20), comprehensive school (COM; n=31), grammar school (GRAM; n=196)) and the population of the town where the school is situated (POP+: >100.000 (n=107), POP-: <100.000 (n=181)). **Results:** Wilcoxon signed-rank tests revealed a positive short-term effect for the overall group for the factor utilization (pre:  $2.26 \pm 0.73$ , post:  $2.13 \pm 0.75$ ;  $p=0.000$ ). Further comparisons showed a positive effect on utilization (pre:  $2.42 \pm 0.82$ , post:  $2.22 \pm 0.84$ ;  $p=0.000$ ) and preservation (pre:  $3.11 \pm 0.79$ , post:  $3.23 \pm 0.77$ ;  $p=0.018$ ) scores for POP+, but only on utilization for POP- (pre:  $2.16 \pm 0.65$ , post:  $2.08 \pm 0.68$ ;  $p=0.003$ ). Additionally there was a positive increase also for the factor preservation in GEN students (pre:  $2.86 \pm 0.89$ , post:  $3.10 \pm 0.89$ ;  $p=0.010$ ), whereas there were no program-induced changes for INT or COM. No persistence of changes in environmental attitudes could be found. **Discussion:** The 5-day extra-curricular outdoor sports programs affected students' environmental attitudes positively. The outdoor sports interventions showed similar effects compared to environmental education interventions (Sellmann and Bogner, 2013). Interventions seem to be most effective for children from urban areas and for secondary general school students representing a lower level of education. However, the improvement did not persist after the program. Consequently, a program design focusing even more on a combination of outdoor sports and education for sustainable development may support a long-term outcome. **References** Bogner FX, Wiseman M (2006). *Environmental*, 26(4), 247-54. Johnson B, Manoli CC (2011). *J Environ Educ*, 42(2), 84-97. Kruse CK, Card JA (2004). *J Environ Educ*, 35(4), 33-45. Sellmann D, Bogner FX (2013). *Eur J Psychol Educ*, 28(3), 1077-86. Contact m.limmer@dshs-koeln.de

## SO SIMILAR AND SO DIFFERENT TO OTHER KIDS! PHYSICAL ACTIVITY AND SPORTS AMONG CHILDREN WITH DOWN'S SYNDROME

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**Introduction** About 100 children with Down's Syndrome (DS) are born in Sweden every year. According to the Swedish National Sports Confederation, these children have the right to play sports and to be physically active like other children. Sports for children should be based on children's own needs and circumstances and take into account the variations in development. The question is whether this also is applied to children with DS? Children with DS have been shown to have low fitness, poor motor skills, high prevalence of overweight and very low participation in sports activities (Whitt-Glover et al, 2006). **Methods** Information was obtained by a questionnaire performed among families with children with DS. Information was given by the parents. The questionnaire was partly inspired by the questionnaire CAPE (Children's Assessment of Participation and Enjoyment) (King et al, 2004). Furthermore, new additional questions focusing on physical activity and sports participation, attitudes and living habits among both children and adults were included. The sample consisted of 60 children with DS aged 8-18 years and their families in Southern Sweden. The statistics were carried out by using PASW. **Results and discussion** The activity patterns among children with DS seemed to be quite similar with patterns among other children. A polarized picture emerged in which some are very active and some are completely inactive. Relationships between parents' own level of physical activity and children's activity could be shown, as well as associations between parental involvement in the activities and children's activity levels. However, the parents expressed the difficulties children with DS have to participate in sports together with other

children. The difficulties were mainly lack of motor skills, perceptual difficulties, poor movement planning and difficulties in changing directions that were seen as the main obstacles for the children with DS. Some parents also indicated a lack of endurance capacity and rapid mood swings as additional factors that contributed to the difficulties. The parents didn't experience any negative reactions from other children or parents when children with DS participated in the same sports activities as other children. However, the parents had a feeling that the children with DS pull down the activity tempo of the whole group, but they have not been exposed to direct comments from other parents about this. References King, G, Law, M, King, S, Hurley, P, Kertoy, M et al. (2004). Children's Assessment of Participation and Enjoyment (CAPE) and Preferences for Activities of Children (PAC). San Antonio, TX: Harcourt Assessment, inc. Whitt-Glover, M.C., O'Neill, K.L., Stettler, N. (2006). Physical activity patterns in children with and without Down syndrome. *Pediatric Rehabilitation*, 9 (2): 158-64

## Oral presentations

### OP-PM34 Pacing Strategies

#### OPTIMAL PACING STRATEGIES AND ASSOCIATED METABOLIC RESPONSES DURING 4-MIN SELF-PACED RUNNING TIME-TRIALS

MCGAWLEY, K., WATKINS, J., PLATT, S., ANDERSSON, E.

*Mid Sweden University*

**Introduction** A fast start followed by a progressive slowing (i.e., a positive pacing profile) has been identified during competitive sporting events lasting 1.5 – 5 min (Ansley et al., 2004; Tucker et al., 2006). An increase in power output towards the end of such events may also occur, which can result in a negative (i.e., faster second half) pacing strategy (Foster et al., 2004). The aim of the current study was to investigate individual pacing strategies and the distribution of physiological resources during 4-min self-paced running time-trials (TTs). **Methods** Five male and five female recreational runners (age  $32 \pm 7$  y) with best 5- and 10-km run times of  $19.5 \pm 1.8$  min and  $40.1 \pm 3.3$  min completed a sub-maximal ramp test and five, 4-min self-paced running TTs on a motor-driven treadmill on separate days. The treadmill was fitted with lasers allowing participants to automatically modify speed during the TTs. The accumulated oxygen deficit (AOD) was calculated by estimating the VO<sub>2</sub> demand throughout each TT from the submaximal linear relationship for speed and VO<sub>2</sub>, then subtracting actual VO<sub>2</sub>. **Results** Distance covered, accumulated VO<sub>2</sub> and AOD for best and worst performances were  $1137 \pm 94$  and  $1094 \pm 94$  m ( $P < 0.001$ ),  $203 \pm 19$  and  $199 \pm 22$  mL/kg ( $P = 0.02$ ) and  $34.1 \pm 7.4$  and  $31.1 \pm 7.2$  mL/kg ( $P = 0.08$ ), respectively. Peak lactate was significantly higher after best ( $11.1 \pm 2.2$  mmol/L) vs worst ( $9.7 \pm 1.5$  mmol/L) performance ( $P = 0.03$ ), while relative aerobic contribution (approx. 86%,  $P = 0.20$ ) and peak heart rate (approx. 96% of maximal heart rate,  $P = 0.41$ ) were not different. Significantly more distance was covered during the first 2 min of the best vs worst performance ( $565 \pm 53$  vs  $528 \pm 41$  m,  $P < 0.001$ ). This was associated with a significantly higher accumulated VO<sub>2</sub> ( $P = 0.01$ ) and AOD ( $P < 0.001$ ) during the first 2 min for the best vs worst performance. By contrast, there was no difference between the best vs worst performance for distance covered ( $572 \pm 47$  and  $567 \pm 57$  m), accumulated VO<sub>2</sub> or AOD during the final 2 min. **Discussion** Findings from the current study show that negative pacing strategies were adopted during both the best and worst performances. Best performance was associated with a greater mean speed, accumulated VO<sub>2</sub> and AOD during the first half of the TT compared with worst performance. A fast start appears effective in minimizing the performance deficit in the first half of a 4-min running TT and maximizing aerobic and anaerobic energy production. References Ansley L, Schabort E, St Clair Gibson A, et al. (2004). *Med Sci Sports Exerc*, 36, 1819-25. Foster C, De Koning JJ, Hettinga F, et al. (2004). *Int J Sports Med*, 25, 198-204. Tucker R, Lambert MI, Noakes TD (2006). *Int J Sports Physiol Perform*, 1, 233-45. Contact [kerry.mcgawley@miun.se](mailto:kerry.mcgawley@miun.se)

#### THE PSYCHOPHYSIOLOGICAL DETERMINANTS OF PACING DURING PROLONGED ENDURANCE EXERCISE: PERFORMANCE LEVEL COMPARISON

VENHORST, A., MICKLEWRIGHT, D., NOAKES, T.D.

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**Introduction:** The Central Governor Model (CGM) revolutionized our current understanding of fatigue and ignited a paradigm shift in the exercise sciences from catastrophic failure towards central regulation. However, the CGM and alternative psychobiological models rely heavily on the Gestalt measurement of perceived exertion to explain behavioral change. This is an oversimplification of the underlying psychophysiological construct. Drawing from Gate Control Theory of pain, a modified three-dimensional model of effort was applied to explore the distinct inputs that shape the perceptual milieu and underpin the goal directed behavior of pacing. **Methods:** Delineated contributions of the sensory-discriminatory, affective-motivational, and cognitive-evaluative dimensions were approximated by means of scales: physical-rating of perceived exertion (p-RPE) and mental sense of effort (TEA), affective valence (FS) and felt arousal (FAS), and perceived action crisis (ACRIS), respectively. Cyclists of different performance levels (PL3, n=12 and PL4, n=11) performed a 70 km individual time trial over a virtual profiled course. The interrelationships between pacing strategy, performance, hematological, and perceptive variables were explored. **Results:** PL4 performed at greater workloads ( $p = 0.015$ ) and higher relative intensities ( $p = 0.042$ ) compared to PL3, and had greater blood norepinephrine ( $p = 0.045$ ) and lactate levels ( $p = 0.039$ ). Despite greater physiologic strain, PL4 felt more pleasure ( $p = 0.045$ ) and better maintained hedonic tone and arousal levels ( $p = 0.022$ ), which deteriorated in PL3 over the last third of the course. FAS correlated with all markers of cardiovascular fitness and performance ( $p < 0.05$ ). Split times were faster in PL4 except during the downhill ( $p = 0.001$ ), which coincided with lower p-RPE ( $p = 0.018$ ) compared to PL3. p-RPE correlated with dynamic change in cortisol ( $p < 0.01$ ). **Discussion:** The current data revealed differences in pacing strategies between performance levels and indicate that perceptions of peripheral strain (approximated by p-RPE) were closer related to dynamic changes in pace than perceptions of mental strain (approximated by TEA). Data also showed a performance level dependent relationship between core affect and performance providing evidence for the important role of affective states in the regulation of exercise behavior. Well-trained cyclists paced themselves in a way that prevented the development of an action crisis, suggestive of performance level dependent differences in the integration and interpretation of perceptual sensory and affective cues. The proposed model provides additional and differential information on the complex processes underpinning exercise behavior. Contact [andreas.venhorst@gmail.com](mailto:andreas.venhorst@gmail.com)

**MODERATING EFFECT OF TRANSCUTANEOUS ELECTRICAL NERVE STIMULATION ON PACED EXERCISE**

HIBBERT, A.W.1, VARLEY, M.C.1,2, BILLAUT, F.1,3, PETERSEN, A.1, POLMAN, R.C.J.1,4

*1: Institute of Sport, Exercise and Active living (ISEAL), Victoria University, Australia; 2: ASPIRE, Qatar; 3: Université Laval, Canada; 4: Bournemouth University, United Kingdom*

**INTRODUCTION** Afferent information from exercising muscle contributes to the sensation of exercise-induced muscle pain (O'Connor et al, 1999). Muscle pain enables conscious awareness of muscle stress and provides information in order to make appropriate pacing decisions (Mauger et al, 2010). Transcutaneous electrical nerve stimulation (TENS), is a process in which low-voltage electrical currents are delivered in order to inhibit ascending afferent information. The use of TENS in reducing exercise-induced pain has not yet been fully explored. This study aimed to investigate the effect of TENS on exercise-induced muscle pain, pacing strategy and performance during a 5-km cycling time trial (TT). **METHODS** On 3 separate occasions, 10 recreationally active participants underwent a 30-min TENS protocol (High intensity (TENS), low intensity (PLACEBO) or no TENS (CONTROL)) applied to the quadriceps, prior to performing a 5-km TT. Quadriceps fatigue was assessed by maximal voluntary contractions (MVC) and evoked responses to magnetic stimulation. Subjective scores of exertion, affect and pain were taken every 1-km. **RESULTS** Application of TENS was associated with greater mean power ( $p=0.08$ ), and resulted in reduced TT duration compared to PLACEBO ( $p=0.09$ ). Increased performance after TENS was achieved with greater power output at the start of the TT (250-m (Increased by 21%;  $p=0.02$ ) compared to CONTROL, and 750-m (Increased by 19%;  $p=0.05$ ) compared to PLACEBO). TENS application did not produce any differences in MVC or evoked responses. Sensations of pain ( $p=0.31$ ), perceptual scores of exertion ( $p=0.70$ ) and affect ( $p=0.20$ ) did not exhibit any significant difference between conditions. **DISCUSSION** Pacing and performance during the 5-km TT was influenced by the application of TENS. Stimulating afferent fibres did not influence sensations of pain and exertion but allowed for an increased power production. This data supports evidence that self-paced exercise is modified so that exercise-induced pain is regulated to an individual's sensation threshold (Mauger et al, 2010). Analgesic effects to pressure pain have been reported 30-mins after TENS application has ceased (Moran et al, 2011). However, residual analgesia for exercise-induced pain may be limited, thus explaining how the TENS session followed a similar pacing strategy to CONTROL and PLACEBO conditions, after the initial greater power output. **REFERENCES** Mauger A, et al. (2010). *J Appl Physiol*, 108(1), 98-104. Moran F, et al. (2011). *J Pain*, 12(8), 929-935. O'Connor P, et al. (1999). *Exerc Sport Sci Rev*, 27, 119-166. **CONTACT** Andrew.hibbert1@live.vu.edu.au

**PREVIOUS ACTIVE COGNITIVE TASK DOES NOT AFFECT SUBSEQUENT SELF-PACED EXERCISE IN THE HEAT**

ROUSSEY, G., GRUET, M., VERCRUYSEN, F., BERNARD, T.

*University of Nice Sophia Antipolis / University of Toulon Var*

**INTRODUCTION** Prolonged periods of strenuous cognitive activity has recently been demonstrated to negatively influence the self-regulated physical tasks and is likely to compromise endurance performance (Brownsberger et al., 2013). In this framework, no studies have yet investigated whether or not hot ambient conditions modified the previously observed production of less power during hard effort bout. The aim of this study was to compare impact of two different (active vs passive) cognitive tasks preceding a hard self-paced exercise in temperate and hot ambient conditions on power output, thermal state and thermal comfort perceived. **METHODS** In a randomized cross-over design, ten well-trained male cyclists completed four 30-min cycling trials at self-selected intensity representative of hard effort (RPE15-Hard), either in temperate (TMP, 20°C) or in hot conditions (HOT, 35°C). Before exercise, participants completed during 60 min either a Stroop-incongruent activity task or a time-matched passive task (control). Physiological, psychological indices were assessed throughout the four trials. **RESULTS** Pre-exercise tasks induced similar subjective feelings of fatigue in spite of higher mental workload induced by cognitive activity task ( $p<0.05$ ). No effect on power and any other assessed variable during the cycling trial has been observed in both ambient conditions. Mean power was significantly lower in HOT than in TMP ( $64.8\pm4.0$  vs  $70.7\pm5.0$  %PMA respectively,  $p<0.001$ ) but pacing design were not be affected. Average values of skin temperature ( $p<0.001$ ) and thermal sensation ( $p<0.001$ ) were significantly higher in HOT whereas heart rate and central temperature were similar. **DISCUSSION** The present study, using an original model of self-paced exercise (Tucker et al. 2006), shows strong links between mean power, higher skin temperature and thermal sensation in the heat. These findings support that perceived exertion plays a key role in self-selected work rate during exercise in the heat through behavior thermal feelings (Schlader et al. 2011). Similar levels of mental fatigue reached the previous two cognitive tasks could explain the lack of difference in perception of effort. **REFERENCES** Brownsberger J, Edwards A, Crowther R, Cottrell D. (2013) Impact of mental fatigue on self-paced exercise. *Int J Sport Med*, 34, 1029-36. Schlader ZJ, Simmons SE, Stannard SR, Mündel T. (2011) Skin temperature as a thermal controller of exercise intensity. *Eur J App Physiol*, 111, 1631-39. Tucker RT, Marle T, Lambert EV, Noakes TD. (2006) The rate of heat storage mediates an anticipatory reduction in exercise intensity during cycling at a fixed rating of perceived exertion. *J Physiol*, 574, 905-15.

# Saturday, July 9th, 2016

08:00 - 09:30

## Oral presentations

### OP-PM45 Extracellular Biomarkers

#### INCREASES IN CIRCULATING CELL-FREE DNA DEPEND ON INTENSITY DURING REPEATED SPRINT EXERCISE

HALLER, N., TÄNNY, P., PETRY, J., SIMON, P.

*Johannes-Gutenberg-University Mainz*

**Introduction:** Circulating cell-free DNA (cfDNA) is becoming increasingly important in molecular diagnostics. Diseases and disease states like cancer, sepsis or trauma associated with inflammation lead to elevated cfDNA levels.<sup>2</sup> Additionally, acute and chronic increases in cfDNA concentrations have been demonstrated to occur in a variety of exhausting exercise settings.<sup>1</sup> Here we assessed for the first time the effects of two repeated sprint exercises differing in pause time on cfDNA levels in human blood plasma. **Methods:** 9 subjects (mean age: 23.6 years  $\pm$  1.7 years; mean height: 179.6 cm  $\pm$  7.9 cm; mean weight: 80.9 kg  $\pm$  9.9 kg) were randomly assigned in two groups (A and B). After a 15 minute warm-up all subjects performed 5 sprints of 40m each. The pause between the sprints was 5 minutes for group A and only 1 minute for group B. After a pause of 75 minutes, the participants repeated the sprint exercise but switched in terms of pause time (cross-over design). Capillary cfDNA from the finger tip and lactate from the ear lobe was measured before, after the warm-up, after every sprint and after the whole series. Venous plasma was drawn before, after the first and after the second sequence of sprints. **Results:** Venous cfDNA increased on average 2.4-fold after the short pause sprints and significantly lower 1.9-fold after the 5 minute pause sprints ( $p < 0.05$ ). Respective lactate increases were 3.4 fold after long pause exercise and 4.9-fold after 1 minute pauses (n.s.;  $p \geq 0.258$ ). Capillary samples did not increase constantly. Venous cfDNA correlated significantly with lactate ( $r = 0.69$ ;  $p < 0.05$ ). **Discussion:** We show for the first time, that repeated sprints lead to a significant increase in venous cfDNA. Shorter pause time and thus a higher intensity of the exercise lead to significantly higher increases of venous cfDNA. Lactate in contrast showed significant increases after 5 sprints but there was no significant difference between short und long pause sprints. Capillary cfDNA blood sampling seems not to be applicable for such short term exercise. Future studies will have to clarify whether cfDNA could be a more appropriate marker for intensity than established parameters. Additionally, controlled longitudinal studies have to clarify intra-individual differences in cfDNA concentrations and reveal the potential of cfDNA as a marker in exercise settings. **References:** Breitbach, S., Tug, S., & Simon, P. (2012). Circulating Cell-Free DNA. *Sports Medicine*, 42(7), 565-586. Van Der Vaart, M., & Pretorius, P. J. (2008). Circulating DNA. *Annals of the New York Academy of Sciences*, 1137(1), 18-26.

#### EFFECTS OF VO<sub>2</sub>-UPTAKE ADJUSTED DOWNHILL AND UPHILL RUNNING ON CFDNA AND CONVENTIONAL EXERCISE MARKERS

OCHMANN, D., HELMIG, S., SIMON, P.

*Johannes Gutenberg-University Mainz*

**Effects of VO<sub>2</sub>-uptake adjusted downhill and uphill running on cfDNA and conventional exercise markers** **Introduction** We observed in previous studies that running leads to significantly higher increases of cell-free DNA (cfDNA) in capillary blood than a comparable cycling protocol. Following the idea that this effect might be based on the more eccentric nature of running compared to cycling, we examined here whether uphill or downhill running adjusted to VO<sub>2</sub>-uptake leads to a differential effect on physiological markers and cfDNA increases. **Methods** Following VO<sub>2</sub>max-testing ten male triathletes took part in four different endurance runs (group). A 5 min warm-up, was followed by 3x10 min at either 60 % or 80 % of VO<sub>2</sub>-max at -3.5 % or +6.5 % incline on a treadmill. The tests included continuous recording of spi-roergometric data, and assessment of heart rate, lactate and cfDNA at rest, following warm-up, after every 10min interval, and 3, 15, and 30min after the runs. The normalized and homoscedastic Data fulfilling sphericity conditions were analyzed by multi-factorial analysis of variance with up/down, 60%/80% and point in time (Rest, 10', 20', 30') as influential factors. **Results** Compared with lactate, heart rate, and RER, cfDNA showed the most robust and significant step-wise increases during the run with an 8.0-fold (95% CI: 6.4-9.9;  $p < 0.0001$ ) in-/crease from rest to 30 min, adjusted for intensity and up/down. Except for heart rate none of the other factors was able to differentiate between uphill and downhill running at 60% of VO<sub>2</sub>max. However at 80% VO<sub>2</sub> max heart rate was not able to differentiate between uphill/downhill, while cfDNA values were on average 2.0-fold (95% CI: 1.6-2.5;  $p < 0.0001$ ) higher during downhill running at a significance level equal to the RER ( $p < 0.0001$ ) and much higher than lactate ( $p = 0.03$ ), both showing slightly higher values downhill. **Discussion** Compared to other physiological markers cfDNA reacts more sensitive to different intensities over a course of an endurance run. Compared to lactate, it showed a stronger association with eccentric load and duration of exposure. This suggests that the cfDNA could be a more sensitive marker especially in intermittent sports with varying intensity and duration and in particular varying eccentric load proportions than conventional exercise markers.

#### „CELL FREE CIRCULATING DNA IN SALIVA DURING INCREMENTAL EXERCISE“

SCHMIDT, S., HELMIG, S., STERZING, B., SIMON, P.

*University Mainz*

**Introduction:** Cell free circulating DNA (cfDNA) is an upcoming biomarker in sports physiology. Significant increases of cfDNA have been described in various exercise settings as well as under pathological conditions (Ziegler et al.). Increases of cfDNA can be up to 100-fold above normal resting levels, depending on intensity, severity or duration of the event or stimulus. So far it is unknown whether alterations in blood cfDNA are accompanied by respective changes in saliva. The aim of this study was to correlate measurements of cfDNA in saliva



with those in blood during incremental exercise test. Methods: 10 subjects participated in a standardized step-wise incremental exercise test on a treadmill with 3min intervals and increases of 2 km/h with every step starting at 6 km/h until exhaustion. Capillary blood and saliva samples using the SARTSTEDT salivette were taken before and after every step. Quantification of cfDNA in saliva and blood was done by a direct quantitative polymerase chain reaction (qPCR) that does not require DNA purification (Breitbach et al.). Results: Resting levels of cfDNA in saliva were on average about 2-fold higher than values in capillary plasma. While increases of cfDNA from rest to exhaustion in capillary plasma were 4,6-fold ( $p=0,0001$ ) the concentrations in saliva did not change significantly (1,6-fold,  $p=0,651$ ). No significant correlations of cfDNA values from saliva with markers for physical load like blood cfDNA, lactate, heart rate or Borg-values were found. This situation did not improve by correcting the cfDNA values with the respective changes in osmolality of the saliva. IN contrast a medium up to high correlation was found between capillary blood cfDNA concentrations and Borg-values ( $r=0,63$ ) or lactate ( $r=0,79$ ). Discussion: CfDNA values in saliva were principally measureable but in contrast to values from capillary blood failed to show an immediate response upon physical stress. At rest cfDNA values in saliva were higher than in blood. This could be due to either a physiological mechanism of cfDNA release, additional cfDNA sources other than blood or by technical bias involving sample preparation. To enable non-invasive measurement of cfDNA from saliva that reflects physiological alterations these factors need to be studied in more detail. References: • Ziegler, A., U. Zangemeister-Wittke, and R.A. Stahel, Circulating DNA: a new diagnostic gold mine? *Cancer Treat Rev*, 2002. 28(5): p. 255-71. • Breitbach, S., et al., Direct measurement of cell-free DNA from serially collected capillary plasma during incremental exercise. *J Appl Physiol* (1985), 2014. 117(2): p. 119-30. Contact: Sebastian Schmidt sschmi08@uni-mainz.de

## CIRCULATING MICROVESICLES DYNAMICS WITH EXERCISE AND THEIR IMPACT ON HUMAN VASCULAR CELL FUNCTION

WILHELM, E.N.1, GONZÁLEZ-ALONSO, J.1, RAKOBOWCHUK, M.2

(1) Brunel University London, Uxbridge, UK; (2) Thompson Rivers University, Kamloops, Canada

Introduction: Microvesicle formation and release into the bloodstream may be a mediated response that ultimately controls vascular cell phenotype and function, but the effect of a typical endurance exercise session on circulating microvesicle concentrations, and their impact upon surrounding endothelial cells remains unknown. Here, we tested the hypothesis that exercise intensity modulates the time-course of platelet-derived (PMV) and endothelial-derived (EMV) microvesicle appearance in the circulation through changes in vascular shear stress and biochemical agonists; and that microvesicles obtained during exercise would enhance angiogenic and reparative potential of endothelial cells. Materials and methods: Nine young healthy men ( $25\pm4$  years,  $1.79\pm0.09$  m,  $80.5\pm12.0$  kg) had venous blood samples taken to measure plasma microvesicle, interleukin-6 (IL-6) and noradrenaline (NA) concentrations prior, during, and throughout the recovery period after 1 h of moderate (MI) ( $36\pm5\%$  of  $VO_{2max}$ ) or heavy (HI) ( $62\pm4\%$   $VO_{2max}$ ) intensity semi-recumbent cycling and during a time matched control trial. Local haemodynamics were determined by ultrasonography. In vitro experiments were performed by incubating human umbilical vein endothelial cells with resting and exercise-derived microvesicles to examine their effects on cell morphogenesis, proliferation and migratory capacity. Results: Circulating PMVs only increased from baseline with HI exercise (from  $21.2\pm3.4$  to  $55.8\pm24.8$  and  $48.0\pm16.6 \times 1000$  PMV/ $\mu$ l at 30 and 60 min, respectively;  $P<0.05$ ), returning to baseline early in post-exercise recovery ( $P\geq0.05$ ), whereas EMVs were unchanged ( $P\geq0.05$ ). Brachial artery vascular shear rate (non-exercising limb) increased more during HI ( $3.1\pm1.5$  fold) compared to MI ( $1.9\pm0.4$  fold) exercise ( $P<0.05$ ), and changes in PMVs were related to limb shear rate ( $r^2=0.43$ ), and NA ( $r^2=0.21$ ) ( $P<0.05$ ), but not to IL-6 ( $P\geq0.05$ ). Incubation of microvesicles obtained during exercise with endothelial cells enhanced their proliferation, migration, healing of scratch wound (all  $P<0.05$ ), and angiogenesis compared to resting microvesicles and microvesicle free plasma control. Discussion: These results demonstrate substantial increases in circulating PMVs with heavy exercise and that shear stress is a potential mechanism triggering this response. The increased microvesicle pool also enhanced functional capacity of human endothelial cells by stimulating angiogenesis and repair. This involvement of microvesicles may be considered a novel mechanism through which exercise mediates vascular healing and adaptation.

## METABOLOMIC INVESTIGATION OF THE EFFECTS OF DIFFERENT EXERCISE TYPES IN INDIVIDUALS WITH METABOLIC SYNDROME

SIOPI, A., DEDA, O., MANOU, V., KELLIS, S., THEODORIDIS, G., CHRISTOULAS, K., MOUGIOS, V.

Aristotle University of Thessaloniki

Introduction Metabolic syndrome (MetS), a condition that involves known cardiometabolic risk factors, such as hyperglycemia, hypelipidemia and increased blood pressure, shows alarmingly increasing rates. Exercise holds a primary role in the treatment and prevention of MetS. A metabolomics study was performed to investigate whether the response of the human urinary metabolic fingerprint to exercise depends on the presence of MetS or the type of exercise performed. Methods Twenty-three sedentary men were divided into two groups: healthy ( $n=9$ ) and MetS ( $n=14$ ). All participants completed four trials randomly: rest, high-intensity interval exercise (HIIE), continuous moderate-intensity exercise (CMIE) and resistance exercise (RE). Urine samples were collected pre-exercise and 1, 3 and 24 h post-exercise for targeted metabolomic analysis by liquid chromatography-mass spectrometry (HILIC-UPLC-MS/MS), followed by repeated-measures ANOVA on the 63 identified metabolites. Results Overall, 6 metabolites presented significant differences between groups, 30 metabolites presented significant differences between trials and 46 metabolites exhibited significant fluctuations over time. Alanine was the only metabolite to present a significant 3-way interaction. Nine metabolites shared the pattern of being higher in the MetS group at all trials except CMIE, where the order was reversed. Fifteen other metabolites presented differences between groups at different trials. Alanine, asparagine, glutamate, glycine, guanine, 4-hydroxyphenyllactate, serine, threonine, tryptophan and xylose were higher in MetS in RE. For glycine, tryptophan and tyrosine, that was also the case in REST and HIIE. Eight metabolites showed significant interactions between time and group; of those, hypoxanthine, kynurenate and proline were higher in MetS 1 h after exercise. Independent of group, alanine, hypotaurine, methionine, serine, tryptamine and trimethylamine increased 1 h after RE only. Guanine, homocysteine, hypoxanthine, kynurenate, lactate, monoisoamylamine and pyruvate increased 1 h after HIIE and RE, while hypoxanthine remained elevated 3 h post-exercise. Twelve more metabolites showed differences between trials and time points. Discussion We have found a multitude of diverse responses of the urinary metabolic fingerprint to different types of exercise in men with and without MetS. Our findings suggest the differential stimulation or inhibition of several metabolic pathways of potential physiological relevance and support the value of urinary metabolic fingerprinting in the study of exercise metabolism. Contact Siopi A.: aikasiop@phed.auth.gr

## Oral presentations

### OP-PM60 Molecular Exercise Physiology

#### SIRTIUIN PATHWAYS AND REDOX HOMEOSTASIS: STUDY ON YOUNG AND OLD TWIN COUPLE

GRAZIOLI, E., DIMAURO, D., FANTINI, C., DURANTI, G., BIANCHINI, S., SGRÒ, P., SBRICCOLI, P., SABATINI, S., PARISI, P., DI LUIGI, L., CAPOROSSI, D.

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Sirtuins are NAD<sup>+</sup> dependent deacetylase that play a key role in the regulation of many processes related to homeostasis, such as the regulation of metabolism, apoptosis, DNA repair and inflammatory response. Studies on humans reported a relation between the alteration of their expression and the incidence of various diseases such as metabolic, cardiovascular, cancer and neurodegenerative diseases. Accordingly to literature, the maintenance of their optimal level of activity is considered important to ensure a low risk of pathologies related with the aging process. Indeed, SIRT1 has been correlated with the redox homeostasis maintenance and with the levels of oxidative damage. The aim of this study is to verify the correlation between sirtuins' expression, histone deacetylation, redox status in young and old monozygotic/dizygotic twins couple and the possible relation with a physically active status. For this study we took advantage from blood samples of young (20-40 years old) and old (70-80 years old) monozygotic and dizygotic twin couples, where we analyzed the different expression of SIRT1 and SIRT2, lysine acetylation proteins, Histone H4 acetylation and the protein carbonilation in PBMCs and the plasma level of oxidized and reduced glutathione and malondialdehyde. We also evaluated the intra-pair correlation of all the markers reported above. The twin couples performed functional tests (i.e. Vo2max, 1RM strength test, balance test) and the Baecke questionnaire Physical Activity (General physical activity, Sport and Leisure level) in order to understand if there is a relation between the fitness level, the sirtuins activity and the redox homeostasis balance. Our analysis reported a decreased SIRT1 levels in the Old group that should lead to a reduced response to redox and inflammatory homeostasis and to the stress hormonal response. Interestingly we experienced that the genetic component seems to be influenced by aging in lymphocytes, especially regarding the oxidative system. Life span and other senescent processes are very sensitive to genetic background; this is the reason because the twin model can help to better understand the interaction between genetic and further epigenetic effects in the age.

#### NOVEL ROLE OF SIRTIUIN RELATED MECHANISMS IN OVERLOAD-INDUCE HYPERTROPHY OF SKELETAL MUSCLE IN RAT

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**Introduction** Skeletal muscle is a dynamic organ, which can change its metabolic rate by many fold during intensive contractions. The multi-nucleated myocytes as a result of resistance training can readily increase their size, indeed, the role of satellite cells in this process is still contradictory. The major member of sirtuin protein family, SIRT1 has been implicated as one of the key regulator in cell metabolism, but its involvement in muscle hypertrophy have not been investigated. SIRT1 has been shown to deacetylate eNOS, FOXO1 and activate Akt (Lee and Goldberg, 2013). Therefore, we suggested that SIRT1 can be a potential regulator of prosynthetic and catabolic processes during compensatory hypertrophy of skeletal muscle. **Methods** Middle aged (15 months) male Wistar rats were used in the study and assigned to control and hypertrophy (N=7) groups. Overload of the plantaris muscle was performed bilaterally via removal of their major synergistic muscles, the gastrocnemius and soleus, as described previously. The surgical procedure was performed under deep anesthesia. The overload period lasted for 2 weeks. Plantaris muscle samples frozen in liquid nitrogen were analyzed by immunohistochemistry, ELISA, western blot and fluorescence technic, and the differences between groups were calculated by t-test (p<0.05). Results Fourteen days of overloading resulted more than 30% increase in the mass of plantaris muscle (p<0.01) compared to control group. Histochemical evaluation of satellite cell marker, Pax7 proteins showed significantly elevated Pax7 levels in hypertrophy group. The markers of muscle differentiation, MyoD and PCNA levels were significantly higher in hypertrophy group compared to control. The level of NAD dependent SIRT1 increased by hypertrophy and the NAMPT levels showed similar changing pattern. p53 is deacetylated by SIRT1 and the level of acp53 decreased in hypertrophy group. Contrary, the eNOS and Akt levels elevated significantly by muscle hypertrophy, while the FOXO1 protein concentration decreased by this treatment. The changes in the levels of ubiquitin ligase and protein ubiquitination suggest, that during hypertrophy ubiquitin mediated signaling pathway also activated. **Discussion** Our data suggest that novel regulatory role of SIRT1 in overload-induce hypertrophy of skeletal muscle. The rate of NAD<sup>+</sup> biosynthesis and the SIRT1 activity - judged by acp53 level - further support the activation of SIRT1-related pathways during hypertrophy. SIRT1 modulates prosynthetic pathways through eNOS, Akt activation and down-regulation of catabolic processes by inhibiting FOXO1 and proteasome's protein degradation. References Lee, D., Goldberg, A.L., 2013. SIRT1 protein, by blocking the activities of transcription factors FoxO1 and FoxO3, inhibits muscle atrophy and promotes muscle growth. *J Biol Chem* 288, 30515-30526.

#### EARLY INSULIN RESISTANCE INDUCED BY PHYSICAL INACTIVITY IS ASSOCIATED WITH A REDUCTION IN MUSCLE GLUT4 CONTENT, AND NOT TO DEFECTS IN SKELETAL MUSCLE INSULIN SIGNALING

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**Introduction** Physical inactivity is a major consequence of technological developments and contributes to increase the risk of development of type 2 diabetes, cardiovascular diseases, colon and breast cancer, depression and dementia. Insulin resistance, the hallmark of type 2 diabetes, is becoming a leading cause of death and morbidity in the world. Dramatic reduction of physical activity rapidly induces insulin resistance. Herein, we aim to determine the early molecular events by which physical inactivity affects skeletal muscle insulin sensitivity. **Methods** To this purpose, young mice were placed in cages with free access to running wheels for seven weeks. Then, wheels were blocked for 10 days to study the effect of physical inactivity. At the end of the protocol, blood was removed to determine glucose and insulin concentrations in fasting state. Due to their role in insulin signaling defects, muscle triglycerides and ceramides levels were determined by UHPLC-ESI-MS/MS. Skeletal muscle insulin sensitivity was assessed by an ex-vivo experiment in which the tibial anterior was stimulated with insulin. In this approach, the phosphorylation states of the insulin receptor substrate 1 (IRS-1) at Ser302 and Akt at Ser473 were assessed by Western blot and used as markers of the insulin pathway. Muscle glucose transporter 4 (GLUT4) mRNA and protein

levels were measured by, respectively, Q-PCR and Western blot. Results and discussion HOMA2-IR index and serum insulin level were higher in inactive than active mice, demonstrating thereby that 10 days of physical inactivity induces insulin resistance. Glucose tolerance (OGTT test) was not different between inactive and active mice. In the ex-vivo experiment, the phosphorylation states of the insulin signaling markers, IRS-1 at Ser302 and Akt at Ser473, were not modified by physical inactivity. Despite an intramuscular triglyceride accumulation in inactive mice, both saturated and unsaturated ceramide levels remained unchanged compared to active mice. Altogether, these results indicate that a short period of physical inactivity does not affect the insulin pathway. GLUT4 mRNA level did not differ between both groups, but GLUT4 protein content was significantly lower in inactive compared to active mice. Consequently, physical inactivity-induced early insulin resistance seems related to a reduction in muscle GLUT4 protein content rather than defects in insulin signaling. References Pierre N, Appriou Z, Gratas-Delamarche A, Derbré F. (2015). *Free Rad Biol Med* [Epub ahead of print]

### DNA METHYLATION AGE IS ASSOCIATED WITH MUSCLE STRENGTH

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Novel biomarkers of biological aging – telomere length and DNA methylation age – correlate strongly with chronological age across the life course (Chen et al. 2011, Horvath 2013). It is, however, unclear how these measures of cellular wear and tear are associated with muscle strength and functional capacity, which are known to decline with older age and are associated with mortality. We investigated, if leukocyte telomere length (LTL) and DNA methylation age (DNAm age) are associated with physical performance and body composition. 48 monozygotic twin sisters were examined. Relative LTL was measured by qPCR (Ahola et al. 2013). Methylation age (DNAm Age, predicted years) was calculated from the DNA methylation data using the online DNAm age calculator tool (Horvath 2013). Body mass index was calculated from measured weight and height (BMI, kg/m<sup>2</sup>). Percentage of body fat and total body lean mass was estimated by bioimpedance. Physical performance was measured by grip strength, knee extension strength and 10 m walking test. Data was analysed by regression models using all individuals and within-pair dependency of twin individuals was taken into account using the cluster option (Stata 14). Mean LTL was 0.91±0.15 and mean DNAm age was 58.4±6.6 years, which is slightly lower than chronological age 61.3±5.9 years. Pairwise correlations between twin sisters were high in LTL ( $r=0.71$ ,  $p<0.001$ ,  $n=22$  twin pairs) and in DNAm age ( $r=0.89$ ,  $p<0.001$ ,  $n=24$  twin pairs). LTL was not associated with physical performance measures or body composition. Higher DNAm age was associated with higher BMI ( $r^2=0.079$ ,  $p=0.045$ ) and lower grip ( $r^2=0.17$ ,  $p=0.001$ ) and knee extension strength ( $r^2=0.23$ ,  $p=0.003$ ). After adjusting these models for chronological age DNAm age was independently associated with grip strength ( $p=0.001$ ). Intrapair correlations showed that there is a strong genetic impact both in LTL and DNAm age. Present findings suggest that LTL has at most weak associations with body composition and physical performance. A novel estimate of the individual biological aging process, DNAm age, seems to be associated with BMI and muscle strength. Higher DNAm age was associated with lower grip strength independently of chronological age. Whether DNA methylation explains decline in muscle strength with aging needs further studies. References Ahola et al. *PLoS One* 2012;7(7):e40186. Chen et al. *J Gerontol A Biol Sci Med Sci*. 2011 Mar;66(3):312-9. Horvath s. et al. *Genome Biol*. 2013;14(10):R115.

## Oral presentations

### OP-BN12 Running Biomechanics 1

#### CHANGES IN RUNNING KINEMATICS AND KINETICS AFTER A 12-WEEK RUNNING PROGRAM FOR BEGINNERS

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Introduction Running is a popular and feasible way of becoming physically active. With reported incidences of overuse injuries up to 70 percent<sup>1</sup>, the injury risk amongst recreational runners is substantial. In a recently published systematic review by Videbaek et al.<sup>2</sup>, it was reported that novice runners have a higher injury risk compared to more experienced recreational runners. This difference in injury risk may result from differences in loading patterns during running between trained and untrained runners. In our previous study (unpublished results), we found a difference in running style between highly trained and untrained runners. We hypothesize that running kinematics and kinetics change with training. Therefore, the aim of this study is to determine the changes in running kinematics and kinetics following a 12-week running program for beginners. Methods 17 novice runners (11 females, 6 males) underwent a 3-dimensional running analysis before and after following a running program. This program consisted of 12 weeks of three running sessions per week, in which the training distance was increased weekly. Overground running kinematics and kinetics were measured using a 10-camera Vicon system (Vicon, Oxford, UK) with a full-body marker model, and a force platform (AMTI, Watertown, US). Joint angles and moments of the hip, knee and ankle of one leg per subject were calculated in Vicon Bodybuilder and averaged over three stance phases. Peak joint angles, moments and ground reaction forces (GRF) were analyzed using a paired-samples t-test. Results After the running program, runners ran with less hip adduction during stance phase (mean difference 1.3 degrees, SD = 2.5,  $p = 0.049$ ). There was no difference in other joint angles and joint moments between the pre- and posttest. Peak vertical GRF was decreased (mean difference 0.09 bodyweight, SD = 0.1,  $p = 0.025$ ). Discussion/conclusion This study showed that with training, novice runners decreased their hip adduction and peak vertical GRF. Although the absolute differences are small, both variables are associated with injury risk<sup>3,4</sup>. These findings support the hypothesis that runners change their running kinematics and kinetics with training in a way that reduces injury risk. References 1 Ferber R et al. Suspected mechanisms in the cause of overuse running injuries: a clinical review. *Sports Health* 2009. 2 Videbaek S et al. Incidence of running-related injuries per 1000 h of running in different types of runners: a systematic review and meta-analysis. *Sport Med* 2015. 3 Davis I et al. Greater vertical impact loading in female runners with medically diagnosed injuries: a prospective investigation. *Br J Sports Med* 2015. 4 Noehren B et al. ASB clinical biomechanics award winner 2006 prospective study of the biomechanical factors associated with iliotibial band syndrome. *Clin Biomech (Bristol, Avon)* 2007.

### THE EFFECT OF SEX, PERFORMANCE STANDARD, AND SPEED ON RUNNING ECONOMY

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**Introduction** The efficiency with which metabolic energy turnover can be converted into forward locomotion i.e. running economy is an important determinant of endurance running performance. Traditionally, running economy has been defined as the oxygen required to maintain a given speed or to cover a given distance. However, it is now known that the oxygen cost is not reflective of the underlying energetic demands and, thus, is an invalid measure of running economy (Fletcher et al. 2009). Due to the methodological inaccuracies of previous investigations, the influence of sex, performance standard, and speed on running economy is unclear and warrants further investigation. **Methods** Following ethical approval, 24 elite (males, n=14; females, n=10) and 73 recreational (males, n=35; females, n=38) runners completed a discontinuous incremental treadmill test for the determination of the caloric unit cost of submaximal running (Erun, kcal.kg<sup>-1</sup>.km<sup>-1</sup>), speed at lactate turnpoint (sLTP) and VO<sub>2</sub>max. Fingertip capillary blood samples were obtained at the completion of each 4 min stage, and breath-by-breath pulmonary gas exchange data were measured continuously throughout. **Results** For the whole cohort, males and females had similar Erun when measured over the same range of running speeds (8-11 km.h<sup>-1</sup>, P=0.345), or when sub-samples of runners were analysed between 8-17 km.h<sup>-1</sup> (all P>0.05). The elite group had a lower Erun at each absolute (-10%) and at each relative (-19% to -7%) running speed compared to the recreational group (all P<0.001). Erun of the elite group was significantly influenced by speed whether expressed in absolute or relative terms (both P<0.001). For example, post hoc tests revealed a 'u-shaped' relationship in which Erun was greater for low (8-10 km.h<sup>-1</sup>) and high (17 km.h<sup>-1</sup>) speeds compared to moderate speeds (11-16 km.h<sup>-1</sup>). A similar profile of response was observed when speed was expressed relative to the sLTP. **Discussion** The results demonstrate that when running economy is expressed as the caloric unit cost of running that: 1) there is no sex-specific difference; 2) elite endurance runner's exhibit better running economy than recreational endurance runners, and; 3) there is an optimal speed for economical running. Fletcher et al. (2009). *J Appl Physiol*, 107, 1918-1922.

### ARE TWO-DIMENSIONAL MEASURED PEAK FRONTAL PLANE JOINT EXCURSIONS RELATED TO THREE-DIMENSIONAL MEASURED KINEMATIC PROFILES DURING RUNNING?

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**Introduction:** The ability to accurately assess kinematics during running in clinical settings is an essential component in the process of preventing running (re-)injuries. The primary purpose of the present study was to investigate the temporal relationship between two-dimensional (2D) measured peak frontal plane joint excursions and three-dimensional (3D) measured kinematic profiles during the stance phase of running in elite athletes. The second purpose was to assess the intra- and intertester reliability of the 2D measured joint angles. **Methods:** Fifteen elite injury-free athletes (6 males, 9 females; age: 18.79±1.67 years) participated in the study. All participants completed 4 overground running trials with a self-selected speed. Maximal contralateral pelvic drop, hip adduction and knee valgus angles were measured through 2D video analysis during midstance. Simultaneously with the 2D video analysis, 3D motion analysis was performed to measure kinematic profiles of the contralateral pelvic drop, hip adduction and knee valgus angles throughout the whole stance phase of running. Both legs were tested. The mean of 4 trials was calculated for both 2D and 3D outcomes. One-dimensional statistical parametric mapping linear regression was used to investigate the temporal relationship between peak 2D angles and 3D kinematic profiles. The 2D videos of the right legs of all athletes were analyzed twice by two independent testers. Intra-class correlation coefficients were calculated to assess the intra- and intertester reliability of the 2D measured angles. **Results:** The 2D measured contralateral pelvic drop and hip adduction angles were significantly related to the corresponding 3D measured kinematic profile during respectively 0 to 82% (P<0.0001) and 22 to 76% (P=0.0095) of the stance phase. No significant relationships were found for 2D and 3D measured knee valgus. The intraclass correlations coefficients showed excellent intra- and intertester reliability for the 2D measured angles (0.90-0.99). **Discussion:** Two-dimensional measured contralateral pelvic drop and hip adduction angles were significantly related to their corresponding 3D measured kinematic profiles during the majority of the stance phase. Furthermore, these 2D angles can be measured with excellent intra- and intertester reliability using 2D video analysis. These findings support the use of clinical-friendly frontal plane 2D video analysis to measure contralateral pelvic drop and hip adduction angles during running as an alternative methodology for 3D motion analysis. Contact: bart.dingenen@faber.kuleuven.be

### THE EFFECT OF AN INNOVATIVE NON-MOTORIZED TREADMILL ON WALKING AND RUNNING BIOMECHANICS

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**Introduction** Walking and running on a treadmill is a diffused sporting activity for wellbeing and sports specific training. Developers of fitness equipment put their efforts in enhancing the flexibility of machines that multiplies the exercises, providing different combination of effort and ambient biofidelity. Traditional motorized treadmills can be compared with non-motorized ones (Sinclair et al, 2013), flat surfaces with curved surfaces (Smoliga et al., 2015). Aim of the study was to study the effect on walking and running biomechanics at different speeds performed by a group of subjects in three different treadmills: a conventional motorized flat treadmill (Technogym Artis TRD), a passive curved treadmill (WOODWAY Curve) and an innovative tunable non-motorized curved treadmill named SkillMillTM (SKM). **Methods** Surface EMG of 12 muscles on right hand side of each subject were investigated applying 2 pre-gelled bipolar electrodes on each muscle: Tib.Ant.(TA), Gastr. Med. (GAM), Vastus med.(VAM), Biceps fem. (BFCL), Rectus fem. (RF), Gluteus max. (GLMA), Rectus abd. (RA), Adductor (ADCL), Erector spinae (ERS), Pect. major (PECM), Lat. dorsi (LD), Triceps brach. (TBCL). Kinematics data were collected by means of an optoelectronic system (BTS), using 12 reflective markers placed in specific bony landmarks. Eight healthy male subjects with similar level of fitness were involved. Each one was asked to walk at 6 km/h, run at 12 and 18 km/h. Walking against an additional resistance on the SKM treadmill (PWLK) was also included in the tests. EMG signals were rectified, integrated with a moving window of 200 ms, filtered at 6 Hz and normalized to the gait cycle. Signals were averaged over 5 consecutive cycles, defined between two consecutive right heel strikes. **Results** Walking on non-motorized curved treadmills resulted in an increased ROM at the ankle (+10%) and the trunk (+50%); on the contrary, when running on the curved treadmills trunk ROM decreased significantly. The trunk mean forward leaning angle increased on curved treadmill, in particular with high resistance on SKM (PWLK). Peak Muscle activation resulted consistently higher in GASM, VAM, BFCL, GLMA, during PWLK than other conditions. When running on SKM at moderate and high speed, GASM and GLMA showed higher



average activations than on TRD. Discussion Results highlight the ability of an adjustable non-motorized treadmill in enhancing the muscle activation on antigravitational muscles; the combination with a curved surface widens the range of motion at the ankle but reduces the trunk ROM when running. This can be correlated with lower impact loads at the feet, as reported by the subjects, due to the curved treadmill surface. References Fellin, R.E., Manal, K., Davis, I.S. (2010) J Appl Biomechanics, 26 (4), 407-414. Sinclair, J., Richards, J., Taylor, P.J., Edmundson, C.J., Brooks, D., Hobbs, S.J. (2013) Sports Biomechanics, 12, (3), 272-282. Smoliga, J., Hegedus, E., Ford, K., (2015), Physical Therapy in Sport 16(3) 262-267.

## RELIABILITY OF BIOMECHANICAL INJURY INDICATORS THAT UNDERPIN RUNNING GAIT

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**Introduction** The aim of the study was to evaluate the reliability of discrete biomechanical running gait measures associated with injury. In addition, waveform analysis was conducted to examine the similarity between data sets from different data collection sessions. **Methods** Ten participants performed 10 running trials ( $3.60 \pm 0.18\text{m/s}$ ). Lower limb marker coordinate and ground reaction force data were collected using a 12 camera infra-red system (100Hz) synchronised with a force plate (1000Hz). The data collection protocol was repeated 1 week later. ANOVA was used to determine differences between the group means from each data collection session for discrete vertical force (VGRF) measures, lower body joint angles and moments. For both data collection sessions the reliability (R) of each measure was determined when the group mean was calculated from 10 trials/participant and 1 trial/participant. The Spearman-Brown prophecy formula established the number of trials required to achieve  $R > 0.90$  for each measure. Statistical parametric mapping (SPM) was used to analyse waveform similarities throughout the stance phase of running gait. **Results** No significant differences were found between each data collection session for all discrete measures examined. An  $R > 0.95$  was achieved for all discrete measures when the group means were determined from 10 trials/participant. Reducing the trials to 1/participant caused a decrease in R for all measures particularly the peak hip flexion moment and hip, knee, ankle sagittal plane ranges of motion. To achieve  $R > 0.90$  across all measures a minimum of 5 trials/participant were required however for the rate of vertical force to first peak, knee flexion and adductor moments only 1 trial/participant was required. The SPM analysis showed significant differences in the VGRF during the first 20% of the stance phase. Discussion Excellent reliability ( $R > 0.95$ ) of biomechanical indicators of injury can be achieved when the mean of ten trials/participant are used which can then be accurately used to enhance the understanding of running related injuries. In situations where fewer trials are available we recommend a minimum of five to achieve  $R > 0.90$ . Waveform analysis provided further insight on the continuous biomechanical changes throughout the stance phase of running. The VGRF differences in the first 20% of the stance phase between the two data collection sessions further supports that the impact phase during running is 'an independent phenomenon' (Bobbert et al., 1991) and that the attenuation of the continuous forces remain inconclusive. Runners demonstrate high variability and seem to develop extensive adaptive capability where impact is concerned. References Hamill J, Haddad J, McDermott W. (2000). J App Biomec, 16, 407-418. Bobbert M, Schamhardt H, Nigg B. (1991). J Biomec, 24(12), 1095-1105. Contact c.diss@roehampton.ac.uk

## Oral presentations

### OP-BN09 Postural Control

#### THE INFLUENCE OF POSTURAL THREAT AND TASK DIFFICULTY ON CORTICOSPINAL EXCITABILITY AND SHORT-INTRACORTICAL INHIBITION

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**Introduction** When individuals experience a potential threat to their balance, they respond by standing with less sway variability but at a higher sway frequency (Adkin et al., 2000). While this "stiffening" strategy is believed to arise through spinally-mediated mechanisms (Sibley et al., 2007), no studies have attempted to examine whether processes at the cortical level also adapt in situations of postural threat. Therefore, our participants completed three balance tasks of varying difficulty at ground level (low threat) or 3 m above ground level (high threat). This combination of balance tasks and surface heights enabled the determination of whether cortical excitability was altered through changes in postural task difficulty, postural threat or both. **Methods** We examined the interaction between postural threat (low threat vs. high threat) and balance task (supported standing vs. normal standing vs. unstable standing) on corticospinal excitability (MEP) and short-interval intracortical inhibition (SICI) in the soleus (SOL) and tibialis anterior (TA) muscles. **Results** MEP amplitudes of SOL were influenced by task ( $p < 0.001$ ) and height ( $p = 0.03$ ) main effects. Not only were SOL MEPs larger during the low compared to the high height condition, post-hoc tests revealed that MEPs were different between all three standing tasks. The largest test MEPs occurring during the unstable, followed by the free standing and supported standing condition. MEP amplitudes in TA were solely affected by a task main effect ( $p < 0.001$ ). MEPs obtained during the unstable condition were larger than those from the free and supported conditions. The amount of SICI was influenced by a task main effect both in SOL ( $p = 0.01$ ) and TA ( $p < 0.001$ ) but not by height. In SOL, there was a decrease in SICI during the unstable compared to the free standing condition ( $p = 0.019$ ) as well as a trend towards a decrease during the free compared to the supported standing condition ( $p = 0.077$ ). Post-hoc analyses in TA indicated reduction of SICI during the unstable compared to both the free ( $p = 0.005$ ) and supported ( $p = 0.003$ ) standing conditions. **Discussion** Our data suggest that the presence of postural threat does alter corticospinal excitability, indicated by modulation of the MEP. However, based on the SICI data, it is unlikely that intracortical inhibitory processes are responsible for this modulation. Intracortical inhibition seems rather to be limited to situations when the physical constraints, i.e. the task difficulty, of a postural task are modified. References Adkin AL, Frank JS, Carpenter MG, Peysar GW. (2000). Gait Posture, 12, 87-93. Sibley KM, Carpenter MG, Perry JC, Frank JS. (2007). Hum Mov Sci, 26, 103-12. Contact martin.keller@unifr.ch

## POSTURAL CONTROL IN THE CONTEXT OF GOAL-DIRECTED ACTION

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**Introduction** In opposite to the classical "quite stance"-paradigm of research on postural control, Stoffregen and his colleagues (e.g., Stoffregen et al., 2007) supposed from an ecological point of view that postural control is functionally integrated into a context of action, which is specified by a superordinate task or goal ("suprapostural tasks"). Results of a meta-analysis (Bund & Lippens, 2009) clearly support the ecological approach to human postural control. Postural control is not an end in itself! Methods In general, our experimental settings in investigating balance performance are similar to those of Stoffregen et al. (2000), except that we prefer the more challenging postural control conditions on an unstable platform (@ MFT S3 check system; e.g., Raschner et al., 2008). The participants (N= 24; age= ~ 24 y) underwent randomized repeated trials (without and with suprapostural task: searching for letters in a text) of monopodal standing on the balance-measurement platform. Results An ANOVA of the balance data (index of sensomotoric) revealed a main effect for the factor task (F(1; 22)= 13.1, p= .00,  $\eta^2_{part} = .37$ ). No effect for the sequencing of the trials was found. No differences in performance of the suprapostural task were obtained. Discussion According to other recent studies (e.g., Lippens et al., 2007) these results show a considerable effect of suprapostural tasks on balance performance. Movement patterns emerge according to personal, environmental and task constraints (Newell, 1986). The modulation of task and environmental constraints is an underestimated method to investigate appropriate movement task solutions for postural control. The reduction of body sway, during the performance of a visual suprapostural task, is consistent with the concept of functional integration. The postural performance is "nested" within other task goals" (van Emmerik 2007, p. 34; cf. Riccio 1993).

## INDIVIDUAL POSITION VARIABILITY UNDER DIFFERENT CONDITIONS TO ASSESSMENT POSTURAL ANALYSIS WITH THE AID OF RASTER STEREOGRAPHY

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**Introduction** Raster stereography is a common method to measure 3d-surfaces to assess human posture. Currently, there is no standard for positioning of subjects in front of the device. In addition, the position variability of subjects in front of a measurement device has not been investigated and no norm data is documented. The visual system as well as the positioning of the feet play an important role for postural control processes. Research is needed to determine any intervention effects on posture beyond natural variability. The aim of the study was to define natural positioning variability of subjects. In addition, potential influences of the visual system and the feet positioning on positioning variability were of interest. Methods In this study 3d back shape analysis (MiniRot-Kombi, abw GmbH) of 15 subjects (9 ♀, 6 ♂;  $40.3 \pm 11$  yrs;  $172.7 \pm 10,8$  cm) were assessed in 4 different randomly arranged conditions: eyes open and closed and standardized foot position or not. Based on 6 predefined anatomical landmarks, 6 postural parameters were determined: deviation of the spine in the frontal plane, deviation of the spine in the sagittal plane, difference of the angulus inferior left and right in y-axis and in z-axis, differences of the SIPS left and right in y-axis and in z-axis. The position variability was defined by means of mean standard deviation (SD) for one parameter over 10 repeated measures per condition. A potential influence of the condition on the variability of the six parameters of the back surface was tested using linear mixed model statistics ( $\alpha \leq 0.05$ ). Results The mean position variability is ranging for the deviation of the spine in the frontal plane from  $2.4 \text{ mm} \pm 0.71$  to  $3.06 \text{ mm} \pm 2.4$ , for the deviation of the spine in the sagittal plane from  $4.96 \text{ mm} \pm 1.88$  to  $5.91 \text{ mm} \pm 2.29$ , for the difference of the angulus left and right in y-axis from  $1.69 \text{ mm} \pm 0.73$  to  $2.06 \text{ mm} \pm 1.51$  and in z-axis from  $3.1 \text{ mm} \pm 0.96$  to  $3.71 \text{ mm} \pm 1.03$  for the difference of the SIPS in y-axis from  $0.43 \text{ mm} \pm 0.2$  to  $0.53 \text{ mm} \pm 0.28$  and in z-axis  $1.33 \text{ mm} \pm 0.71$  to  $1.55 \text{ mm} \pm 0.59$ . Statistics did not identify any differences of positioning variability between tested conditions. Discussion From the results we can conclude that our tested conditions have no influence on the variability of posture, defined by six parameters of the back surface. Therefore, it is optional and may be up to preference if 3d back shape analysis is performed in a standardized foot position or closed eyes. The data of natural position variability can help to objectively identify effects of aids and supporting tools in order to optimize human posture. Contact meike.bohlmann@tum.de

## CHANGES OF POSTURAL STABILITY DURING A REPEATED KARATE KICK TASK IDENTIFIED BY MEANS OF SUPPORT VECTOR MACHINES

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**INTRODUCTION** Technique training in Karate is usually based on movement repetitions. Hundreds of repetitions within one training session are not uncommon. Alterations of kicking movements within 20 repetitions have been reported by Quinzi et al. (2015). Especially when analyzing kicks, the supporting leg is a relevant factor for the movement result. The aim of this study is to identify changes of center of pressure (COP) variables of the supporting leg when executing a frontal karate kick (mae-geri) during fatigue accumulation by means of support vector machines (SVM). **METHODS** Thirteen experienced (minimum brown belt) karate practitioners (4 women, 9 men) performed 9 training sets of 60 kicks. The period of rest between the sets was 90 s. Each set consisted of alternating subsets of 10 repetitions of each leg. All kicks were performed at a frequency of 1 kick/2 s at submaximal intensity without impacting a target. Subjects stood with each foot placed on different force platforms (Kistler, Switzerland, 1000 Hz). COP data of the supporting leg was determined, low-pass filtered (30 Hz) and then discrete values (direction dependent and independent ranges, velocities and traces, and angular data) were calculated. Classifications of subjects, sets within subjects and subsets within sets were performed by applying SVM with linear kernel. The leave-one-out method was used for cross-validation. **RESULTS** Mean classification rates are considerably higher than expected by chance. The mean subject classification rate (chance: 7.7 %) is 69.3 % and varies for individuals from 13.8 % to 98.1 %. SVM application on sets (chance: 11.1%) resulted in a mean classification rate of 22.9 % for the right kicking leg (left: 23.8 %). The first sets show the highest classification rates (right: 42.6 %, left: 40.6 %), but rates decrease until the sixth set (right: 12.6 %, left: 11.0 %). For later sets the values increase. Misclassification occurred mainly to temporally adjacent sets. The classification rates of the subsets (chance: 33.3 %) were 42.7 % (41.0 %) for the mean and 46.4 % (43.5 %), 39.7 % (37.9 %) and 42.0 % (41.5 %) for subsets 1, 2 and 3, respectively. **DISCUSSION** Results of subject classification underline the relevance of individuality in technique execution. The relatively high classification rates of the first set when compared to later sets might be an effect of fatigue, but also of familiarization. Although COP variables do not discriminate perfectly the different sets, a time dependency is shown. Within sets, fatigue mainly has an effect on postural stability between the first and the

remaining subsets. REFERENCES Quinzi F, Camomilla V, Di Mario A, Felici F, Sbriccoli P (2015). Int J Sports Physiol Perform. Epub ahead of print. CONTACT eekhoff@uni-mainz.de

## AGE DIFFERENCES IN POSTURAL CONTROL ANALYZED VIA A PRINCIPAL COMPONENT ANALYSIS OF KINEMATIC DATA

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**Introduction** Postural control plays a major role in sports and in everyday life. It is achieved by coordinating the movements of all body segments. Age differences in postural control were observed, for example, as decreased stabilometric entropy (Kang et al. 2009) indicating reduced complexity of postural movements. However, what specific changes occur due to aging in the coordination or control of the postural movements remains unclear. In the current study, we hypothesized that aging leads to an altered coordinative structure of postural movements (H1); fewer movement adjustments (H2); or more irregular timing of these corrections (H3). **Methods** Twenty young (ages 20-30; 14 females and 6 males) and 20 older (55-70; 15 f, 5 m) volunteers performed a 100s-tandem stance. Their postural movements were quantified using 37 retroreflective markers captured at 240 Hz by an 8-camera motion capture system (Motion Analysis Corporation, Santa Rosa, CA, USA). The marker data was submitted to a principal component analysis. H1 was tested by comparing the subject specific relative variances (Federolf et al. 2013); H2 and H3 by comparing the number of zero-crossings  $N(k)$  and the standard deviation of the time between zero-crossings  $\sigma(k)$  of the  $k$ -th principal postural acceleration (Federolf, 2016). **Results** The first 12 principal movements explained over 98.5% of the total postural variance. The subject specific relative variances showed significant differences in the 2nd (lateral ankle sway; +3.4%;  $p=.035$ ), 9th and 11th (both combined head-elbow strategies; -0.7% and -0.4%;  $p=.020$  and  $p=.033$ ) components. The older volunteers showed decreased  $N$  and increased  $\sigma$  in the postural acceleration quantifying lateral ankle sway ( $N2$ : -2.6%,  $p=.038$ ;  $\sigma2$ : +20.7%,  $p=.028$ ), upper body rotation ( $N5$ : -2.5%,  $p=.043$ ;  $\sigma5$ : +6.4%,  $p=.022$ ) and a coupled knee- and hip flexion ( $N6$ : -2.7%,  $p=.025$ ;  $\sigma6$ : +8.1%,  $p=.016$ ). **Discussion** Our results supported H1, H2 and H3. Relative variance quantifies how much specific movement components contribute to the overall postural variations. The principal postural accelerations represent the neuromuscular control of these movement components. Our results therefore suggest that aging changes the coordinative structure of the postural movements and leads to fewer and more variable adjustments in the neuromuscular control of some movement components. Our study uses a novel approach to investigate neuro-mechanical control, allowing to identify what aspects of postural movements are affected by age. We expect that these results will help focusing fall prevention exercises to better address age-related deficits. **References** Federolf P. et al., (2013). J Biomech. 46(15), 2626-33. Federolf P., (2016). J Biomech., in press. Kang H., (2009). J Gerontol A Biol Sci Med Sci, 64(12), 1304-1311.

## Oral presentations

### OP-PM71 Injury Prevention & Rehabilitation

#### INJURY BURDEN IN FOUR SPORTS OF ADOLESCENT ELITE ATHLETES: A 52-WEEK PROSPECTIVE STUDY

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**Background:** The injury burden of adolescent elite athletes is in most sports limited or unknown, due to lack of prospective long-term injury surveillance reports. **Objectives:** To describe injury patterns in terms of injury type, location, prevalence/incidence, recurrence, relative impact of injuries (severity grade), time to first injury in adolescent elite athletes, competing in handball, athletics, orienteering and cross-country skiing. **Methods:** 262 adolescent elite athletes (age range 15-19) were weekly, over 52 weeks, monitored using a web-based questionnaire. **Results:** In total, 290 injuries were identified, including 27.6% recurrent injuries. Female athletes reported significantly higher prevalence of injury ( $P<.001$ ) and substantial injury ( $P<.001$ ) than male athletes. The injury incidence rate and average weekly injury prevalence was for handball 4.7/1000 hours exposure to sports, 47.2%; athletics 4.1/1000 hours exposure to sports, 33.6%; orienteering 5.7/1000 hours exposure to sports, 26.0%; cross-country skiing 2.5/1000 hours exposure to sports, 21.1%. A higher proportion of severe injuries, defined as injuries resulting in absence from normal training for at least one month, occurred in handball (43.2%), orienteering (41.2%), athletics (38.4%) compared to cross-country skiing (12.5%). In addition, 16.2% and 7.7% of all injuries resulted in more than six months from normal training in handball and athletics, respectively. The average weekly prevalence of severe injury was 28.6% in handball, 17.6% in athletics, 8.9% in cross-country skiing and 8.2% in orienteering. Most injuries occurred in the lower extremity (78.7%). Knee injuries had the most serious injury consequences in handball players (severity score: 12.86) and injuries in the foot the most serious injury consequences in athletics, orienteering and cross-country skiing (severity score: 1.47-3.60). Handball players had a significantly ( $P<.001$ ) shorter time to first injury, median 9 weeks, compared to athletes of other sports, median 20-41 weeks. **Conclusions:** An alarming high number of adolescent elite athletes are weekly injured, resulting in serious consequences regarding sports participation, training or performance level. The highest injury burden was found in handball and athletics. Directing preventive interventions on knee and foot injuries will target both the majority and the injuries with the most serious consequences.

#### SPORT INJURIES IN MOTORCYCLE WORLD CHAMPIONSHIP/MOTOGP: OUR EXPERIENCE IN A PRELIMINARY STUDY.

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**Introduction.** The authors report all the Clinica Mobile interventions for musculoskeletal traumas during the MotoGP World Championship 2013/2014. The Clinica Mobile is a medical service which follows all the races of the MotoGP World Championship to treat pilot for any pathology. We evaluated epidemiological and demographic data of each trauma and the short-term outcome of the patients. **Methods.** All the reports of orthopedic intervention during the 2013/2014 World Championship were collected. The authors distinguished 2 groups: traumatic events (A) and chronic musculoskeletal pathology (B). For each acute trauma were analyzed the following data: circuit, category of the pilot, type of competition (test/race), weather (wet or dry track), open/closed injury, site of trauma. An univariate and multivariate statistical analysis was performed on data to individuate the presence of risk factor of trauma. **Results.** 204 patients for injury and 176

patients for chronic musculoskeletal pathology were treated. In Group A were included: 51 open and 46 closed upper limb injury, 21 open and 34 closed lower limb injury. In 20 cases a fracture was diagnosed involving: acetabulum (1 pt), tibial diaphysis (1 pt), metatarsal bone (2 pts), heel (1 pt), foot phalanx (2 pts), proximal ulna (2 pts), distal radius (5 pts), metacarpal bone (3 pts), hand phalanx (5 pts). Nine patients were affected by a joint dislocation which interested following joint: gleno-humeral (2 pts), acromion-clavicular (3 pts), elbow (2 pts), metacarpal-phalangeal (2 pts). In 3 cases patients were treated for a mild traumatic brain injury and in 7 cases for spine injury. The distribution of acute trauma in the different category of pilot was as following: 91 cases in Moto3, 68 cases in Moto2, 45 cases in MotoGp. No single circuit resulted statistically significant as more dangerous. At statistical analysis the probability of acute trauma resulted higher with a wet track ( $p=0.035$ ) and during the race ( $p=0.028$ ). At multivariate analysis was identified as predictive factor for a higher risk for acute trauma the membership to Moto3 category ( $p=0.041$ ). Discussion. Musculoskeletal traumas are one of the most frequent events during Motorcycle World Championship. The circuits have a similar rate of accident, instead the univariate analysis shows that the probability of injury is higher with a wet track and during the race. The multivariate analysis highlighted that the Moto3 category can be considered as a predictive factor for acute trauma.

## THE HEALTH AND INJURY PROFILE OF AUSTRALIAN COMPETITIVE SURFERS

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Introduction Surfing is a popular and rapidly expanding sport worldwide. Its popularity notwithstanding, there is a scarcity of published data elucidating the health and injury profile of competitive surfers. The objectives of this study, therefore, were to describe the health and injury profile of Australian competitive surfers. Methods All registered participants at the Australian Surfing Titles (Coffs Harbour, August 2014), aged 18 years or older, were invited to complete an online survey administered via SurveyMonkey. The survey comprised 51 questions distributed across three sections, namely: (1) demographic information, including details about surfing activities; (2) health-related quality of life using the Short Form health questionnaire; and (3) surfing injury history. Descriptive statistics were used to describe the responses to the survey items. The injury incidence rate (IIR) per 1000 hours was calculated with a 95% confidence interval (CI) using standard methods. Injuries were classified according to the Orchard Sports Injury Classification System version 10, and presented as proportions by anatomical region and type of injury. Results The sample consisted of 228 (77% male) adult Australian surfers with mean age of 36.1 (sd 13.2; range 18-71) years and a mean body mass index of 24.7 (sd 2.7; range 17.3-31.3). The mean number of years of surfing experience was 20.0 (sd 14.0; range 1-55) years, while the mean number of hours of surfing per week was 9.1 (sd 6.8; range 0-50). The estimated overall IIR was 4.1 (95%CI 3.6-4.7) per 1000 hours of exposure. The most commonly injured body regions were the lower back, foot, knee, and ankle; while the most common types of injury were abrasion, laceration, muscle strain, and contusion. Discussion This is one of the largest studies of the health and injury profile of Australian competitive surfers conducted to date. It reveals that competitive surfers report similar health-related quality of life as the general population. Although the present study highlights a substantial injury problem in the sport, the estimated IIR is lower than that previously reported in competitive surfers in the United Kingdom (Nathanson et al., 2007). The present study also reveals a higher burden of lower back injuries compared to previous reports (Furness et al., 2015; Nathanson et al., 2007). Further efforts are required to prevent and reduce the burden of injuries in surfing. References Furness J, Hing W, Walsh J, Abbott A, Sheppard JM, Climstein M. Acute injuries in recreational and competitive surfers: incidence, severity, location, type, and mechanism. *Am J Sports Med* 2015;43:1246-54. Nathanson A, Bird S, Dao L, Tam-Sing K. Competitive surfing injuries: a prospective study of surfing-related injuries among contest surfers. *Am J Sports Med* 2007;35:113-7.

## ANALYSIS OF THE HAMSTRING MUSCLE ACTIVATION DURING TWO INJURY PREVENTION EXERCISES

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Introduction: Hamstring injury is one of the most common injuries within football players (Woods, C., et al, 2004). Many hamstring exercises have been proposed to reduce the risk of hamstring strain injury in team sports (Arnason, A., et al, 2008; Goldman, Elliott F., et al, 2010). The aim of this study was to perform an electromyographic and kinetic analysis of two commonly used hamstring eccentric strengthening exercises; Nordic curl (NC) and Ball leg curl (BLC). Method: Muscle activation during a maximum isometric voluntary contraction of the knee flexors was measured and used as a reference value. Ten female football players performed 3 repetitions of both NC and BLC, whilst knee angular displacement and activation of biceps femoris (BF) and semitendinosus (ST) were monitored. Results: No significant difference was found between BF and ST activation. Additionally the activation of the ST was higher at the closest knee angles ( $>40^\circ$ ) in NC compared to BLC ( $p=0.003$ ). Similarly, BF showed a non-significant trend ( $P=0.06$ ) to produce a higher activation during NC [closest knee angles ( $>40^\circ$ )] in comparison to BLC. At the knee open angles ( $<40^\circ$ ) no significant difference was observed between two exercises. Hamstring muscles activation during NC increased over the first  $60^\circ$  ( $100^\circ$  to  $40^\circ$ ) of knee flexion from 30% to 77% of MVIC and then decreased (from 77% to 27% MVIC) during the last  $40^\circ$  of knee flexion. Conclusion: Overall, BF and ST showed similar levels of activation during both NC and BLC. Although the overall hamstring muscles activation during NC was higher than the observed during the BLC, the level of activation during the knee open angles (where majority of hamstring injuries occur) was similar. During NC, the degree of hamstring muscle activation is highly influenced by the range of motion, meaning, activation during the open ( $<40^\circ$ ) and close ( $>40^\circ$ ) knee angles are distinctly different. This needs to be taken into consideration when designing an injury prevention program. 1- Woods, C., et al. 'The Football Association Medical Research Programme: an audit of injuries in professional football—analysis of hamstring injuries.' *British journal of sports medicine* 38.1 (2004): 36-41. 2- Arnason, A., et al. 'Prevention of hamstring strains in elite soccer: an intervention study.' *Scandinavian journal of medicine & science in sports* 18.1 (2008): 40-48. 3- Goldman, Elliott F., and Diana E. Jones. 'Interventions for preventing hamstring injuries.' *Cochrane Database Syst Rev* 1 (2010).

## NEGOTIATING A CHALLENGING WALKING SURFACE DEMANDS GREATER VISUAL ATTENTION BOTH PRIOR TO AND DURING LOCOMOTION IN OLDER COMPARED TO YOUNG FEMALES

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Introduction Negotiating obstacles is an additional challenge during locomotion which may cause falls in older adults (Begg and Sparrow, 2000). Challenging environmental conditions such as uneven walking surfaces make necessary to rely on visual information for a successful passage. Gaze fixations with regards to targeted footfalls are known to differ between young and older individuals with older



giving more attention to footfalls and obstacle avoidance (Chapman and Hollands, 2006). The present study aims to determine how both young and older females extract information from the environment both prior to and during locomotion. Methods Six young ( $20 \pm 2$  years) and six older ( $73 \pm 7$  years) healthy females without visual, gait or balance deficits were presented with two 7 m walkways (even and uneven). The uneven walkway presented a variety of challenges replicating possible urban terrains including kerbs and angled pathing. Visual fixations were quantified using eye tracking equipment (Tobii Glasses 2). Duration, was defined as the total time spent fixating on any part of the walkway, and frequency, as the total number of fixations on any part of the walkway. Fixations duration and frequency were compared between age groups for each walkway and for both the pre-movement scanning phase (SCAN) and during locomotion (WALK). Due to the small sample size, Mann-Whitney U test was used for between group comparisons, with Holm-Bonferroni correction for repeated pairwise comparisons and presented as mean  $\pm$  SD. Results Results show that older adults had a significantly higher total fixation duration and frequency during both SCAN and WALK for the uneven walkway (SCAN duration,  $696 \pm 330$  vs  $1841 \pm 778$  ms;  $p=0.024$ , frequency:  $3.5 \pm 1.8$  vs  $8.5 \pm 2.1$ ;  $p=0.024$ , for young and older, respectively; WALK duration:  $1365 \pm 1804$  vs  $4534 \pm 1643$  ms;  $p=0.024$ , SCAN frequency:  $9.8 \pm 4.9$  vs  $21.3 \pm 8.3$ ;  $p=0.03$ , for young and older, respectively). There was no difference between the groups for the fixations on the even walkway. Discussion The more challenging walkway demanded greater visual attention from the older adults compared to the young both in preparation for walking and during. This suggests that more visual information is needed by the central nervous system of the older individuals, to both help plan and guide limb movement to allow successful negotiation of the obstacles presented. References Begg RK and Sparrow WA. (2000). J. Gerontol. 55. M157-M154 Chapmans GJ and Hollands MA. (2006). Gait Posture. 24. 288-294

## Oral presentations

### OP-PM54 Exercise & Neurology

#### EFFECTS OF AEROBIC EXERCISE ON DTI PARAMETERS OF AMNESTIC MCI

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UNICAMP

Balthazar, M.L.F. Introduction: The cognitive changes in aMCI can be associated to the neurodegeneration of Alzheimer's pathology, such as white matter atrophy. Increasing evidence demonstrates that physical activity is an important modifiable factor not only for cardiovascular fitness, but also for brain health. Therefore, the aim of this study was to analyze possible effects of 6 months of aerobic training on structural connectivity of aMCI with CSF biomarkers. Methods: 19 aMCI subjects were diagnosed using the core criteria of the NIA/AA for MCI and presented positive CSF biomarker. All of them underwent MRI procedure, which data was required on a 3.0T MRI Philips Achieva scanner. They were divided into Aerobic group AG (who practiced aerobic exercise 3x/week for 6 months with a group at our institution) and control group CG (who were stimulated to practice physical exercise by themselves). Aerobic fitness was assessed by graded maximal exercise testing on a motor-driven treadmill. For WM analysis, we used the Tract-based-spatial-statistics (TBSS) method (<http://fsl.fmrib.ox.ac.uk/fsl/fslwiki/TBSS>) to compare the diffusion parameters maps (fractional anisotropy FA, medial diffusivity MD, radial diffusivity RD, axial diffusivity AxD) between times. Results: We found an increase in FA and AxD values for AG group after 6 months of intervention while CG had a decrease in those parameters, in corpus callosum, forceps major, corticospinal tract, inferior fronto-occipital fasciculus, inferior and superior longitudinal fasciculus and cingulum. In the same areas, AG presented a decrease in MD and RD values while CG showed increased values. Discussion: Our results showed a positive influence of aerobic intervention on DTI parameters. Higher FA values shows better WM integrity. While higher MD and RD values mean alterations in the membrane density and desmyelinization, respectively. Studies have reported positive relation between aerobic fitness and WM integrity in cognitive normal old (Tseng et al, 2013; Johnson et al., 2012; Marks et al, 2007), especially in the areas our study showed improvement. Also a negative relation between aerobic fitness and MD and RD (Song et al., 2002), corroborating to our results. Conclusions: 6 months of aerobic exercise have positive influence on DTI parameters. References: Johnson, et al. Neuroimage, 59, 1514 – 23, 2012. Marks, et al. Ann N Y Acad Sci, 1097, 171- 4, 2007. Song, et al. Neuroimage, 17, 1429 – 36, 2002. Tseng et al. Neuroimage, 82, 510 – 6, 2013. Contact: cateixeira98@yahoo.com.br

#### EXERCISE INDUCED AMELIORATIONS IN LOCOMOTION OF PATIENTS WITH ALZHEIMER'S DISEASE.

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Introduction: Alzheimer disease (AD) is the most frequent cause of dementia worldwide. Oxygen uptake and gait biomechanics are severely compromised in AD, likely affecting energy demand during locomotion. The literature, underline several exercise-induced positive effects in patients with AD. However, the effect of exercise training (ET) on the energy cost of walking (Cw) and gait biomechanics in AD are inconsistent. Therefore, the aims of this study were to determine potential AD-induced alterations in locomotion and to compare the effects of ET with respect to sham therapy (ST) on Cw and gait biomechanics in patients with AD. Methods: In seventeen patients with AD ( $77 \pm 7$  yrs) and 11 healthy old controls (OLD), Cw, and spatio-temporal gait parameters (velocity, stride, step, swing, stance, double and single support, cadence) were assessed by oxygen uptake measurement during walking, and GaitRite respectively. Cw, heart rate (HR), pulse of oxygen ( $VO_2/HR$ ) were than calculated. Following, AD patients were randomly assigned to ET group ( $n=8$ ) or ST group ( $n=9$ ) that performed 72 treatment sessions, 3 times a week. ET included 90 min of aerobic and strength training. ST included cognitive stimuli. Baseline measurements (T0) were repeated (T1) after 6-month of treatment. Results: In comparison to the OLD group AD patients exhibited significant reduction of locomotion parameters (Cw +50.2%, Velocity -30.9%, Stride -17.4%, Step -18.4%, Single support -7.0%, Double support +33.2%, Stance +5.7%, Swing -9.2%, Cadence -12.2%). After ET the Cw was significantly improved (-13.3%), while differences in spatio-temporal gait parameters were negligible (-15.8%,  $p=.041$ ) In addition, both HR and  $VO_2/HR$  were significantly ameliorated (-8.7%, and +15.7% respectively). At the contrary, changes in Cw, spatio-temporal gait parameters, HR,  $VO_2/HR$  after the ST were undetectable. Conclusion: Data from the current study demonstrates an AD-induced alteration in human locomotion. However, it appears that an ET program can reverse the progressive reduction in gait biomechanics, usually exhibited by patients with AD. Further benefits of ET were retrieved in the improvement of Cw, associated with enhancement of HR and  $VO_2/HR$ . The results of this study suggest that ET-induced

amelioration in locomotion of patients with AD are mainly caused by positive adaptations of central and peripheral components of the VO2.

### ACUTE EFFECTS OF PERTURBATION TREADMILL TRAINING ON GAIT AND POSTURAL CONTROL IN PATIENTS WITH PARKINSON'S DISEASE

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**Introduction** Treadmill training is an effective therapeutic option in gait rehabilitation of Parkinson's patients (Mehrholtz et al., 2010). Novel training paradigms have emerged, focusing on perturbations during treadmill walking (Reisman et al., 2010). In order to understand potential mechanisms of adding perturbations during walking, gait and balance adaptations to a single session of perturbed treadmill walking were investigated in individuals with Parkinson's disease (PD). **Methods** 39 PD patients (Hoehn & Yahr 1 to 3) performed a single session of 20 minutes treadmill walking. Participants were randomly allocated into two groups. The experimental group (n=19) walked on a treadmill prototype (zebris Medical GmbH, Isny, Germany) which constantly induced small three-dimensional tilting movements of the walking surface. The control group (n=20) walked on the same treadmill without perturbations. Outcomes included overground walking speed (10m walk test) and postural sway during quiet standing (30 seconds at 100Hz, pressure sensor matrix). Additionally, spatiotemporal gait parameters were recorded during treadmill walking using a treadmill-integrated pressure sensor matrix. Outcomes were measured repeatedly throughout the training session and after 10 minutes retention. Linear mixed models were used to analyze within- and between-group changes over time. **Results** The experimental group significantly increased overground walking speed after intervention compared to the control group ( $p = .014$ ;  $d = +0.41$ ). Gait variability during treadmill walking significantly decreased in the experimental ( $p < .05$ ;  $d = 0.33 - 0.48$ ), but not in the control condition. Effects were more pronounced if patients were able to walk without handrail support. Sway area increased with treadmill walking only in the control group ( $p = .009$ ;  $d = +0.49$ ). No other postural sway measures changed over time. Subgroup analyses revealed that in the experimental group more disabled patients demonstrated larger increases in overground walking speed ( $p = .016$ ;  $d = +0.40$ ) and stance phase symmetry ( $p = .011$ ;  $d = -0.42$ ). **Conclusions** A single session of perturbation treadmill training led to larger gait improvements compared to unperturbed treadmill walking. Adaptations were mainly related to a reduction of gait variability. Postural control appeared to be minimally affected. **References** Mehrholz J, Friis R, Kugler J, Tworok S, Storch A, Pohl M. (2010). *Cochrane Database Syst Rev* (1), CD007830. Reisman DS, Bastian AJ, Morton SM. (2010). *Phys Ther*, 90 (2), 187–195.

### SOMATOSENSORY TRAINING IMPROVES SENSORY INTEGRATION AND QUALITY OF LIFE IN INDIVIDUALS WITH MILD TO MODERATE PARKINSON'S DISEASE

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**Introduction:** Parkinson's disease (PD) presents proprioceptive processing and integration deficits, which cause postural control (PC) deterioration (Vaugoyeau et al., 2011). However, applying light touch improves postural sway (PS) in individuals with PD (Rabin et al., 2013). The aim was to determine whether an eight-week somatosensory training programme (SSTP) would influence joint position sense (JPS), sensory integration and Quality of Life (QoL) in individuals with PD. **Methods:** Thirty-seven individuals with idiopathic PD ( $67 \pm 9$  years; H&Y:  $2 \pm 1$ ) were divided into two groups: somatosensory training (EXP;  $n = 24$ ) and placebo group (PBO;  $n = 13$ ). Joint position sense, sensory integration (mCTSIB) and QoL were assessed at baseline, pre- and post-intervention. For the mCTSIB, the Instrumented Sway tri-axial accelerometer was used to assess Jerkiness (JERK), Centroidal Frequency (CF) and Root Mean Square (RMS) during 4 conditions i.e. eyes open (EO), eyes closed (EC), both off and on a foam pad (+F). Joint position sense was tested by means of the Active Movement Extent Discrimination Apparatus (AMEDA) and QoL with the Parkinson's Disease Quality of Life Questionnaire Summary Index (PDQ-39 SI). **Results:** A treatment effect was found for EC+F ( $p = 0.0002$ ) and a strong tendency for a treatment effect for PDQ-39 SI ( $p = 0.06$ ). The EXP group improved in JPS ( $p = 0.02$ ) and PDQ-39 SI ( $p = 0.03$ ) after the eight weeks. Furthermore, the EXP group showed less EC+F JERK compared to PBO group after the intervention ( $p = 0.002$ ). **Conclusions:** The study findings provide evidence that SSTP might improve JPS and sensory integration in individuals with PD, which may contribute to improve PC and QoL. **References:** Rabin E, et al. Haptic feedback from manual contact improves balance control in people with Parkinson's disease. *Gait & posture* 2013;38(3):373-379. Vaugoyeau M, et al. Proprioceptive impairment and postural orientation control in Parkinson's disease. *Human Movement Science* 2011;30:405-414. Contact: taniagregory@gmail.com

### SPATIAL LEARNING IN HUMANS IN A REAL LIFE WATER MAZE

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**INTRODUCTION** The Morris water maze (MWM) represents the gold standard for testing spatial learning in laboratory rodents. To assess disease-related changes in spatial learning in humans, virtual water mazes have been developed. However, it has been shown that small-scale learning (e.g. looking at a monitor) is partly based on different functional brain systems than large-scale learning (navigation in real, complex settings) (Hegarty, 2006). This raises the question whether testing humans in a virtual task captures the essential aspects of spatial learning in the physical world. The aim of this study was to develop a "real" human water maze to evaluate the potential of mimicking an established test paradigm for laboratory animals and to prove the ecological validity of a virtual navigation task. **METHODS** 27 healthy subjects (age  $22.6 \pm 2.4$  years) conducted the real water maze (RWM) as well as a virtual navigation task (VNT). The setup used for the RWM consisted of a circular swimming arena in a large lake, with a diameter of 18 meters. Subjects performed four trials to locate and remember an invisible target position using the available distant visual cues (e.g. trees, buildings). The process of spatial navigation in both the VNT and RWM was analysed by measuring established parameters such as latency and path length, but also by evaluating more advanced read-outs such as salience, number, and spatial distribution of re-used landmarks. **RESULTS** Both rodents and humans are using highly similar search and/or navigation strategies to find and remember an invisible target position. Irrespective of species-specific sensory and cognitive abilities mice and men use distant landmarks to navigate the arena. Quantitatively, the type of landmarks used (out of all cues available) appears to be comparable between species and independent of a cues salience. There is also evidence that presenting the water maze task as a computer setup does not change the importance of using a specific set of stable distant visual cues for efficient navigation. The correlation analysis between RWM and VNT is still in progress. **DISCUSSION** The presented study con-

firmed that the established water maze paradigm could be effectively applied to humans for studying spatial learning in a complex environment. Transferring the task into virtual reality preserves most aspects of spatial navigation. The specific roles of proprioceptive and vestibular inputs which are absent in the VNT remain to be identified. REFERENCES Hegarty M., Montello D.R., Richardson A.E., Ishikawa T., Lovelace, K. (2006): Spatial Abilities at Different Scales: Individual Differences in Aptitude-Test Performance and Spatial-Layout Learning. Intelligence, 34, 151-176. Contact Jacqueline.boehr@hsw.tu-chemnitz.de

## Oral presentations

### OP-PM76 Antioxidants & Glycolysis

#### POLYMORPHISM OF MNSOD AND GPX GENES AND BIOCHEMICAL RESPONSE TO THREE-MONTH SWIMMING TRAINING

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The aim of the study was to analyse the influence of antioxidant enzyme genetic polymorphisms, MnSOD Val9Ala and GPx Pro198Leu, on the response of biochemical parameters of the blood to three-month swimming training. Methods: The study included 52 Polish (Caucasian) male students of physical education, who participated in a three-month swimming training program (1.5 h/day; 4 days/week). Blood samples were drawn from the ulnar vein prior to and after the training period. The activity of superoxide dismutase (SOD) was determined in erythrocytes and serum, and the concentration of total glutathione (TGS) and activity of glutathione peroxidase (GPx) were measured in whole blood. Moreover, lipid hydroperoxides (LHs), total antioxidant capacity (TAC) and creatine kinase (CK) activity were determined in serum, along with the lipid profile: total cholesterol (TC), triglycerides (TG), LDL (LDL-C) and HDL cholesterol (HDL-C). Genomic DNA was isolated from peripheral blood using QIAamp DNA Blood MiniKit (Qiagen, Germany). Genotyping was based on real-time PCR with TaqMan SNP assays. Results: The three month-training resulted in a decrease in LHs, TAC and GPx ( $p < 0.05$ ) and an increase in serum SOD and TC. The post-training decrease in LHs, GPx and CK turned out to be associated with Ala/Ala genotype of MnSOD Val9Ala polymorphism ( $p < 0.05$ ), whereas the decrease in TAC was observed in both Ala/Ala and Ala/Val genotype carriers ( $p < 0.05$ ). Moreover, Ala/Val genotype was associated with an increase in serum SOD, TC and LDL-C ( $p < 0.05$ ), and Val/Val genotype correlated with an increase in TGS level ( $p < 0.05$ ). Val/Val genotype carriers presented with significantly higher pre-training activity of SOD in erythrocytes than individuals with Ala/Ala genotype ( $p < 0.05$ ) and showed higher post-training TGS levels than Ala/Val heterozygotes ( $p < 0.05$ ). GPx Pro198Leu polymorphism exerted less pronounced effects on the post-training changes in biochemical parameters. No mutant homozygotes (Leu/Leu) were identified in the study group. Pro/Pro genotype correlated significantly with a decrease in LHs and GPx ( $p < 0.05$ ), and Pro/Leu genotype predisposed to a decrease in TAC ( $p < 0.05$ ). Furthermore, both genotypes were associated with an increase in serum SOD. None of the analysed genotypes exerted significant effects on the lipid profile. Conclusions: Three-month swimming training induces changes in oxidative stress parameters and lipid profile. These changes seem to be mainly associated with the presence of Val16Ala SOD2 polymorphism. Presence of minor (mutant) allele Ala, especially as homozygote, is associated with some beneficial training-induced changes, such as a decrease in lipid peroxidation and less pronounced muscle damage. In turn, Ala/Val genotype may predispose to some unfavorable changes in the lipid profile.

#### POLYPHENOL SUPPLEMENTATION IMPROVES CARDIOMYOCYTE RECOVERY AFTER MARATHON RUNNING: A DOUBLE-BLIND, RANDOMIZED, PLACEBO-CONTROLLED TRIAL.

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Background: The increase of cardiac troponin (cTn) during and after strenuous exercise are known phenomena. Polyphenols have anti-inflammatory and anti-oxidative effects that may counteract cTn release and inflammation-associated alterations of the cardiovascular system. Objective: We investigated, whether supplementation with a polyphenol containing beverage has cardiomyocyte protective effects in marathon runners. Design: We examined the effects of polyphenol supplementation in 277 male marathon runners ( $42 \pm 9$  yrs.) in a randomized, double-blind and placebo-controlled manner with regard to levels of cTnT and inflammatory biomarker levels before a marathon race (V1 & V2), and immediately (V3), 24 (V4) and 72hrs (V5) afterwards. Participants were asked to ingest  $\geq 1$ L (corresponding to  $\geq 326$ mg gallic acid equivalents of polyphenols) of the supplementation beverage per day. Data of 210 participants (105 verum group (V=polyphenol supplementation), 105 placebo group (PL=identically with V except for polyphenols)) were analyzed in the full analysis set. To evaluate kinetics of biomarkers, area under the curve (AUC) was calculated for each participant. Results: We observed no significant difference between V and PL regarding cTnT concentration from V2 to V5 (median [IQR]: AUC: V: 33.3[23.7-54.0]  $\text{d} \cdot \text{ng} \cdot \text{L}^{-1}$  vs. PL: 42.4[24.9-59.0]  $\text{d} \cdot \text{ng} \cdot \text{L}^{-1}$ ,  $p=0.168$ ). However, there were lower areas under the cTnT curve from immediately to 72 hrs post-race in V (30.0[21.6–49.0]  $\text{d} \cdot \text{ng} \cdot \text{L}^{-1}$ ) compared to PL 39.0[22.4–54.5]  $\text{d} \cdot \text{ng} \cdot \text{L}^{-1}$  ( $p=0.16$ ), becoming statistically significant after adjustment of immediately post-race values ( $p=0.015$ ,  $\beta=0.09$ ,  $SE = 0.03$ ). Also AUC from 24 to 72 hrs post-race were significantly lower in V ( $p=0.030$ ). This resulted in a clinically relevant higher number of participants with a cTn value above the upper reference limit (14  $\text{ng} \cdot \text{L}^{-1}$ ; and therefore being suspicious for myocardial injury) in the placebo group compared to the verum group in all post-race visits (immediately post: 91.4% vs. 82.9%, 24 hrs post: 30.5% vs. 24.8%, 72 hrs post: 5.7% vs. 4.8%) Conclusion: Supplementation with a polyphenolic mixture was linked to enhanced cardiomyocyte recovery after prolonged and strenuous exercise.

#### EFFECTS OF ALTITUDE TRAINING ON CHANGES IN HEMOGLOBIN MASS, VO<sub>2</sub>MAX AND BODY COMPOSITION IN ELITE ENDURANCE ATHLETES; IMPACT OF INCREASED ANTIOXIDANT-RICH FOOD INTAKE ON THE ADAPTATION RESPONSE

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1: Norwegian Olympic Sports Centre, Oslo 2: Dept. of Nutrition, Institute of Basic Medical Sciences, University of Oslo 3: Dept. of Physical Performance, Norwegian School of Sport Sciences, Oslo, Norway INTRODUCTION Training at high altitude increases the production of

reactive oxygen and nitrogen species (RONS), which potentially induce cellular damage. As a countermeasure, athletes are recommended to increase antioxidant intake. However, RONS are important cellular signalling molecules, and high-dose single-antioxidant supplementation may blunt responses to endurance training. Whether increased consumption of antioxidant-rich foods will affect training adaptations in a similar manner, is currently unknown. Thus, this study aimed to assess the effects of training at moderate altitude in elite endurance athletes and evaluate the impact of antioxidant rich foods on the adaptation response. **METHODS** Thirty-one national team endurance athletes (8 females, 23 males) were randomly assigned to antioxidant rich snack (AO, n=16) or placebo group (PL, n=15). During a 3-week training camp at moderate altitude (2340 m) athletes received daily eucaloric AO (smoothies, nuts, dried berries/fruit, dark chocolate) or PL snacks. Before and after the altitude camp hemoglobin mass (Hbm<sub>ss</sub>), blood volume (BV), lean body mass (LBM) and fat mass (FM) were determined and fasting blood samples collected and analyzed for hemoglobin (hb), hematocrit, erythrocytes and ferritin. Additionally, VO<sub>2</sub>max (treadmill) was assessed in 16 athletes (AO, n=10, PL, N=6). **RESULTS** Moderate altitude training induced increases in Hbm<sub>ss</sub> (4.9 %, p<0.001), hematocrit (4.0 %, p=0.001), erythrocytes (5.0 %, p<0.001), and VO<sub>2</sub>max (2.6 %, p<0.01), whereas S-ferritin was reduced (-16.5 %, p=0.001). Body mass, LBM, and FM remained unchanged. No significant differences were found between groups for any of the adaptation response parameters. Compliance in AO group was 95%. **DISCUSSION** Three-weeks of training at moderate altitude increased Hbm<sub>ss</sub> and VO<sub>2</sub>max, important physiological determinants for endurance performance in elite athletes. Increased consumption of antioxidant-rich foods (doubling AO intake) was well tolerated by the athletes and did not interfere with the adaptive responses to altitude training. Whether high intake of antioxidants from food modulated systemic redox balance and inflammation markers awaits further analyses. **REFERENCES** Elkington et al. 2015. Antioxidants in Sports Nutrition, 171-181. CRC Press. Paulsen et al. 2014. J Physiol 592(Pt 8), 1887-1901. Pialoux et al. 2009. Eur J Clin Nutr 63(6), 756-762. **CONTACT** anu.koivisto@olympiattoppen.no

## ANTIOXIDANTS REDUCE THE GLYCOLYTIC RATE DURING SPRINT EXERCISE IN HUMANS WITHOUT IMPROVING PERFORMANCE

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**Introduction:** About 80% of the energy yield during a 30s-Wingate test is provided by the anaerobic energy metabolism (2/3 by the glycolysis and 1/3 by phosphocreatine and ATP). This generates a fast and great production of pyruvate which overwhelms the capacity of the pyruvate dehydrogenase (PDH), leading to the accumulation of pyruvate, which is rapidly converted to lactate by lactate dehydrogenase. Consequently, sprint exercise ends with high muscular lactate concentration, acidification and increased production reactive oxygen and nitrogen species (RONS), which have been historically associated with fatigue. These effects are accentuated when the sprints are performed in severe acute hypoxia. Antioxidants may influence PDH activity by reducing RONS effects. Thus, the aim of this study was to determine if antioxidants might alter the anaerobic energy production during sprints exercise by modifying PDH activity and mitochondrial efficiency. **Methods:** Nine volunteers performed a single isokinetic (100-rpms) 30s Wingate test in four trials while breathing normoxia (N) or hypoxic gas (H, PIO<sub>2</sub>=75 mmHg) preceded by the ingestion of a placebo (P) or antioxidants (A) (alpha-lipoic acid, vitamin C, and vitamin E), with a double-blind design. Muscle metabolites and PDH phosphorylation was determined in muscle biopsies taken before, at the end of the sprint. **Results:** Peak power output (PPO) was similar between conditions. Mean power output (MPO) was a 5% lower in H than normoxia (FIO<sub>2</sub> effect, P<0.05). Antioxidants did not influence significantly performance in any condition. The glycolytic rate was 23% higher in hypoxia than normoxia (P<0.05). Compared to placebo, antioxidant ingestion reduced the glycolytic rate by 38% (P<0.05). However, Ser293-PDH-E1alpha and Ser300-PDH-E1alpha phosphorylation, as index of PDH activation, decreased similarly between conditions, suggesting similar PDH activation, regardless of antioxidant ingestion. **Discussion and conclusions:** Antioxidants (alpha-lipoic acid, vitamin C, and vitamin E) decrease the glycolytic rate and the level of muscle acidification during sprint exercise without any impact on performance. This finding has two implications. Firstly, that muscle acidification does not limit performance during sprint exercise, even in severe acute hypoxia (when acidification and lactate accumulation are greater). Second, since VO<sub>2</sub> was not increased to compensate for the reduced energy yield by glycolysis. This study implies that antioxidants must increase the efficiency of the oxidative phosphorylation or the contraction coupling efficiency. **Granted by DEP 2010-21866**

## Oral presentations

### OP-PM65 Cardiovascular Physiology

#### THE EFFECT OF LOWER BODY POSITIVE PRESSURE ON THE CARDIORESPIRATORY RESPONSE TO SUBMAXIMAL RUNNING EXERCISE.

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Alter-G is an anti-gravity treadmill facilitating walking and running in patients with lower limb problems, by applying a positive pressure on the lower body (LBPP). Apart from providing weight support, LBPP could translocate blood from the lower limb to the trunk. It is unknown if this phenomenon leads to a modification in the cardiorespiratory response to running exercise. Six healthy males (31±14.3 yrs, 167.7±4.5 cm, 68.8±4.8kg) performed three bouts of running at 9, 11, 13 and 15 km.h<sup>-1</sup> (5 min stages), at 0, 15 and 40 mmHg LBPP. Steady state cardiac output (CO) was estimated from thorax bio-impedance changes and heart rate; oxygen uptake (VO<sub>2</sub>) was monitored breath-by-breath using a respiratory gas analyser. Blood pressure was monitored beat-by-beat with finger plethysmography. To monitor potential effects of pressure on the lower abdomen any changes in FRC were monitored with inspiratory capacity (IC) manoeuvres. While the increase of speed was accompanied by an increase in VO<sub>2</sub> in all conditions, increasing LBPP to 40 mmHg led to significant decreases in VO<sub>2</sub> (2274±475 vs 1961±320 vs 1365±418 ml.min<sup>-1</sup> at 15 km.h<sup>-1</sup> at 0, 15 and 40 mmHg, respectively (p<0.05)) and in CO (22.2±2.0 vs 19.7±1.7 vs 14.9±2.2 l.min<sup>-1</sup>, respectively (p<0.05)). Mean arterial blood pressure (MAP) remained unchanged, while peripheral resistance increased with LBPP (4.7±0.3 vs 5.2±0.5 vs 6.6±0.9 mmHg.min.ml<sup>-1</sup> at 15 km/h at 0, 15 and 40 mmHg, respectively (p<0.05)), suggesting increased left ventricular afterload. Regardless the level of pressure, the relationship between CO and VO<sub>2</sub> remained linear and with similar slope for each subject with a mean r<sup>2</sup> of 0.88±0.07. For a given level of ventilation IC values remained constant, suggesting an unchanged thoracoabdominal breathing configuration in all conditions. Our findings suggest that LBPP reduces the cardiorespiratory load proportionally to the reduced metabolic demand resulting from the body weight support, but increases left ventricular work for a



given metabolic demand. Whether these results could be clinically relevant when designing rehabilitation programs using LBPP-type devices for bodyweight support for patients with cardiorespiratory disease remains to be investigated.

## DYNAMICS OF ARTERIAL BAROREFLEX RESETTING AT EXERCISE ONSET IN UPRIGHT AND SUPINE POSTURE

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1: HUG (Genève, Switzerland), 2: UNIGE (Genève, Switzerland), 3: UCLA (Torrance, USA), 4: UNIBS (Brescia, Italy), 5: HUG (Genève, Switzerland), 6: UNIVR (Verona, Italy) **INTRODUCTION** The concept of baroreflex resetting during exercise is well established, yet its dynamics is poorly understood. This can be investigated using close-loop procedures. The aim of this study was to identify possible temporal components of the mechanisms of baroreflex resetting during exercise transient, on the hypothesis that resetting does not necessarily start at exercise onset. Since cardiac filling pressure is higher supine than upright, we investigated both postures, expecting that the baroreflex operating point in supine posture is displaced with respect to the upright posture even at rest (Schwartz et al., 2013). **METHODS** Eleven young volunteers (8 women, 3 men), performed light exercise in upright and supine posture. Heart rate (HR) was continuously determined by electrocardiography, and beat-by-beat mean arterial pressure (MAP) was computed from pulse pressure profiles recorded non-invasively. Assuming HR versus MAP relationship, between the exercise onset and the minimum of MAP (MAP<sub>m</sub>), lying on the steep part of a baroreflex curve, this segment was modelled by linear regression. **RESULTS** Just before exercise start, HR was higher than at quiet rest, conversely to MAP. As exercise started, MAP fell in about 10 s to a minimum (MAP<sub>m</sub>) of  $72.8 \pm 9.6$  mmHg upright and  $73.9 \pm 6.2$  mmHg supine. HR consequently grew. Before attainment of MAP<sub>m</sub>, the slope of HR versus MAP relationship were  $-0.66 \pm 0.16$  and  $-1.04 \pm 0.43$  mmHg<sup>-1</sup> min<sup>-1</sup>, respectively upright and supine ( $P < 0.05$ ). After MAP<sub>m</sub>, both HR and MAP increased toward exercise steady state. **DISCUSSION** As exercise started, HR grew while MAP fell, whence a negative linear relation between these two variables, until the attainment of MAP<sub>m</sub>. The slope of this segment corresponded to the slope of the HR vs MAP relationship at rest, obtained with different baroreflex procedures (Ogoh et al, 2005; Schwartz et al., 2013). Also, the slopes of this relationships were flatter upright than supine (Schwartz et al., 2013), indicating reduction of baroreflex sensitivity in the former case. Notwithstanding a potential feed-forward mechanism, exercise baroreflex resetting started after attainment of MAP<sub>m</sub>, which may be interpreted as a threshold value triggering baroreflex resetting. After MAP<sub>m</sub> subjects operated along different baroreflex curves. **REFERENCES** Ogoh S, Fisher JP, Dawson EA, White MJ, Secher NH, Raven PB (2005). *J Physiol.* 566, 599-611. Schwartz CE, Medow MS, Messer Z, Stewart JM (2013) *Am J Physiol Regul Integr Comp Physiol* 304, R1107-R1113. **CONTACT** aurelien.bringard@unige.ch

## TECHNOLOGY-ENABLED CARDIAC REHABILITATION THROUGH PATHWAY. DESIGN AND RATIONALE FOR THE INVESTIGATION OF ITS FEASIBILITY, CLINICAL EFFECTIVENESS AND COST-EFFECTIVENESS

CORNELISSEN, V.A., MOYNA, N.M., CLAES, J., BRIGGS, A., MC DERMOTT, C., CHOUVARDA, I., FILOS, D., FINLAY, D., DARAS, P., WALSH, D., BUDTS, W., MORAN, K., WOODS, C., BUYS, R.

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**Background** Exercise-based cardiac rehabilitation (CR) favorably and independently alters the clinical course of cardiovascular diseases resulting in a significant reduction in all-cause and cardiac mortality. However, only 15-30% of all eligible patients participate in a phase 2 ambulatory program. Uptake rates of community based programs following phase 2 CR are even lower and adherence to long-term CR is extremely poor. Newer care models, involving programs that are delivered remotely such as telehealth programs, show considerable promise for increasing adherence. In this view, PATHway (Physical Activity Towards Health) is being developed and needs to be evaluated on feasibility and potential clinical benefit. **Methods** In a multicentre randomized controlled pilot trial, 120 patients (m/f, age 40-80yrs) completing a phase 2 ambulatory CR program will be randomized on a 1:1 basis to PATHway or usual care. PATHway involves a complex comprehensive, internet-enabled, sensor-based home CR platform. It consists of several modules with an exercise module as the core component. PATHway provides individualized heart rate monitored exercise programs (exerclasses and exergames) as the basis upon which to provide additionally a personalized, comprehensive lifestyle intervention program (managing exercise, smoking, diet, stress, alcohol use). The control group will receive normal care. Study outcomes will be assessed at baseline, 3 months and 6 months. The primary outcome is the change in active energy expenditure. Secondary outcomes include health-related fitness (cardiopulmonary endurance capacity, muscle strength, body composition), vascular health (vascular stiffness and endothelial function), cardiovascular risk score, health-related quality of life, patient satisfaction, healthcare costs and safety. Intervention feasibility will be assessed via participant and stakeholder debrief. **Discussion** This study investigates the feasibility of the PATHway system in supporting patients to maintain a physically active lifestyle, and investigates its short-term effectiveness on cardiovascular health. It has the potential to further extend the provision of poorly accessible, hospital-based rehabilitation programs to effective, cost-effective delivery models in the community. This project has received funding from the European Union's Horizon 2020 Framework Programme for Research and Innovation Action under Grant Agreement no.643491. **PATHway:** Technology enabled behavioural change as a pathway towards better self-management of CVD ([www.pathway2health.eu/](http://www.pathway2health.eu/)).

## RESPIRATORY MUSCLE TRAINING AFFECTS PERIPHERAL VASCULAR FUNCTION

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**RESPIRATORY MUSCLE TRAINING AFFECTS PERIPHERAL VASCULAR FUNCTION** **Introduction** Changes in breathing patterns, that are influenced by respiratory muscle training (RMT)(1), may also affect the autonomic balance by decreasing sympathetic drive and improve vascular function (2). Therefore, the aim of this study was to evaluate the efficacy of RMT on vascular function, assessed by flow mediated dilation (FMD), in young healthy subjects. Our hypothesis was that RMT could ameliorate both lung functions and brachial-artery FMD without affecting sympathetic and parasympathetic neural drive. **Methods** Twenty-three physically active participants were randomly assigned to an RMT group (TG: age  $27 \pm 8$  yrs, BMI  $24 \pm 4$  kg·m<sup>-2</sup>; RMT 3 times a week for 2 months, 15-30 minutes of progressive RMT assessed weekly) or to a sham group (SG: age  $33 \pm 11$  yrs, BMI  $24 \pm 4$  kg·m<sup>-2</sup>; 3 times a week for 2 months of RMT-Placebo). Maximal inspiratory mouth pressure (MIP) and maximum voluntary ventilation (MVV) were utilized to assess the pulmonary effects of RMT. Heart rate variability (HRV, the ratio between low and high frequency: LF/HF) was utilized to assess the autonomic balance. Vascular function was determined by measuring vessel vasodilation (%FMD), normalized by the shear rate (FMD/SR). **Results** After 2 months of RMT, MIP and MVV increased significantly by 25% and 8%, respectively, while in the SG, MIP and MVV didn't change. In both TG and SG the chang-

es in LF/HF were negligible. However, vascular function improved significantly only in TG (FMD/SR TG = -31 % FMD/SR; SG = -4 % FMD/SR). Discussion Data from the current study indicate a positive effect of RMT on both pulmonary and vascular function. However, contrary to our hypothesis, these positive results seem not primarily induced by adaptations of the autonomic balance. Therefore, physiological factors other than the modulation of sympathetic and parasympathetic nerve activity, seem positively triggered by the RMT (3). References (1) Vieira DS, Mendes LP, Elmiro NS, Velloso M, Brito RR, Parreira VF. (2014) *Braz J Phys Ther.* 18:544-52. (2) Joseph CN, Porta C, Casucci G, Casiraghi N, Maffei M, Rossi M, et al. (2005) *Hypertension*, 46:714-8. (3) Atkinson CL, Lewis NC, Carter HH, Thijssen DH, Ainslie PN, Green DJ. (2015) *J Physiol*, 593:5145-56.

## Oral presentations

### OP-PM26 Cycling

#### EFFECTS OF AN ULTRA-ENDURANCE BIKE MARATHON ON THE HEART OF RECREATIONAL CYCLISTS

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*Ernst von Bergmann Klinikum Potsdam*

1: UP (Potsdam, GER), 2: UAS (Gleichenberg, AT), 3: EvB (Potsdam, GER) Introduction In normotensive athletes ultra-endurance sports had no negative impact on arterial stiffness (Radtke et al., 2014). Even so, such competitions were associated with acute reductions in large artery compliance (Burr et al., 2012). The effects of an ultra-endurance bike marathon on heart wall motion still remains unclear. The aim of this study was to determine the effect of an ultra endurance cycle marathon on wall motion in recreational cyclists. Methods 8 healthy male recreational cyclists (age: 42.8±13.2yrs, VO2max: 47.4±5.8ml.kg<sup>-1</sup>.min<sup>-1</sup>) were investigated by an isolated speckle tracking echocardiography (STE) at rest, within 30min, 2h and 12h after a 300km cycle marathon. One week prior the competition a maximum cycle ergometer exercise test was conducted to determine the exercise intensities during the cycle marathon retrospectively (Hofmann et al. 2010). Echocardiographic loops for STE-analyses were acquired after race and determined offline. Average longitudinal peak strain of apical four-chamber view, apical long axis view and apical two-chamber view were measured. Presented global longitudinal peak strain (GLPS) is averaged over all measured segments. Data are given as mean±SD and were analysed via Shapiro-Wilk normality test, ANOVA for repeated measurements and Tukey's multiple comparisons test. Results Mean exercise intensity during the competition was 53±18% of lactate turn point 2 (LTP2). No significant differences were found in GLPS over time (p=0.21). In comparison to resting conditions (-20.6±2.6%) no significantly reduced GLPS immediately (-19.7±2.7%; p=0.38), 2h (-20.9±1.7%; p=0.51) and 12h after the competition (-21.4±0.8%; p=0.35) was found. Discussion An ultra-endurance bike marathon seems not to cause cardiac stress with respect to wall motion abnormalities as a sign of cardiac fatigue and increased risk of arrhythmia in recreational cyclists. Further studies have to prove by larger trials including different durations, weather conditions, exercise intensities, courses during ride and especially in older aged groups. References Radtke T, Schmidt-Trucksäss A, Brugger N, Schäfer D, Saner H, Wilhelm M (2014). *Eur J Appl Physiol*, 114(1), 49-57. Burr JF, Bredin SSD, Phillips A, Foulds H, Cote A, Charlesworth S, Ivey AC, Drury TC, Fougere R, Warburton DER (2012). *Int J Sports Med*, 33(3), 224-229. Hofmann P, Tschakert G (2010). *Cardiol Res Prac*, Article ID 209302, 10 pages. doi: 10.4061/2011/209302. Contact [a.ruessmann@web.de]

#### ADAPTIVE RESPONSES TO EXTREME LOADS DURING ULTRA-CYCLING EVENT.

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Introduction. Red Bull Trans-Siberian Extreme Race is the longest cycling race in the world: from Moscow to Vladivostok. During this race the subjects are pushing their limits for 21 days and are covering 9200 km of distance. This study represents an attempt to investigate the limits of the adaptive response of human bodies. Methods. Ten athletes (177 (175-183) cm, 82.4 (75.4-85.6) kg, body mass index 22.7 (22-22.8) kg/m<sup>2</sup>, 34 (29-37) years old) participated in the study. Body composition (bioelectrical impedance analysis), total haemoglobin mass (tHb-mass) and blood volume (CO-rebreathing method, Bloodtec, Radiometer), pulmonary oxygen consumption (breath-by-breath, Cortex MetaMax), anaerobic threshold (AT) were measured in the laboratory. During the race monitoring of hydration status, heart rate monitoring (Bodyguard, Firstbeat) and rate of perceived exhaustion were performed. For rating sample characteristics, median and interquartile dispersion was used. Non-parametric Wilcoxon tests were applied for referencing bound samples. Significance level P was rated at 0.05. Results. Before the race athletes body mass (n=10) was 74 (69-78) kg. After the race there was a significant decrease in body mass, reaching 71 (70-76) kg (p<0.01). Fat mass was the key factor causing body weight deterioration from 10.9 (9.5-12.9) kg to 8(5.8-9.2) kg: the decrease was 4 (5-2)% (p<0.01). Most pronounced two athletes demonstrated decrease: SH decrease of 12% and FE decrease of 8 %. There was no significant dynamics in muscle mass. tHb-mass in group was 999 (931-1054) g. The highest values were demonstrated by IM, EF, KI: 14.4 g/kg, 14.3 g/kg and 14.0 g/kg respectively. No significant decrease was observed. Decrease in maximal heart rate from 180 (177-189) bpm to 172 (160-178) bpm and heart rate on anaerobic threshold from 165 (159-172) bpm to 144 (137-145) bpm were observed. During the race the mean heart rate decrease was demonstrated by all athletes: from 145 (142-156) bpm to 131 (117-140) bpm despite increase in difficulty of path profile (p<0.05) The most pronounced reduction was observed with DR and SH: 20% and 19% respectively. At maximal aerobic power (MAP) the workload was 380 (345-403) W and 299 (272-336) W at AT and after race the workload at maximal aerobic power was 348 (314-387) W and 260 (253-294) W at AT. The maximal decrease we found in FE - 21%. Discussion. Pronounced fatigue developed in all athletes within the race duration. It was characterized by heart rate and workload reduction at MAP and AT. tHb-mass test accurately predicted race winners and precisely described aerobic capacity parameters. Such extreme workloads are hard to model within laboratory conditions, therefore further research of human body adaptive responses should be undertaken.

## PHYSIOLOGICAL DEMANDS OF SIMULATED OFF-ROAD CYCLING COMPETITION

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**Introduction:** Only limited empirical evidence is available to assess the physiology of competitive off-road cycling (COMP). Earlier studies investigating energetic demands of mountain bike (MB)-cycling were often based on heart rate (HR) and blood lactate (BLA) measures. Only few papers are available dealing with power output (PO)-and respiratory gas measures during COMP. However, the workload-pattern of COMP limits the utility of HR and BLA measures since BLA is slowly removed from blood and rather may reflect high intensity periods while HR has been shown to be influenced by psychological components. PO measures represent exertion of force expended by lower limbs and not overall physical demands of COMP requiring recruitment of additional muscle mass stabilizing against gravity and vibration. Considering these limitations the aim of our study was to describe COMPs via the combination of BLA measures and real-time measures of PO, HR and respiratory gas parameters. **Methods:** 24 male competitive cyclists performed our COMP and also laboratory tests (LabT). From LabT study parameters data were determined at maximal load and 2 ventilatory thresholds (VT1, VT2). A high-performance athlete (HPA) was used to demonstrate COMP on high level. The COMP-trail was a rocky, hilly single trail with many roots and stones (four identical laps, entire distance of ~24.348 km). **Results:** During the COMP, athletes achieved a mean oxygen uptake (VO2COMP) of  $57.0 \pm 6.8$  ml.kg<sup>-1</sup>.min<sup>-1</sup> vs.  $71.1$  ml.kg<sup>-1</sup>.min<sup>-1</sup> for the HPA. The POCOMP was  $2.66 \pm 0.43$  W.kg<sup>-1</sup> and  $3.52$  W.kg<sup>-1</sup> for the HPA. We further analyzed POCOMP, VO2COMP, HRCOMP in relation to corresponding variables of LabTs. Mean POCOMP was 61.9% of POVT2 and 47.2% of Pmax, whereas VO2COMP was 112 % of VO2VT2 and 88 % of VO2peak and HRCOMP was 102 % of HRVT2 and 90% of HRmax. POCOMP, VO2COMP and HRCOMP were compared to corresponding variables at the VT2 of LabT. LabT variables correlated with racing time (RTCOMP) and POCOMP ( $P < 0.01$  to  $< 0.001$ ;  $r = 0.59$  to  $-0.80$ ). **Discussion/ Conclusion:** The study resulted in following findings: During COMP high oxygen costs exist probably influenced by the high muscle mass simultaneously working. POCOMP turned out to be lower when compared to VO2COMP, likely caused by phases of low force production (downhill phases) and also by the high mass performing COMP at this selective MB-trail. Data determined from LabT might be utilized to describe semi-specific abilities of MB- athletes and cannot be transferred to MB-cycling. Data originating from COMPs might be useful when designing MB-specific training. Gregory J et al (2007) J Strength Cond Res 2007; 21(1): 17-22 Impellizzeri FM et al (2005) Br J Sports Med: 39(10): 747-751 Nishii T et al. (2004) Sports Med Phys Fitness: 44(4): 356-360 Seifert JG et al (1997) Int J Sports Med 18(3): 197-200 Stapelfeldt B et al. (2004) Int J Sports Med 25(4): 294-300

## THE INFLUENCE OF TRAINING AND CADENCE ON GROSS EFFICIENCY IN YOUNG ELITE CYCLISTS

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Sport Science & Innovation Papendal, Sportcentrum Papendal, Arnhem, The Netherlands MOVE Research Institute Amsterdam, VU Amsterdam, Amsterdam, The Netherlands **Background:** Successful road cycling requires energy preservation for the last and decisive part of the race. Therefore, high cycling efficiency during the majority of the race increases the chance on a good result. Gross efficiency (GE), considered as a key determinant of cycling performance, is the ratio between mechanical power output and metabolic power input [1], expressed as a percentage. Cadence is a factor that influences GE [1], therefore, determining a cyclist's most efficient cadence and using this cadence during racing may preserve energy during the bulk of the race. As training status also influences GE [2], changes in training status during the season may result in an altered GE and most efficient cadence during submaximal cycling exercise. Currently, the change in GE and most efficient cadence have not been investigated in young elite athletes during the preparation phase of the season. Therefore, the goal of this study was to determine GE and the most efficient cadence during submaximal cycling exercise of a group of young elite cyclists in the winter and in the spring. **Methods:** To investigate GE and the most efficient cadence, respiratory data (Cosmed Quark CPET) were collected in six young elite male road cyclists ( $18.5 \pm 1.9$  yrs), at five different cadences (70, 80, 90, 100, and 110 RPM), while cycling 6 min for each RPM at 4 W/kg (Lode, Excalibur Sport). Repeated measures ANOVA was used to determine differences in GE between cadences, while a post hoc analysis was then conducted to identify the significant differences between groups. **Results:** GE at 70 and 80 RPM ( $23.4 \pm 0.6$  and  $23.5 \pm 0.3$  %) was significantly higher ( $p < 0.05$ ) than GE at 90, 100 and 110 RPM ( $22.7 \pm 0.4$ ,  $22.1 \pm 0.6$  and  $21.2 \pm 0.5$  %). Four cyclists were most efficient at 80 RPM and two cyclists at 70 RPM. Although the data of the first testing period have been collected, the data of the second testing period (which consists of an identical testing day as the first and an additional day to determine VO2max using an incremental test) have to be collected in a few months' time. **Conclusion:** These talented young cyclists are almost as efficient as world-class cyclists [3]. Whether GE and most efficient cadence change after a winter training period will be determined in the coming months. **References** 1. Ettema, G. and H.W. Loras, Efficiency in cycling: a review. Eur J Appl Physiol, 2009. 106(1): p. 1-14. 2. Hopker, J., D. Coleman, and L. Passfield, Changes in cycling efficiency during a competitive season. Med Sci Sports Exerc, 2009. 41(4): p. 912-9. 3. Lucia, A., et al., Inverse relationship between VO2max and economy/efficiency in world-class cyclists. Med Sci Sports Exerc, 2002. 34(12): p. 2079-84.

## GROSS EFFICIENCY DURING FLAT CYCLING IN LABORATORY AND FIELD CONDITIONS

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**Introduction** Gross efficiency (GE) is described as the ratio of mechanical work accomplished to the metabolic energy required to do that work and is considered as important determinant of cycling performance. Only a few studies examined GE in field conditions and Bertucci et al. (2012) reported GE to be 10% lower in laboratory compared to field conditions when cycling at freely chosen cadences. Previously it was shown, that cadence (60 vs. 90 rpm) and terrain (flat vs. uphill) affect GE in field conditions (Nimmerichter et al. 2015). The aim of this study was to compare GE at controlled power output and cadence during laboratory and field cycling. **Methods** Thirteen trained cyclists (mean  $\pm$  SD: age  $24 \pm 5$  years; stature  $177.4 \pm 6.3$  cm; body mass  $67.6 \pm 7.8$  kg) performed an incremental ergometer test to determine maximal power ( $402 \pm 39$  W), VO2max ( $68.3 \pm 4.2$  mL/min/kg) and the first ventilatory threshold (VT:  $180 \pm 19$  W). On two separate days the participants performed two trials of 6-min in a seated position on level ground cycling (1.5%) at 90 rpm at an exercise intensity of 90%VT ( $162 \pm 20$  W) in laboratory and field conditions. Power output was measured with an SRM professional power crank. To simulate the gradient in laboratory conditions, the bicycle was mounted on an indoor trainer (TACX Elite) and was fixed on a treadmill. Oxygen uptake was measured breath-by-breath with a portable gas analyser (MetaMax3B, CORTEX). Gross efficiency was calculated as  $GE (\%) = \text{work rate/energy expenditure} \times 100$ . Energy expenditure was calculated using the formula of Brouwer (1957). Paired samples t-tests were used to compare GE, VO2 and power output between laboratory and field cycling. The level of significance was set at  $p < 0.05$ . **Results** There were no significant differences between laboratory and field conditions for power output ( $163 \pm 21$  W vs.  $167 \pm 22$  W;  $t_{12} = 1.88$ ;  $p =$

0.09), GE ( $18.6 \pm 1.2\%$  vs.  $18.8 \pm 1.9\%$ ;  $t_{12} = 0.29$ ;  $p = 0.77$ ) and  $VO_2$  ( $2.54 \pm 0.37$  L/min vs.  $2.61 \pm 0.43$  L/min;  $t_{12} = 1.41$ ;  $p = 0.25$ ). Discussion As both, power output and cadence affect GE, the results of the present study indicate the importance to control these variables to determine GE in laboratory and field conditions. In contrast to a previous study where significant differences were reported at freely chosen cadences (Bertucci et al. 2012), this was not found under controlled conditions. Although effects of terrain on GE were reported in a previous study (Nimmerichter et al. 2015), there were no interactions between terrain and cadence, which suggests, that the present findings would also apply to uphill cycling in laboratory and field conditions. References Bertucci, W. et al. (2012). J Appl Biomech 28 (6):636-644. Brouwer, E. (1957). Acta Physiol Pharmacol Neerl 6:795-802. Nimmerichter, A. et al. (2015). Int J Sports Physiol Perform 10 (7):830-834. Contact nimmerichter@fhwn.ac.at

## DIFFERENCES IN SHORT TERM PARASYMPATHETIC REACTIVATION IN MALE AND FEMALE CYCLISTS; PRACTICAL IMPLICATIONS FOR PREDICTING AND MONITORING TRAINING STATUS IN CYCLISTS

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Differences in short term parasympathetic reactivation in male and female cyclists; practical implications for predicting and monitoring training status in cyclists Introduction The measurement of parasympathetic reactivation after exercise to monitor changes in training status has gained popularity over the last few years (Plews et al., 2013). Recently, Lamberts et al showed that short term parasympathetic reactivation after the LSCT (a submaximal cycling test) is an accurate predictor of cycling performance (Lamberts, 2014). In this study 50 male cyclists were tested, but no female cyclists. Therefore the main aim of this study was to determine if parasympathetic reactivation patterns and their relationship with cycling performance are the same in female and male cyclists Methods Twenty trained female cyclists ( $4.8 \pm 0.3$  W/kg) and 50 trained male cyclists ( $5.1 \pm 0.6$  W/kg) were recruited for this study. All cyclists performed, after familiarisation, a LSCT followed by a peak power output (PPO) and 3 days later, a LSCT followed by a 40km time trial (40km TT) test. Short term parasympathetic reactivation (LnRMSSD60s) was captured as part of the LSCT and correlated to PPO, maximal oxygen consumption ( $VO_{2max}$ ) and 40km TT time. Results Strong relationships were found between PPO & LnRMSSD60s in male ( $r = 0.93$ ;  $p < 0.0001$ ) and female ( $r = 0.85$ ;  $p < 0.0001$ ) cyclists, while slightly weaker relationships were found between  $VO_{2max}$  & LnRMSSD60s in male ( $r = 0.71$ ;  $p < 0.0001$ ) and female ( $r = 0.63$ ;  $p < 0.0001$ ) cyclists and 40km TT time & LnRMSSD60s in male ( $r = -0.83$ ;  $p < 0.0001$ ) and female ( $r = -0.63$ ;  $p = 0.003$ ) cyclists. Although similar slopes were found in male and female cyclists, the y-axis intercept was significant different in all three (PPO,  $VO_{2max}$  and 40km TT) performance parameters relationships with LnRMSSD60s ( $p < 0.0001$ ). Discussion Although similar strength relationships were found between LnRMSSD60s and cycling performance parameters in male and female cyclists, different y-axis intercept were found between male and female cyclists. This finding indicates that different regression formulas need to be used when predicting and cycling performance parameters from short term parasympathetic reactivation measurements. Plews DJ et al (2013) Sports Med. 43,773-781 Lamberts RP (2014) Int J Sports Physiol and Performance 9(4):610-614 Lamberts RP (2014) ECSS conference (19-0973), Amsterdam, The Netherlands

## Oral presentations

### OP-PM29 Body Composition

#### RELIABILITY AND VALIDITY OF 3D BODY SCANNING FOR ANTHROPOMETRIC PROFILING

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Introduction: Surface anthropometry is widely used to assess and monitor athletes due to its strong relationship with sporting success. Furthermore, some measures are frequently used for talent identification in certain sports. Recently, 3D body scanning has emerged as a promising alternative to traditional surface measurements, offering greater accuracy and precision. However, various steps in the 3D data collection process and analysis can potentially introduce error. Therefore, assessing the reliability and validity of the 3D body scanning (3D) technology is required to ensure best practice for its use in the assessment of anthropometric variables. Methods: Physical measurements (PM) were collected using both traditional ISAK protocols and 3D body scans on 30 highly trained young male athletes (age  $15.8 \pm 1.7$  y, body mass  $62.9 \pm 15.1$  kg, height  $174.0 \pm 7.9$  cm). Digital data analyses of the 3D scans were carried out in duplicate by 3 trained technicians. Interclass correlation coefficients (ICC) and relative technical error of measurements (%TEM) were calculated to assess the reliability of the 3D analyses between technicians, and also between the 3D and PM data. Pearson correlation and a paired sample t test ( $p \leq 0.05$ ) were also conducted. Results: There was no significant difference for intra-retest reliability (ICC: 0.97 – 1.00) and inter-rater reliability for the 3D analyses (ICC: 0.63 – 1.00) or between each technicians 3D data analyses and the PM (ICC: 0.47 – 1.00). 3D intra-tester %TEMs ( $\leq 1\%$ ) showed agreement for height and 4 body lengths. Inter-tester %TEMs ( $\leq 1.5\%$ ) showed agreement for height and 5 body lengths between 3D data analyses and PM. The correlation analyses revealed moderate to strong but statistically significant Pearson correlation coefficients (range: 0.67 – 0.99) for all variables. Results of the paired t tests were significant for several variables, indicating a significant difference between the 3D and PM. Discussion: This study shows that there is evidence for the repeatability of 3D measurements when assessing height, breadths, and several limb lengths and girths. Even though, 3D scans can easily be reviewed post-collection as many times as needed, it cannot exactly replicate the techniques used for PM (i.e. ISAK protocols). Therefore, a combination of both digital and physical methods should be considered. References: Daniell, N. (2008). Kinanthropometry X, 39-54. New York, NY. Schranz, N., Tomkinson, G., Olds, T., & Daniell, N. (2010). J of Sports Sci, 28, 459 - 469 Contact: Fabricio.Forchino@aspetar.com



## FAT PATTERNING DIFFERENCES IN MALE AND FEMALE PERSONS: APPLICATION OF A HIGHLY ACCURATE AND PRECISE ULTRASOUND TECHNIQUE

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**Introduction** Body composition influences both health and physical performance. Particularly in weight-sensitive sports, underweight and body composition disturbances can cause serious medical problems and can lead to severe performance setbacks [1]. For investigating body fat and subcutaneous adipose tissue (SAT) patterning in athletes, highly accurate and precise measurement methods should be applied. Diagnostic ultrasound (US) fulfills these criteria and also enables measurements in the field. The aim of this study was to examine the sex specific fat distribution differences at eight standardised sites used in this novel US method. **Methods** Measurements were carried out according to the standardised measurement protocol of W. Müller et al., 2016 [2]. The used sites in this protocol were: upper abdomen (UA), lower abdomen (LA), erector spinae (ES), distal triceps (DT), brachioradialis (BR), lateral thigh (LT), front thigh (FT) and medial calf (MC). 24 subjects (12 males and 12 females) were examined. In order to cover a wide range of SAT thicknesses the BMI ranged from 18.6 to over 40 kgm<sup>-2</sup>. For evaluating the US images, a semi-automatic tissue contour detection and measurement algorithm was used (FAT software, rotoSPORT.com). **Results** The five sites UA, LA, LT, FT, and MC showed significant differences between men and women in this group ( $p < 0.05$ ), whereas ES, DT, and BR did not. In men, UA and LA contributed 51% to the sum of the eight fat thicknesses, whereas in women it was only 34%. In women, all three sites on the leg: LT, FT and MC (women: 26%, 12% and 8%; men: 15%, 8% and 5%, respectively) showed significantly higher SAT values. Mean value of the total sum of SAT was 85 mm in the men's group (mean BMI 26.8 kgm<sup>-2</sup>) and 117 mm in the women's group (mean BMI 24.6 kgm<sup>-2</sup>). **Discussion** The results obtained in this group show the pronounced SAT thickness differences at the eight sites chosen for the standardised fat patterning analysis in individuals and between a group of men and a group of women. LT, a site that has not been used in preceding studies, was found to be a fat depot site which is more pronounced in women than in men. In further studies, the differences between males and females should be investigated in larger groups. This measurement technique can also be applied for SAT studies in various groups of athletes and also in overweight persons. This method [2] provides a sensitivity for fat patterning studies not reached by any other method before. **References** [1] Müller, W., Maughan, R. J. (2013). *BJSM*, 47(16), 1001–1002. [2] Müller, W., Lohman T.G, Stewart A.D. et al. (2016) *BJSM* 50:45–54.

## BODY COMPOSITION INFLUENCE IN AEROBIC PROFILE IN TETHERED SWIMMING

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**Introduction** As training methods have become more sophisticated, each athletics group has become specialized, modifying its typical physique imperatives away from general morphological norms. However, the influence of total and regional body composition on swimmers aerobic capacity remains to be better clarified. The aim of this study was to analyze the influence of total and regional body composition on swimmers aerobic profile. **Methods** Eleven male (18.0±4.0 years of age, 180.2±6.8 cm in height and 71.8±9.5 kg in body weight) and five female swimmers (16.8±3.6 years of age, 166.2±5.5 cm in height and 61.1±9.8 kg in body weight) underwent the following evaluations: 1) Maximal tethered swimming force (F<sub>maxtethered</sub>), which consisted of two 30 seconds maximal efforts in tethered apparatus (Cefise®) with a 10 minutes rest interval to maximum and mean force determination (F<sub>max</sub> and F<sub>mean</sub>) 2) and 2) a incremental test with a conventional load system tied to the swimmer with increments of 5% per minute (range 30–100% of F<sub>mean</sub>). Oxygen uptake was assessed by an automatic and portable system (K4b2 Cosmed, Italy) for direct breath-by-breath analysis of pulmonary gas exchange, which was attached to the swimmer by a snorkel with a tri-dimensional valve (Aquatrainer®). Maximum oxygen uptake (VO<sub>2max</sub>), respiratory compensation point (RCP) and gas exchange threshold (GET) were determined. Body composition was assessed by dual-energy X-ray absorptiometry method (DXA). Correlations were analyzed using Pearson's coefficient,  $p \leq 0.05$  was adopted. **Results** Lean mass of the upper limb (LM\_UL, 6741.9±1573.1 g) was significantly correlated to VO<sub>2max</sub> (3423.0±601.9 ml.min<sup>-1</sup>;  $r=0.83$ ,  $p<0.01$ ), RCP (3046.2±588.7;  $r=0.80$ ,  $p<0.01$ ) and GET (2214.8±455.0 ml.min<sup>-1</sup>;  $r=0.81$ ,  $p<0.01$ ). The same was observed between lean mass of the lower limb (LM\_LL, 20146.5±3844.4 g) and VO<sub>2max</sub> ( $r=0.81$ ,  $p<0.01$ ), RCP ( $r=0.79$ ,  $p<0.01$ ) and GET ( $r=0.67$ ,  $p<0.01$ ) and between total lean mass (LM, 56852.8±10125.7 g) and VO<sub>2max</sub> ( $r=0.81$ ,  $p<0.01$ ), RCP ( $r=0.79$ ,  $p<0.01$ ) and GET ( $r=0.66$ ,  $p<0.01$ ). VO<sub>2max</sub> and RCP was not correlated to body fat (BF), only GET was correlated to BF\_UL (16.0±8.6%;  $r=-0.73$ ,  $p<0.01$ ), BF\_LL (19.6±8.1%;  $r=-0.67$ ,  $p<0.01$ ) and total BF (17.0±6.8%;  $r=-0.66$ ,  $p<0.01$ ). **Discussion** This study highlight that body composition plays an important role in swimming metabolic demand. The higher the physiological demand (respectively VO<sub>2max</sub>, RCP, GET), the higher the influence of body composition. Tethered swimming may represent a useful method for aerobic assessment and regional body composition analysis seems relevant as the relationship between upper limb body composition and aerobic profile of the swimmers was always higher compared to total and lower limb. **References** 1Acland, T.R., Lohman, T.G., Sundgot-Borgen, J., Maughan, R.J., Meyer, N.L., Stewart, A.D., Müller, W. *Sports Med.* 2012 Mar 1; 42(3): 227–49. 2Mouroço, P., Keskinen, K.L., Vilas-Boas, J.P., Fernandes, R.J. *J Appl Biomech.* 2011 May; 27(2): 161–9.

## BODY COMPOSITION AND MENSTRUAL CYCLE IN ENDURANCE-TRAINED FEMALES. A PILOT STUDY

DELGADO, B., CASTRO, E.A., CUPEIRO, R., BARBA, L., BARRIONUEVO, E., PEINADO, A.B.

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**Introduction** The association between menstrual cycle and body composition (BC) in healthy sedentary women has been widely studied (Elliot et al., 2015; Marsh and Jenkins, 2002); however, few studies have evaluated the relation between the different menstrual cycle phases and BC in athletes (Wojtyś et al., 2015). Therefore, the aim of this study was to assess the influence of the menstrual cycle phases on BC variables in endurance-trained females. **Methods** Six endurance-trained females (body mass index 18.4 kg/m<sup>2</sup>; aged 36.67±4.46 years, participated in this study. BC variables were measured by bioelectrical impedance (OMRON BF 306W analyzer, OMRON HEALTHCARE Co., Ltd, Ukyo-ku, Kyoto, Japan), at three phases of the menstrual cycle: Early Follicular Phase (EFP), Midfollicular Phase (MFP) and Luteal Phase (LP). One-way ANOVAs with repeated measures were used to analyze differences among menstrual cycle phases and BC variables. **Results** No significant differences were observed for body weight, fat mass and lean body mass percentages, water or impedance among phases ( $p>0.05$ ). **Discussion** Differences between menstrual and follicular phases for weight and fat free mass, as well as between the follicular and luteal phase for weight, has already been reported for sedentary women (Gleichauf and Roe, 1989). However, our results did not show differences in BC throughout the cycle in trained females. Although our data are preliminary, our outcomes are in agreement with other findings in female athletes (Marsh and Jenkins, 2002; Teixeira et al., 2013). Suggesting a different BC behaviour

throughout the menstrual cycle in trained women compared with healthy non-athlete females. More data are needed in order to elucidate the specific interaction between sex hormones changes and BC variables when studying endurance-trained women. References Elliot SA, et al. (2015). *Eur J Nutr*, 54(8):1323-32. Gleichauf CN, Roe DA. (1989). *Am J Clin Nutr*, 50:903-907. Marsh SA, Jenkins DG. (2002). *Sports Med*, 32(10):601-614. Teixeira AL, et al. (2013). *Percept Mot Skills*, 117(3):892-902. Wojtys EM, et al. (2015). *J Athl Train*, 50(2):185-92. Contact b.rael@alumnos.upm.es

### COMPENSATORY CHANGES IN HABITUAL PHYSICAL ACTIVITY IN RESPONSE TO AEROBIC EXERCISE UNDER WEIGHT STABLE CONITIONS

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**Introduction.** A high total daily energy expenditure (TDEE) is generally associated with better long-term weight management. Many participants in exercise-based interventions, however, display a less pronounced increase in TDEE than what could be expected from the exercise program. The present study examined differences in habitual physical activity (PA) between compensators and non-compensators participating in an aerobic exercise program that targeted an increase in TDEE, while maintaining body weight. **Methods.** A total of 40, previously sedentary adults (65% male, 31±7 years) provided valid measurements at baseline and 3-month follow-up. Body weight was measured at baseline and at the beginning of every exercise session to ensure participants maintained their body weight. TDEE, exercise energy expenditure as well as time spent sedentary, in light PA and moderate-to-vigorous PA (MVPA) was measured with a multi-sensor device over a period of one week at each measurement time. Compensation was determined based on the difference in TDEE between BL and follow-up relative to energy expenditure during exercise; participants whose change in relative energy expenditure was less than exercise energy expenditure were classified as compensators. **Results.** Compensation was observed in 21 participants, while 19 increased their TDEE beyond the exercise energy expenditure. There was no significant association between compensation and the amount of exercise (i.e. number of exercise days, exercise duration, and exercise energy expenditure). Exercise participation was associated with an increase in MVPA on exercise days in both groups ( $p<0.01$ ) but the increase was more pronounced in non-compensators ( $84\pm23$  min/d vs.  $62\pm32$  min/d). Compensators displayed a significant decline in light PA ( $-37\pm29$  min/d,  $p<0.01$ ), while the reduction in sedentary time was non-significant. In non-compensators sedentary time declined significantly ( $-80\pm42$  min/d;  $p<0.01$ ), while light PA did not change significantly. Non-compensators further significantly increased MVPA at the expense of sedentary time on non-exercise days ( $31\pm8$  min/d,  $p<0.01$ ). **Discussion.** Given the limited amount of time spent in supervised exercise during a specific intervention, non-exercise behavior is a crucial aspect in the success of exercise-based interventions. In addition to compensatory adaptations on exercise days, the present study emphasizes the role of PA on non-exercise days. Participants, therefore, need to be encouraged to increase their MVPA outside any supervised exercise session while reducing sedentary time.

## Oral presentations

### OP-PM30 Training Methods in Soccer

#### WARM-UPS WORK! EXAMINING THE TIME-COURSE OF CHANGES IN MUSCLE TEMPERATURE AND CONTRACTILE FUNCTION FOLLOWING THE PRE-MATCH WARM-UP IN SOCCER AND THE USE OF PASSIVE HEATING

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**Background** We were interested in examining the time-course of changes in quadriceps muscle contractile function and voluntary drive around a soccer specific warm-up, and how any changes contributed to measures of rate of force development as an experimental measure of muscle power. Moreover, considering the links between muscle temperature ( $T_m$ ) and mechanisms of power output, we examined the effect of a 'cool-down' period commensurate with that observed in the EPL prior to match-play on measures used. Finally, we tested whether a passive heating garment applied after the warm-up would have any effect on measures we performed. **Methods** Ten amateur soccer players performed two experimental sessions that involved performance of a modified FIFA 11+ soccer specific warm-up, followed by a 12.5 minute rest period where participants were required to either wear normal clothing or a passive electrical heating garment was applied to the upper thigh muscles. Assessments around the warm-up and cool down included measures of maximal torque, rate of torque development, vastus lateralis muscle temperature (measured at a depth of 4cm), and electrically evoked measures of quadriceps contractile function and voluntary activation (10Hz and 100Hz doublet stimulation of the femoral nerve). **Results**  $T_m$  was increased after the warm-up by  $3.2 \pm 0.7$  °C ( $p<0.001$ ). Voluntary and evoked rates of torque development increased after the warm-up between 20 to 30% ( $p<0.05$ ), despite declines in both maximal voluntary torque and voluntary activation ( $p<0.05$ ). Application of a passive heating garment in the cool-down period after the warm-up did not effect variables measured. While  $T_m$  was reduced by  $1.4 \pm 0.4$  °C after the rest period ( $p<0.001$ ), this value was still higher than pre warm-up levels. Voluntary and evoked rate of torque development remained elevated from pre warm-up levels at the end of the cool-down ( $p<0.05$ ). **Conclusion** The soccer specific warm-up elevated muscle temperature by 3.2°C and was associated with concomitant increases of between 20 to 30% in voluntary rate of torque development, which seems explained by elevations in rate dependent measures of intrinsic muscle contractile function. Application of a passive heating garment did not attenuate declines in muscle temperature during a 12.5-minute rest period.

#### AN EVALUATION OF THE RESISTANCE TRAINING PROGRAMMES IN AN ELITE SOCCER ACADEMY AND IT'S EFFECTS ON THE DEVELOPMENT OF ISOMETRIC STRENGTH

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**INTRODUCTION** Muscular strength is a desirable attribute in soccer players of all ages. The aim of this study was to evaluate the training completed by English Premier League soccer players in an academy over an 8-week period and to determine whether such training

increased isometric strength compared to a control group. METHODS Training for 184 elite soccer players from under 9 (U9) to under 21 (U21) was recorded over an 8-wk period. Data was examined to establish distribution of training time in soccer training, matches, non-resistance training athletic development activities and resistance training. From that group 155 elite and 93 control participants completed two isometric mid-thigh pull tests 8-wks apart. Isometric strength was expressed as both absolute and allometrically scaled (force \* body mass<sup>0.66</sup>). RESULTS Total training time progressively increased between the U9 (268 ± 25 min/wk) and U14 (477 ± 19 min/wk) age groups with only a small proportion of training time (3 ± 18%) consisting of training focussed on solely improving physical attributes. Total training time was then subsequently reduced from the U14 to the U15 (266 ± 77 min/wk) age groups, with no differences in training duration for any groups between U15 and U21 (P > 0.05). When the U15 to U21 squads (the only players who completed resistance training) were compared no difference in session duration was observed (P > 0.05). No main effect for peak isometric force (PF) between elite (1617.10 ± 611.15 N) and control (1535.69 ± 624.83 N) groups was present (P = 0.087). For allometrically scaled force (RF) a main effect was noted with the elite cohort (118.29 ± 21.96 N) being stronger than controls (109.69 ± 27.91 N) though no interaction between group and maturity status was observed (P = 0.167). Following 8 weeks of training no changes were seen in either group for PF (at 8 wk elite group 1580.12 ± 632.55 N; control group 1496.38 ± 555.51 N) or RF (elite group at 8 wk, 119.12 ± 23.43 N; control group at 8 wk, 110.89 ± 25.75 N) (P > 0.05). DISCUSSION These data examine training practices and isometric strength throughout an English Premier League soccer academy compared with a matched control group. They suggest that training practices evaluated here do not elicit increases in isometric strength. This is likely a result of the focus of training time on technical development. This data can provide practitioners with baseline isometric strength data and training data for comparisons across teams.

## DEVELOPMENT OF STRENGTH AND BALANCE ABILITIES DURING ONE COMPETITIVE SEASON IN HIGH LEVEL FEMALE FOOTBALL PLAYERS OF DIFFERENT AGE GROUPS

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Introduction: Isokinetic assessment of thigh muscle strength is frequently applied to assess the risk of injury. Similarly, trunk muscle strength and a well-developed dynamic balance are considered beneficial with regard to sports performance and injury prevention. The aim of the present study was to assess leg and trunk muscle strength as well as dynamic balance in high-level female football players of different age groups over the course of a competitive season. Methods: 45 female soccer players of a high-level Swiss football club (under-16: N=19; age = 15.0 (SD 0.7) years; body mass = 54.6 (5.8) kg; under-18: N=15; age = 16.8 (0.6) y; body mass = 59.9 (8.0) kg; body fat = 18.4 (8.8)%; adult players: N=11; age = 21.2 (2.4) y; body mass = 61.1 (6.1) kg) participated. 26 (58%) of these players were tested twice (under-16: N=10; under-18: N=10; adults: N=6), at the end of the pre-season (November 2014) as well as at the end of the second leg of the season (May 2015). Hamstrings (H) and quadriceps (Q) strength was measured on an isokinetic device (IsoMed 2000) at a speed of 60°/sec, 240°/sec and -30°/sec (eccentric). H:Q-ratio was calculated at 60°, 240° and -30°/240° (Croisier et al., 2003). Ratios between flexion/extension and rotation were calculated for trunk strength measures. Dynamic balance performance was assessed by means of the Y-balance test. Results: Quadriceps strength in the preferred leg was higher in all age-categories for flexion (60°, under-16: +11% (p=0.004); under-18: +10% (p=0.004); adults: +10% (p=0.007) and extension (i.e. 60°, under-16: +4% (p=0.31); under-18: +7% (p=0.09); adults: +3% (p=0.27)) as compared to the non-preferred leg. H:Q-ratio also showed higher values in the preferred leg. Trunk strength and flexion-to-extension-ratios rose with age (under-16: 1.59 (0.28); under-18: 1.68 (0.21); adults: 1.86 (0.14)). Balance performance showed no differences between age groups and legs (p>0.75). An increase from pre- to post-season was found for knee extension peak torque (60°, preferred leg: +12% (p=0.001); non preferred leg: +10% (p=0.08)) in the under-16 players. Discussion: Our results show an inconsistent development in leg and trunk strength over age categories. However, players showed only small differences from pre- to post-season. H:Q ratios as well as the balance score developed differently in preferred and non-preferred leg. Whether strength and balance imbalances are potentially harmful cannot be clarified by our data. However, in order to prevent injuries and to detect maldevelopment timely, regular strength and balance assessment is advisable. References: [1] Croisier, J.-L., et al. (2003). IES 11(1): 61-62.

## THE DEVELOPMENT OF A STANDARDISED PROTOCOL FOR MONITORING HEART RATE RECOVERY IN SOCCER PLAYERS

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Introduction Physiological monitoring during the recovery process following elite soccer performance has been an area of considerable interest over recent years. The aim of this study was to develop a standardised exercise protocol for use in the calculation of heart rate recovery (HRR) that can be integrated into a training strategy used by an elite team. Furthermore, this study attempted to evaluate the reliability of the HR response to the protocol as well as compare the protocol to specific physical loads completed during the recovery period following soccer match play. Methods Three exercise protocols (1-6x60m 6ms 10:20s; 2-6x80m 5ms 16:14s; 3-6x60m 5ms 12:8s) were tested for reliability of HR response and suitability with regards to soccer training loads. Nine male competitive soccer players (Mean±SD: age 17±0.6 years, height 1.7±0.9m, body mass: 63±9.0kg) took part in the study. All subjects completed one trial of each protocol on each of 5 data collection days (3 familiarisation trials and 2 testing sessions). Trials completed on each data collection day were separated by 30 min of seated rest. HR and GPS data was collected throughout all trials (duration, total distance, peak speed, %MAXHR, HRR at 1 min post exercise). Data were analysed using standard error of measurement (SEM) and coefficient of variation (CV) for reliability assessment and by the use of paired t-tests to compare the physical loads completed in the protocol and by players during actual recovery training sessions. Results There were no significant differences (P<0.05) between previous soccer recovery activities completed in training (duration- 3min, distance- 399m, peak speed- 4.7ms, %MAXHR- 74%) and the exercise protocols developed in this study (duration- 4min, distance- 406m, peak speed- 5.3ms, %MAXHR- 86%). All protocols elicited a %MAXHR above 80% (protocol 1-82.5%, protocol 2-85.5%, protocol 3-89.5%). CV and SEM were lower for both HRR and %MAXHR for protocol 2 (HRR CV=9.95%, HRR SEM=2.14% - %MAXHR CV=2.57%, %MAXHR SEM=2.19%) compared with protocol 1 (HRR CV=21.99%, HRR SEM=5.74% - %MAXHR CV=4.08%, %MAXHR SEM=3.36%) and 3 (HRR CV=40.41%, HRR SEM=10.41% - %MAXHR CV=2.62%, %MAXHR SEM=2.33%). Discussion This study developed a protocol (6x80m 5ms, 16:14s) that is suitable for use as a real world monitoring tool during the recovery period following soccer match play. The developed protocol presented CV and SEM data to suggest that this protocol is suitable for use to detect changes in the HR response. Contact p.j.orme@2009.ljmu.ac.uk

## THE EFFECT OF STATIC STRETCHING ON MUSCLE RECOVERY FOLLOWING COMPETITIVE SOCCER MATCHES

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**Introduction** Static stretching (SS) is a recovery intervention often used in elite football for assisting in the reduction of muscle soreness post-exercise, and in research as a control for comparing alternative recovery interventions. However, its effects on elite young footballers has received little attention, and therefore the aim of this study was to assess the effects of static stretching on muscle recovery following competitive soccer matches in elite young footballers. **Methods** Participants used in this study were recruited from a professional football academy from the Premier League. Participants were male ( $16 \pm 1$  years) and of elite standard. Using a controlled cross-over design, participants completed a total of 6 competitive soccer matches followed by one of two recovery interventions (static stretching or passive recovery). The recovery interventions were conducted immediately following completion of competitive soccer matches. The static stretching protocol was administered comprising 7, 15 second stretches on lower body muscles whilst the passive recovery protocol comprised 10 minutes passive seating. Assessments used to measure muscle damage were taken before, within 30 minutes after, and 48 hours post match and consisted of muscle oedema, Creatine Kinase (CK) assessment, countermovement jump (CMJ) height and perceived muscle soreness. To maintain control, players were excluded from individual games if they failed to complete a minimum of 80% of the competitive soccer match. **Results** When comparing the effects of recovery interventions over time, results showed that competitive soccer matches had a significant effect on markers of muscle damage, with almost all indicators showing significant differences for pre and immediately-post competitive match for recovery interventions, with only gastrocnemius oedema assessment showing no significant difference. Additionally, significant differences between pre- and 48 hours post-exercise assessments were found in perceived soreness, CK values and CMJ height. When comparing the effects of recovery interventions between conditions, the only difference observed was between CK which demonstrated improved levels of recovery in the static stretching group at 48 hours following exercise. **Discussion** The findings from this study demonstrate that competitive soccer matches provide strenuous exercise, inducing muscle damage which may have detrimental effects on future performance. This is demonstrated by the reduction in CMJ performance and elevation in CK and muscle soreness at 48 hours post-exercise. Furthermore, there is limited evidence to suggest that a static stretching protocol would assist in the reduction in muscle damage post-exercise, with only CK showing improved effects. The improved effects of static stretching on CK are unclear, however may be linked to the idea that static stretching assists in the removal of muscle oedema following exercise. Additionally, it may be possible that due to the elite standard of participants, they have a heightened level of CK removal post-exercise.

## Oral presentations

### OP-PM42 Recovery Modalities

#### EFFECT OF TWO RECOVERY STRATEGIES ON PERFORMANCE RECOVERY: COLD-WATER IMMERSION VS WHOLE-BODY CRYOTHERAPY.

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**Introduction** Cold-water immersion and whole-body cryotherapy are two commonly used strategies to accelerate recovery following muscle-damaging exercise. Some studies have shown a positive effect of both strategies on accelerating the recovery kinetics (Ingram et al., 2009; Ferreira-Junior et al., 2015). However, to our knowledge, no study has yet compared these two strategies in direct competition with each other. The purpose of this study was therefore to investigate which recovery strategy; cold-water immersion versus whole-body cryotherapy was more effective at enhancing the recovery kinetics following a muscle-damaging exercise. **Methods** In a randomized cross-over design, ten subjects performed a muscle-damaging exercise protocol: 5 sets of 15 single leg eccentric contractions for the hamstring muscle. Immediately following the exercise, subjects were either, immersed in cold-water (10 minutes at  $10^{\circ}\text{C}$ ) or exposed to whole-body cryotherapy (3 minutes at  $-110^{\circ}\text{C}$ ). The recovery kinetics were assessed immediately, 24h, 48h and 72h after the muscle-damaging exercise. Specifically, the recovery protocol consisted of measuring; creatine kinase, hamstring maximal force, countermovement jump height, perceived muscle soreness and perceived recovery. **Results** A very likely (99% and 97%) moderate effect was found in favour of cold-water immersion for one-leg (Effect Size=-0.63; 90% CI=-1.38 to 0.13) and two-leg countermovement jump (ES=-0.68; 90%CI=-1.43 to 0.08) 72h after exercise respectively. The perceived muscle soreness was moderately lower 48h after exercise in the cold-water immersion condition (ES=0.68; 90% CI=-0.07 to 1.44). Perceived recovery was moderately improved 24h after the exercise in the cold-water immersion group (ES=0.62; 90% CI=-0.13 to 1.38). Trivial and small effects of condition were found for the other outcomes. **Discussion** According to the findings in the present study, cold-water immersion was more efficient to accelerate recovery kinetics compared to whole-body cryotherapy. Specifically, recovery was enhanced for one and two-leg countermovement jump 72h post-exercise. Cold-water immersion also showed a greater ability to reduce perceptions of muscle-soreness and improve the level of perceived recovery. In regards to muscle strength indices, there was no difference in recovery between both strategies. **References** Ferreira-Junior JB, Bottaro M, Vieira A et al. (2015). Scand J Med Sci Sports 2015; 25: e524-e530. Ingram J, Dawson B, Goodman C, Wallman K, Beilby J (2009). J Sci Med Sport 12(3):417-21. Contact Abd-elbasset.abaidia@etu.univ-lille2.fr

#### THE EFFECTS OF TWO DIFFERENT CRYOTHERAPY INTERVENTIONS ON MARKERS OF RECOVERY FOLLOWING A 26.2 MILE TRAIL RUN

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**Introduction** Following strenuous exercise, it is common for athletes to experience symptoms of muscle damage, inflammation, oxidative stress and fatigue (Appell et al., 1992). The use of cryotherapy as a recovery strategy is becoming increasingly popular as a means to try and minimise the negative impact of strenuous physical activity on subsequent exercise performance (Leeder et al., 2012). Therefore, this



study aimed to assess the effects of whole body cryotherapy (WBC) and cold water immersion (CWI) on markers of recovery following a bout of prolonged endurance exercise. Methods Thirty one endurance trained males (mean age  $39.4 \pm 7.9$  years; height  $1.77 \pm 0.07$  m; mass  $77.7 \pm 9.05$  kg) completed a 26.2 mile trail run (average completion time  $229.3 \pm 23.4$  minutes). Participants were randomly assigned to a CWI (10 min at  $8^\circ \pm 0.5^\circ\text{C}$ ), WBC (1 x 3 and 1 x 4 min separated by 15 min at  $-85^\circ \pm 5^\circ\text{C}$ ) or placebo group. Ratings of perceived muscle soreness, changes in muscle function, and perceptions of training stress were recorded before exercise, immediately after completion of the assigned intervention and at 24 and 48 hours following completion of the trail run. Self-reported sleep quality data was also recorded for a week before, and a week after completion of the trail run. Results Exercise resulted in significant increases in muscle soreness immediately, and 24 hours following the trail run. Significant decreases in peak knee extensor torque, maximal voluntary isometric contraction (MVIC) and counter-movement jump (CMJ) height were recorded immediately, and 24 hours post exercise. Perceptions of training stress were significantly increased immediately after exercise but returned to baseline by 24 hours post. Self-reported measures of sleep quality did not alter significantly at any time point. Despite significant main effects for time across all dependent variables except sleep quality, there were no significant differences between groups at any time point. Discussion These results suggest that cryotherapy (CWI or WBC) applied immediately following strenuous endurance exercise is no more effective than a placebo intervention for improving these specific markers of recovery in endurance trained athletes. References Appell, H. J., Soares, J. M. C., & Duarte, J. A. R. (1992). Exercise, muscle damage and fatigue. *Sports Medicine*, 13(2), 108-115. Leeder, J., Gissane, C., van Someren, K., Gregson, W., & Howatson, G. (2012). Cold water immersion and recovery from strenuous exercise: a meta-analysis. *British Journal of Sports Medicine*, 46(4), 233-240.

## PRE- OR PERCOOLING BY ICE SLURRY INGESTION TO IMPROVE CYCLING TIME TRIAL PERFORMANCE IN THE HEAT

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Pre- or percooling by ice slurry ingestion to improve cycling time trial performance in the heat Introduction The ingestion of ice slurry has become a popular way of cooling to improve endurance exercise performance in the heat. Consuming ice slurry can take place before exercise (precooling) or during exercise (percooling) and it has been shown that both methods can be beneficial for performance (Bongers et al., 2015). However, at this moment it is still unclear which regime should be preferred: pre- or percooling. Therefore, the aim of this study is to compare the effect of precooling and percooling by ice slurry ingestion on performance during a 30-km cycling time trial in the heat. Methods Ten experienced, trained cyclists (age:  $27 \pm 9$  years, body mass:  $77 \pm 8$  kg,  $\text{VO}_{2\text{max}}$ :  $58 \pm 4$  ml/kg/min) performed one maximal incremental exercise test, one 30-km familiarisation time trial and two experimental 30-km cycling time trials in the heat ( $29.9 \pm 0.5^\circ\text{C}$ , relative humidity:  $38 \pm 7\%$ ). The cycling time trials were preceded by the Lamberts and Lambert Submaximal Cycling Test (LSCT: Lamberts et al., 2011) as a warm-up. The participants ingested 7.5 g/kg body mass ice slurry during the LSCT (PRE) or during the cycling time trial (PER). Power output (PO), rectal temperature (Tre), mean skin temperature (Tsk), heart rate (HR), rating of perceived exertion (RPE), thermal sensation (TS) and thermal comfort (TC) were measured. Results Finish time of the time trial did not differ between conditions (PRE:  $2752 \pm 133$  s, PER:  $2739 \pm 176$  s;  $P=0.65$ ). In line with this, PO was similar (PRE:  $257 \pm 36$  W, PER:  $263 \pm 43$  W;  $P=0.39$ ). A statistical trend was observed towards a difference in pacing pattern between PRE and PER (interaction-effect:  $P=0.08$ ), displayed by a higher PO towards the end of the time trial in PER. Mean HR during the time trial was similar for PRE and PER ( $P=0.27$ ). Precooling did not result in a lower Tre at the start of the time trial (PRE:  $37.9 \pm 0.3^\circ\text{C}$ , PER:  $37.9 \pm 0.3^\circ\text{C}$ ;  $P=0.66$ ) but the increase in Tre during the time trial was smaller in PER than in PRE ( $P=0.008$ ). Tsk and RPE were similar during the time trial for both conditions ( $P=0.93$  and  $P=0.83$ , respectively) whereas TS and TC during the time trial were higher for PRE than for PER in the last 10 km. Discussion No difference was observed in performance during a 30-km cycling time trial in the heat between precooling or percooling. Therefore, the moment of ice slurry ingestion, either before or during a cycling time trial, appears to be irrelevant. References Bongers C, Thijssen D, Veltmeijer M, Hopman M, Eijssvogels. (2015) *Br J Sports Med*, 49, 377-384. Lamberts R, Swart J, Noakes T, Lambert M. (2011) *Br J Sports Med*, 45, 797-804.

## ACUTE EFFECTS OF FOAM-ROLLING ON JUMP HEIGHT AND SOFT TISSUE STIFFNESS

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Foam-rolling is frequently used during warm-up and regeneration procedures for self-myofascial release [1]. However, the acute effects on performance and potentially underlying soft tissue properties are not fully understood. Therefore, the study aimed to evaluate the acute effects of foam-rolling on jump height and soft tissue stiffness of the lower extremities. Twenty male active subjects ( $26.9 \pm 2.6$  years,  $181.6 \pm 6.8$  cm,  $80.4 \pm 9.1$  kg) were randomized to execute the following three interventions: 2x30 repetitions of foam-rolling (FR) on the thigh and calf (BLACKROLL, Bottighofen CH), 10 min of ergometer cycling (EC), and controls (CO). Before as well as 0, 15, and 30 min after each intervention, three countermovement jumps were performed on a force plate (Kistler 9287BA, Winterthur CH). Soft tissue stiffness was measured on two points (M. rectus fem., M. gastrocnemius med.) of both legs by myomechanography (MyotonPRO AS, Tallinn EST). Data were analyzed using a two-way repeated measures ANOVA (time x intervention) as well as one-way repeated measures ANOVA with post-hoc Bonferroni correction. Pearson correlation coefficients were used to investigate relationships between changes in the jump height and stiffness. A significant main interaction (time x intervention) was found in jump height ( $p<0.001$ ,  $\eta^2=.81$ ) and stiffness of M. rectus fem. (left:  $p=.002$ ,  $\eta^2=.74$ , right:  $p=.008$ ,  $\eta^2=.67$ ). Thereby, jump height increased only after EC ( $34.8 \pm 3$  vs.  $36.4 \pm 3$  cm,  $p=.001$ ) and decreased thereafter as in FR and CO. Stiffness of M. rectus fem. decreased after FR (left:  $266 \pm 24$  vs.  $260 \pm 27$  N/m,  $p=.01$ ; right:  $268 \pm 32$  vs.  $260 \pm 33$  N/m,  $p=.004$ ) and return to pre-values afterwards. However, the increase in stiffness of M. rectus fem. after EC was not significant (left:  $265 \pm 28$  vs.  $270 \pm 31$  N/m,  $p=.17$ ; right:  $270 \pm 33$  vs.  $275 \pm 34$  N/m,  $p=.12$ ). The Pearson correlation coefficient between the changes in jump height and stiffness of M. rectus fem. after all interventions was .40 ( $p=.002$ ). Soft tissues properties were altered after foam-rolling. In contrast to a traditional warm-up on a cycling ergometer, the jump height did not increase and the soft tissue stiffness of the thigh decreased after foam-rolling. Therefore, the isolated use of a foam-roller as a warm-up procedure before explosive activities seems to be questionable. Future studies have to show if the decrease of the stiffness is caused by fascial, muscular, and/or other soft tissues. [1] Schroeder AN, Best TM. Is self myofascial release an effective preexercise and recovery strategy? A literature review. *Current sports medicine reports*. 2015;14(3):200-208.

### THE EFFECT OF FOAM ROLLING ON RECOVERY BETWEEN TWO 800-M RUNS

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**Introduction** With the increased popularity of foam rolling as a means of recovery, it is important to establish the exact manner in which the practice is useful. Therefore, the purpose of this study was to examine the impact of foam rolling on recovery between two 800 m runs. **Methods** Sixteen male middle distance runners (mean±sd; age, 20.5±.5 years; 800 m run time, 145.2±1.8 seconds) participated in the study, using a randomized, crossover design. The subjects completed two 800 m runs on a treadmill, separated by a 30 min rest, during which time a foam rolling protocol or passive rest period was performed. The speed of each run was as fast as possible. Subjects had access to speed controls, but were blinded to the actual speed. Blood lactate concentration and VCO<sub>2</sub> were measured prior to and following each run. Stride length, running economy, 800 m run time, and hip extension were measured during each run. **Results** VCO<sub>2</sub>, stride length, running economy, 800 m run time, and hip extension were not significantly different between conditions ( $p > .05$ ). For blood lactate, no statistical interaction was found between condition and time ( $p > .05$ ). **Discussion** Foam rolling between two 800 m runs separated by 30 min performed by trained male runners does not alter recovery and subsequent performance. These findings are in contrast to investigations utilizing longer periods of time between exercise bouts, such as 24, 48, or 72 hr, and measures of strength and power (Macdonald et al., 2014; Pearcey et al., 2015). Our research was limited to the influence of foam rolling on short-term recovery in 800 m runners. The length of the rest interval and the type of athletic event may determine the efficacy of foam rolling towards an athlete's recovery. **References** Macdonald GZ, Button DC, Drinkwater EJ, Behm DG. (2014). *Med Sci Sports Exerc*, 46(1), 131-42. Pearcey GP, Bradbury-Squires DJ, Kawamoto J, Drinkwater EJ, Behm DG, Button DC. (2015). *J Athl Train*, 50(1), 5-13. Contact adamico@salemstate.edu

### ROLLER MASSAGE DOES NOT ALTER EVOKED PAIN PERCEPTION OR CONTRACTILE PROPERTIES

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**Introduction** Foam-rolling (FR) and roller massage (RM) have become a common practice with warm-up or recovery from exercise. It is believed to promote soft-tissue extensibility, improve muscle function, and reduce pain. However, it is not known if RM directly alters muscle properties. Therefore, the aim of this study was to determine if RM has an immediate effect on evoked contractile properties and sensation of evoked pain. **Methods** In a randomized repeated-measures design ( $n = 12$ ) the acute effects of three different RM interventions on evoked pain perception (PP / i.e. pain visual analog scale (VAS) with evoked twitch and submaximal and maximal tetanic stimulation of the dominant calf muscles), maximum voluntary isometric contraction (MVIC) force and evoked contractile properties (twitch and tetanic maximum force, time to peak force, half relaxation time and rate of force development) were investigated. The interventions consisted of 3 x 30s bouts of 1) heavy rolling massage (7/10 perceived pain) on the stimulated calf, 2) heavy rolling massage (7/10) on the contralateral limb and 3) light rolling (<1/10) on the stimulated calf (Control). Testing was conducted prior to the RM intervention as well as 1 and 5 min after the intervention, respectively. **Results** A two-way repeated measures ANOVA revealed no statistically significant main effects or interactions (roller massage intervention x testing) regarding PP, MVIC and evoked contractile properties. **Discussion** This data suggests that a single bout of RM had no effect on evoked or voluntary contractile properties. Furthermore, evoked twitch and tetanic pain remained unaffected by RM. Based on the present and prior research; RM may not predominately affect muscle properties nor reduce all types of pain.

## Oral presentations

### OP-SH13 Sociology: Development

#### SPORT-FOR DEVELOPMENT: ARE WE CROSSING BORDERS IN RESEARCH?

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**Introduction** Over the past decade, the field of sport-for-development (SFD) has received significant attention from practitioners and researchers around the world. We have seen a strong proliferation of sport-based projects that aim to contribute to developmental outcomes such as economic development, social inclusion, cultural cohesion, healthy lifestyles, fair education, and gender equity (Coalter, 2013; Schlenkorf & Adair, 2014). In this paper, we critically analyse the research context of SFD by asking the question: Where is SFD research undertaken, by whom, and are researchers crossing borders? **Methods** Building on project information listed on the established SFD platform of the Swiss Academy for Development (sportanddev.org) and the comprehensive integrative review of SFD literature that was recently published by Schlenkorf, Sherry and Rowe (in press), we conducted a content analysis that investigated the geographic representation of SFD projects around the world; the home-location of the researchers involved in SFD studies; and any joint research projects in which international researchers have been 'crossing borders' to cooperate with local researchers. **Findings** First, by February 2016 a total of 639 organizations are involved in SFD programs all over the world (see sportanddev.org); however, a large majority of projects are implemented in Africa, Latin America, Asia and the Middle East. Second, the significant majority of the total 383 researchers that contributed to published SFD studies are based in Europe (37%), North America (36%), and Australia/New Zealand (19%), and much of SFD research is being undertaken in the "home countries" of these researchers. Third, local contributors from low- and middle income countries were significantly under-represented in the research teams, with less than 10% of journal articles noting their inclusion. **Discussion** The geographical contexts of study location and research authorship present an interesting paradox: Although the majority of SFD projects are carried out in LMICs, a staggering 90% of SFD research authors are based in high-income countries. This suggests that there is a clear practitioner-scholar divide in SFD. Moreover, only a minority of academics is 'crossing borders' for their research work and, perhaps most alarmingly, for their research engagement with local actors in the field. We conclude that hundreds of SFD projects in LMICs are therefore not benefitting from any kind of research engagement or academic support. In addressing these issues, research capacity building exercises should be promoted that strengthen the integration of—and collaboration with—academics in LMICs to improve their research access, skills, and/or opportunities. **References** Coalter, F. (2013). *Sport for Development: What Game Are We*

Playing? London: Routledge. Schulenkorf, N., & Adair, D. (Eds.). (2014). *Global Sport-for-Development: Critical Perspectives*. Basingstoke: Palgrave Macmillan.

## A COMPARATIVE STUDY ON THE ROLE OF ATHLETIC AND COMMUNITY SPORT IN SOCIAL DEVELOPMENT

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*Allameh Tabataba'i University,*

The aim of this study was to examination and compares the role of athletics and community sport on social development indicators (social welfare, personal, health, social health and social Justice) from the perspective of sport Professionals and Managers. Instrument was, 50-Item questionnaire in four indicators of social development. Of 235 questionnaires 65% returned to the researchers. A Construct factor analysis was conducted to establish validity of the measurement scale, followed by ANOVA to examine and compare the role of athletic and community sport on development indicators by occupation. The results showed that in social welfare, role of athletic sport ( $M = 3.47$ ,  $SD = .47$ ) was more than role of the community sport ( $M = 3.34$ ,  $SD = .52$ ). In personal and social health, Unity and social solidarity, Social Justice, the role of community sport was greater than the role of athletic sport. In total of 4 Dimensions, role of community sport ( $M = 3.49$ ,  $SD = .48$ ) was more than role of athletic sport ( $M = 2.34$ ,  $SD = .46$ ). Discussion: The results suggest that both types of sport have great role on social development indicators. However, in most of indicators, role of community sport is greater than athletic sport. This finding is consistent with results of, Ekholm (2013) that showed sport had an important role on prevent and reduce crime and social deviations. The results are also in consistent with Sugden (2006), who showed sport had an important role in forge a community spirit in the face of social ills, promote peace and conflict resolution, prevention of cultural violence and building social structure. Sport is an activity which has great potential to development. According to the results, sport is generally considered as a tool for development of society. However, more comprehensive type of sport, community sport, has greater effect on social indicators. Nickolson et al (2013) showed that the role of sport organizations, generally greater than non-sport organizations in some social indicators like, attachment, social integration, reliable alliance, guidance, and opportunity for nurturance. The present study compared the role of two sectors within sport organizations in social indices. The results include an important message for governments; although athletic sport may bring political prestige for you, community sport can bring personal prestige for majority of people you lead! Additionally, they will be able to play their role in making of modern and healthy community. References: Ekholm, D. (2013). Sport and crime prevention: individuality and transferability in research. *Journal of sport for development*. Vol.1 edition 2. Nicholson, M. Et al. (2013) Sport's social provisions, *Sport Management Review* 16 148–160 Sugden, J. (2006). Teaching and Playing Sport for Conflict Resolution and Co-existence in Israel. *International Review for the Sociology of Sport* 41(2) (2006):221–240.

## ADULT SPORT PARTICIPATION IN THE U.S. AS CULTURAL CAPITAL

STEMPEL, C.

*California State University, East Bay*

Stempel, C.11: CSUEB (Hayward, California, USA) Introduction Dominant class adults in the U.S. participate more in competitive and fitness sports than middle/working class counterparts. More study is needed on cultural capital processes of sport participation, lifestyle divisions between the culturally and economically dominant classes, and where sport fits in the field of high status practices (Bourdieu, 1984; Stempel, 2005; Thrane, 2001; Veenstra, 2010). We test these questions by exploring relationships between participation in 3 types of sporting activities (fitness, competitive, attending elite sporting events) and participation in 3 types of high culture practices (residual, hegemonic, scholastic). Methods Data from the Survey for Public Participation in the Arts is analyzed using logistic and linear regression. Building on Bourdieu's focus on the volume and structure of capital we test a mapping of class lifestyles that fits the U.S. Key hypotheses are: 1. Dominant class occupations will lead participation in all 3 types of sports. 2. Fitness sport participation will be highest in the culturally dominant occupations. 3. Attending sporting events and sport omnivorousness (does all 3) will be highest in the economically dominant occupations. 4. All sport practices will be most weakly associated with the residual/traditional high culture. 5. All sports, particularly fitness sport, will be most strongly associated with scholastic high culture. 6. Hegemonic high culture will also be strongly associated with attending sporting events and participation in all 3 sports. Results Results generally confirm hypotheses. Discussion Sport participation is a neglected, but leading indicator of changes in the structure of cultural capital processes labeled 'omnivorousness.' Contra interpretations that emphasize democratization, the patterns better fit emphases on moral individualism and personal responsibility related to neoliberalization, and a remasculinization of culture (Burstyn, 1999; Hall & Lamont, 2013; Lizardo & Skiles, 2012; Wacquant, 2009). References Bourdieu, P. 1984. *Distinction*. Cambridge, MA: Harvard University Press. Burstyn, V. 1999. *The rites of men*. Toronto: University of Toronto Press. Hall, P., M. Lamont, eds. 2013. *Social resilience in the neoliberal era*. NY: Cambridge University Press. Lizardo, O., S. Skiles. 2012. Reconceptualizing and theorizing 'omnivorousness': Genetic and relational mechanisms. *Sociological Theory* 30: 260-280. Stempel, C. 2005. Adult participatory sports as cultural capital: A test of Bourdieu's theory of the field of sports. *International Review for the Sociology of Sport* 40: 411-432. Thrane, C. 2001. Sport spectatorship in Scandinavia: A class phenomenon? *International Review for the Sociology of Sport* 36: 149-163. Veenstra, G. 2010. Class and culture in Canada. *Canadian Journal of Sociology* 35: 83-111. Wacquant, L. 2009. *Punishing the poor*. Durham, NC: Duke University Press. Contact [carl.stempel@csueastbay.edu]

## THE ROLE OF FUNDING WITH INCLUSIVE PHYSICAL ACTIVITY PROGRAMS

WRIGHT, E.M., STEMPEL, C., HAFT, N.

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Introduction We report on a study on non-governmental organizations providing socially marginalized youth opportunities for sport and physical activity in Oakland and San Francisco, California. We contextualize the study in terms of the growing privatization and adult organization of youth sports and recreation (Coakley, 2014; Messner, 2009), and an increasing emphasis on 'competitive kid capital' (Levey Friedman, 2013) among the dominant classes in the U.S. In this context we wonder how intentionally inclusive play leaders are envisioning the role of sport and physical activity in the lives of marginalized youth and how they have organized their programs to foster their goals. Methods We conducted semi-structured, in-depth interviews with leaders of 5 organizations serving marginalized youth. Interviews were analyzed using a comparative case study framework focusing on how organizational leaders developed their programs, including how their vision of sport and the role of sport has evolved; challenges they have overcome to sustain their program; challenges they are currently facing; and current practices that foster inclusivity. Results We found that programs had a variety of starting places, visions, motivations, and initial pathways. Securing ongoing funding is a primary challenge that shapes program goals and structures,

and organizational practices and routines. Analysis of current challenges includes managing tensions between maintaining inclusivity and pressures to focus on high performance sport; serving a population being dispersed by gentrification; and meeting the demands of funders for evidence of program effectiveness. Discussion These findings are discussed relative to the existing literature and frameworks on inclusive programming (e.g. Donnelly & Coakley, 2002). Further, we specifically highlight the role of grants and funding opportunities for inclusive sport/physical activity organizations and how these shape available programs. We discuss adapting to funders' definitions of program success and possibilities for using research to build a network of support for increased public funding. We conclude with this observation that research evaluating program effectiveness is a great need of organizations offering sport and physical activities for marginalized groups. References Coakley, J. (2014). *Sports in Society: Issues and Controversies*. McGraw-Hill. Donnelly, P., & Coakley, J. (2002). Perspectives on social inclusion: The role of recreation in promoting social inclusion (pp. 1–19). The Laidlaw Foundation. Levey Friedman, H. (2013). *Playing to Win: Raising Children in a Competitive Culture*. Berkeley: UC Press. Messner, M. (2009). *It's All for the Kids*. Berkeley, UC Press.

## Oral presentations

### OP-SH23 Statistics

#### BELIEVES AND ATTITUDES AMONG YOUTH AND PROFESSIONAL FOOTBALL PLAYERS REGARDING INJURY PREVENTION

ZECH, A., WELLMANN K.

*University of Jena*

**Introduction** Although injury prevention strategies can be successfully promoted among team coaches and physiotherapists (Junge et al. 2011) it is still unknown which of these measures are generally accepted and regularly used by athletes. The objective of this study was to collect first data on perceptions on injury mechanisms and risk factors as well as used prevention strategies among professional and youth football players. **Methods** The study was a cross-sectional survey among professional and youth football players in one German high-level football club. 139 youth (n=115) and professional players (n=24) between age 13 and 35 years completed a standardized questionnaire. It included categories with history of injuries and perceptions regarding the influence of intrinsic and extrinsic factors on lower extremity football injuries. Athletes were also asked to report which of several prevention strategies they regularly use for injury prevention. Pearson's Chi-Square test was used to test whether these injury rates, perceptions on potential risk factors and preventive measures were differently distributed between teams or between injured and non-injured players. **Results** The response rate of returned questionnaires was at 98%. 84.2% of respondents reported a previous injury in the lower extremities. Most injuries of players between U17 and the first team occurred at the ankle joint whereas the younger teams (U16 and U15) reported more injuries at the thigh / groin. 47.5% of respondents believed that physical contact with other players is a risk factor for lower extremity injuries, followed by physical fatigue (38.1%), environmental factors (including equipment, 25.9%), muscle impairments (25.7%) and previous injuries (21.7%) The majority of respondents consider injury prevention important or very important. 91.5% of all players declared regularly to use stretching exercises in order to prevent injuries. About half of all respondents (54.0%) perform specific warm up exercises and one third (33.1%) specific strength exercises. External measures used regularly by players are taping (27.3%), shoe insoles (27.0%) and bracing (11.5%). **Conclusions** The results show that athletes in general are positively disposed towards injury prevention. Nearly all athletes perform stretching in order to prevent injuries although no scientific evidence exists for this measure. Thus, effective transfer measures are needed to promote use of research evidence in football practice. **References** Junge A, Lamprecht M, Stamm H, Hasler H, Bizzini M, Tschopp M, Reuter H, Wyss H, Chilvers C, Dvorak J. Countrywide campaign to prevent soccer injuries in Swiss amateur players. *Am J Sports Med* 2011; 39: 57-63

#### GAME STYLES IN FIELD SPORTS: DEFINING AND MEASURING IT

NORTON, K., HEWITT, A., GREENHAM, G.

*University of South Australia*

**Introduction** 'Game style' is a term commonly used by coaches, sports scientists, performance analysts and media to refer to patterns of play in team sports. Despite these pervasive references there is not a definition for game style and consequently it is not possible to measure game style. Team sports are dynamical systems and we can quantify how players interact in various contextual environments and circumstances. These interactions, particularly successful, dominant or recurrent patterns, are important in forming a game style and play a part in our perceptions of game style. This study proposes a definition of game style and an initial framework of variables that can be measured and used to describe game style. **Methods** The game style framework is based on metrics within five key moments of play: (1) Established Attack, (2) Transition from Attack to Defense, (3) Established Defense, (4) Transition from Defense to Attack, and (5) Set Pieces. If variables can be reliably measured and assigned to one of these moments then they can be used to categorise game style in sports. The total number of variables is potentially unlimited. We trialed the system in several sports in 2015-16 using multiple games per team and multiple measurements within each moment (a total of 12 performance variables). The variables measured were compared among 6 teams in the competition to calculate z-scores. They were then combined for a single z-score within each moment, reflecting the relative strength or weakness of that moment within games. ANOVA can then be used to determine differences among teams within each moment. **Results** Our working definition of game style was: 'the characteristic playing pattern demonstrated by a team during games. It will be regularly repeated in specific situational contexts such that measurement of variables reflecting game style will be relatively stable. Variables of importance are player and ball movements, interaction of players, and will generally involve elements of speed, time and space (location)'. Game style plots of the 5 moments were generated following 14 games in an elite football competition. These allowed visual and statistical comparisons that highlighted a team's typical play pattern and game style. **Discussion** Our game style assessment system and plots have practical applications for coaches and practitioners when evaluating efforts to create or compare game styles. Importantly, they allow performance analysts to: (1) categorise and monitor game styles over time, across leagues and age groups, (2) compare against benchmark performances of top teams, and (3) produce evidence of dominant and weaker elements of a team's game style in invasion-based field sports that can also be used to model training drills.



## THE INFLUENCE OF CONTEXTUAL FACTORS AND PLAYER CHARACTERISTICS ON MATCH ACTIVITY PROFILE IN PROFESSIONAL AUSTRALIAN FOOTBALL

COUTTS, A.J., SULLIVAN, C.J., CIANCIOSI, M., BILSBOROUGH, J., KEMPTON, T.J.

*University of Technology, Sydney (UTS)*

**Introduction** Match activity profiles in Australian Football (AF) have been shown to vary between individuals and throughout the season. Indeed, factors such as playing position, the opponent, individual player characteristics, player interchange, skill involvements, the environment, match score and competition scheduling have been shown to independently influence match activity profile. However, previous studies have failed to control, or account for the interactive effects of these contextual factors when interpreting player activity profiles. Therefore, this study used multi-level, mixed-modelling to examine the independent effects of match contextual variables and player characteristics on match activity profile in professional AF. **Methods** Global positioning system (GPS) and technical performance measures were collected from 35 players competing in the Australian Football League over two seasons to provide 327 individual matches. The GPS data were categorized into relative total distance (m/min) and relative high-speed running distance (HSR m/min, >14.4 km/h). Each match was classified according to season phase, location, recovery length, opposition strength, match result, win/loss margin, environmental temperature, skill involvement and objective performance rating. Individual player fitness was obtained from a 2-km maximal run time-trial conducted prior to the start of the competition seasons. Two separate multi-level, mixed-models were constructed to examine the influence of match-related and individual player characteristics on relative total and HSR distances. **Results** Higher player fitness (i.e. time-trial performance), increased interchange, away games, and stronger opposition increased HSR m/min and m/min. Matches following short recovery cycles were associated with greater HSR m/min distances. Players who had greater objective performance scores also had greater m/min but not HSR/min. **Conclusions** A complex interplay of match contextual and individual player characteristics affect match activity profiles in professional AF players. These results underline the importance of considering the effects of match scheduling (i.e. location, recovery period), opponent, playing tactics and individual fitness and performance characteristics when interpreting match activity data in professional AF. Contact: aaron.coutts@uts.edu.au

## SEARCHING TACTICAL PATTERNS IN SOCCER GAME PLAY BY UNSUPERVISED MACHINE LEARNING

LESER, R., HOCH, T., TAN, X., MOSER, B., BACA, A.

*Centre of Sport Science*

Location systems in game sports provide a wealth of data, which is capable of reconstructing game play from a tactical point of view. Precise position measurements up to 50 times per second/player during an entire soccer game enable in-depth analyses of individual and collective game behavior. Small-sided games (SSGs) are used in soccer training to simulate specific game situations. By the given constraints (smaller pitch size, lower number of players) SSGs are used to provoke intended player behavior with a higher rate than it occurs in the full-size game. Due to these properties SSGs are also suited to analyse successful/unsuccessful tactical patterns in a reasonable framework. The research described in this paper aims to identify behavioral patterns in soccer SSGs based on the players' positional data. The approach is demonstrated by a 3vs2-SSG (3 attackers playing versus 2 defenders), which is often used in soccer training to acquire collective and individual goal-scoring skills against a shorthanded opponent. Based on expert information the SSG is temporally segmented and for each defined key moment and temporal phase a couple of parameters are derived from the position data. Statistical methods (e.g., the Laplacian score for feature selection) reduce the high-dimensional parameter space to a manageable number of variables. This resulted in the 3vs2 analyses in 9 parameters describing the shot and the assist (last pass) situations. For each of the two situations unsupervised pattern recognition was performed by spectral clustering. For the shot as well as for the assist situation three different patterns were identified. The goal ratios for the assist patterns range from 0 to 29%, the goal ratios for the shot patterns from 8 to 24%. By a fuzzification of the quantitative parameters into linguistic variables the outcome of the pattern recognition process becomes understandable and interpretable for experts like coaches. The results give evidence that the most efficient assist is a middle distance to goal pass from the side to the centre, whereas rear-faced passes are far more successful than forward-faced passes (47 to 8% goal rate). Shots with the highest success rate are performed from a middle distance to the goal in the centre of the field. The findings of our study give data-based hints for successful tactical principles in soccer, which are likely valid also for the 11-a-side game. For the 3vs2 test case we can support the common coaches' assumption that ball possession at the wing moves the defenders to the side, which creates space in the centre field. This enables opportunities with the highest goal-scoring probability.

## IDENTIFYING TACTICAL PATTERNS IN SOCCER GAME PLAY BY MEANS OF AN EXPLANATORY COMPUTATIONAL MODEL

HOCH, T., LESER, R., TAN, X., BACA, A., MOSER, B.A.

*Software Competence Center Hagenberg*

**Introduction** The tactical analysis of player behaviour in team sports like association football is of great interest. The increasing availability of position data allows for an in-depth analysis of tactical behaviours of individual players (Leser et al., 2015). The high complexity of player interactions, however, makes the assessment of individual tactic skills based on time-continuous position data difficult. **Methods** We address the problem of designing an explanatory computational model for player assessment by fusing fuzzy human-like knowledge related to tactical behaviour with unsupervised feature extraction based on time-continuous position data from a tracking system. Our hierarchical model architecture consists of two layers. The first layer provides an abstract representation of the time domain via temporal segmentation of the data into game-situation specific temporal phases. Conceptually the coarsened view on the time domain is modelled via a Markov chain where transitions between states represent meaningful events. In a second step we then identify different behaviour patterns hidden in the data with unsupervised machine learning techniques. The main focus of this layer is to provide the trainer with a qualitative description of the key differences of the behaviour patterns based on key performance indicators. We show how to reduce the high dimensionality of the input space using unsupervised dimensionality reduction methods and how to provide a meaningful explanatory model for the trainer using natural language expressions. **Results and Discussion** We illustrate our approach by means of three different kinds of small-sided games in association football with increasing complexity. Starting with a 1vs1 situation with low complexity, we show the principals of our modelling approach. Next we show that for 3vs2 and 5vs5 situations our approach is able to identify the underlying dynamical patterns of player interactions. With the multifactorial statistical analysis, as presented in this paper, we are able now to present the complex interaction between the automatically selected measurement variables in a qualitative way that is

suitable for the trainer. Reference Leser, R., Moser, B., Hoch, T., Stögerer, J., Kellermayr, G., Reinsch, S. & Baca, A. (2015). Expert-oriented modelling of a 1vs1-situation in football. *International Journal of Performance Analysis in Sport*, 15 (12), 949-966.

## FUNCTIONAL SEMANTICS EMBEDDED IN THE ASSESSMENT OF SELF ORGANIZATION IN SOCCER

LOPEZ-FELIP, M.

*University of Connecticut*

**Introduction** To date, much of the research on coordination dynamics in team sport has benefitted from concepts and tools from Dynamical Systems Theory (DST). However, while DST provides suitable techniques for modeling living systems, it makes no direct claims about their status nor provides a theoretical basis for understanding the principles of their behavior. The aim of this study was to develop a method of analysis to measure the self-organization of teams based on a recently developed ecological ontology of perception and action in soccer [1]. This framework applies DST to the functional semantics of the game, where, for example, self-organizing behaviors in the defensive team are defined by the relations between the position of the possessor of the ball relative to the goal as a function of time. **Method** Twenty-two elite soccer players from La Liga played a practice game during a training session. Player position data were collected via GPS (10 Hz) for an entire match (two halves of thirty minutes). We analyzed the degree of synchronization in the defensive team in terms of the Kuramoto order parameter (cluster amplitude)  $r$ , (high synchronization = 1) by measuring location data ( $x, y$  coordinates on the pitch) over time [2]. **Results** Team synchronization was measured in 4 blocks of 5 minute time-epochs. For block 1 ( $r = 0.978 \pm 0.014$ ); block 2 ( $0.962 \pm 0.033$ ); block 3 ( $0.981 \pm 0.026$ ); and block 4 ( $0.968 \pm 0.046$ ). However, while mean synchronization across blocks was fairly consistent,  $F(1, 8) = 0.22$ ,  $p = 0.65$ , the overall degree of synchronization ranged between 0.84 and 0.99. To account for this drastic changes we compared our synchronization time series of all blocks to corresponding events in the match. Visual inspection of these time series revealed five instances when  $r$  decreased by more than 0.20. These dramatic decreases in the defensive team's synchrony corresponded with scoring opportunities of their opponent. **Discussion** Our analysis by means of the Kuramoto order parameter revealed that the synchronization measure was able to distinguish between periods of low and high group synchronization. Using this approach as a foundation, we are building a preliminary model that captures systematic changes in coordination between defensive players at the local (one-on-one) and global (team-wide) scales—quantifying breakdowns in the stability of the defensive team's coordination and showing how they anticipate scoring opportunities for an opponent. This approach promises to address gaps in this literature by taking DST measures related to group coordination and synchrony and integrating them with measures that capture the functional, qualitative aspects of the game. **References** 1. Lopez-Felip, M. A (2014). A scale to measure the complexity and perceptual-cognitive skills in soccer. MSc Thesis, Southern Illinois University. 2. Frank, T. D., & Richardson, M. J. (2010). On a test statistic for the Kuramoto order parameter of synchronization: An illustration for group synchronization during rocking chairs. *Physica D*, 239, 2084–2092.

09:45 - 11:15

## Invited symposia

### IS-PM13 Physical activity and brain vascular function

#### DEHYDRATION AND EXERCISE – CEREBROVASCULAR CONTROL AND ORTHOSTATIC TOLERANCE

RICKARDS, C.

*University of North Texas Health Science Center*

Exercise represents a physiological stressor that challenges the maintenance of cerebral blood flow and oxygenation as a result of increased metabolic demand (cerebral and systemic), elevated perfusion pressure (arterial pressure), changes in arterial PO<sub>2</sub> and PCO<sub>2</sub>, dehydration, and heat stress. These interrelated factors play a role in the regulation of cerebral blood flow and oxygenation during exercise, and can also affect subsequent tolerance to orthostasis following the exercise bout, particularly when combined with post-exercise hypotension. In particular, dehydration due to environmental/situational conditions (heat stress, lack of adequate hydration fluids, exercise intensity and duration) or purposeful dehydration (fluid restriction for weight loss) can further exacerbate the exercise-induced impairments in cerebral blood flow regulation, placing the athlete at greater risk of orthostatic intolerance. The modality (aerobic vs. resistance) and duration (endurance vs. sprint) of exercise influences the magnitude of dehydration, the timing and magnitude of cerebral blood flow impairment, and risk of subsequent orthostatic instability. This presentation will explore the independent and combined effects of exercise (aerobic and resistance), dehydration, and heat stress on cerebral blood flow and cerebral oxygen regulation, highlighting recent advances in the examination of cerebral oxygen metabolism, and regional cerebral blood flow responses. The implications of these responses on the risk of orthostatic intolerance will be examined. Knowledge gaps in this field of investigation will be presented, and future research directions will be discussed.

#### EXERCISE, CEREBRAL BLOOD FLOW AND PERCEIVED EXERTION IN TYPE 2 DIABETES PATIENTS

VAN LIESHOUT, J.J.

*Academic Medical Centre, University of Amsterdam, Netherlands & School of Life Sciences, University of Nottingham, United Kingdom*

Reduced exercise tolerance in type 2 diabetes mellitus (T2DM) patients is incompletely understood, and has been attributed to cardiac impairment and impaired muscle metabolism. Physical activity by T2DM patients markedly improves the impaired insulin action, but unfortunately these patients also perceive sustained aerobic exercise to be considerably more strenuous than healthy, non-diabetic people. This, in turn, sets a limit to the effectiveness of physical activity as a preventive life-style factor for this patient population. In this talk I will review ideas about the role of brain blood flow (BBF) control during exercise in their physiological limits of performance. When the brain is activated, as during exercise, an increment in BBF enhances cerebral oxygenation. The cerebral hyperperfusion in the early phase of exercise may be an important precaution because BBF declines in the later stages of exercise, mainly by the dominant negative effect of progressive hypocapnia on BBF. Brain function deteriorates when its oxygenation is reduced by more than 10% from the resting

level. In contrast, skeletal muscles tolerate oxygen desaturation down to 10%. In healthy exercising subjects a progressive reduction in cerebral oxygenation precedes development of so-called central fatigue. Debate continues on whether the subsequent reduction in cerebral oxygenation in the later stages of exercise could play a role in the development of central fatigue with reduced motor drive to working muscles. A key focus of the lecture will be on how in T2DM an inability to increase cardiac output sufficiently may interfere with the normal increase in BBF in response to exercise with consequences for maintaining brain oxygenation. [j.j.vanlieshout@amc.uva.nl](mailto:j.j.vanlieshout@amc.uva.nl)

## Invited symposia

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### IS-PM14 Achieving and maintaining a large weight loss: The role of exercise

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#### EFFECTS OF EXERCISE ON APPETITE REGULATION

ROSENKILDE, M.

*University of Copenhagen*

The body weight of human beings is defended by a host of compensatory responses after a diet-induced weight loss. The biological responses range from changes in both long term and short term hormonal regulators of appetite to the efficiency of storage and utilization of energy, such that weight regain is biological predisposed in the weight reduced. In the context of human evolution and survival mechanisms opposing a negative energy balance seems logical. However, in response to an bout of endurance exercise where energy is expended and energy balance must be acutely negative, a biological reverse pattern in markers of appetite is immediately observed favoring suppression of appetite, a phenomena known as exercise-induced anorexia. Despite this immediate suppression of appetite habitual exercise is not regarded as an effective weight loss strategy. Whether this transient suppression in hormonal markers of appetite persists when exercise becomes habitual is not well described in the literature. Here the physiological regulation of appetite in response to exercise is reviewed.

#### EXERCISE, OBESITY AND CARDIOMETABOLIC RISK: DOES EXERCISE INTENSITY MATTER?

ROSS, R.

*Queen's University*

Although progress has been made to elucidate the effects of exercise as a strategy for reducing obesity and related cardiometabolic risk, the specific exercise exposures required to achieve optimal benefit continue to be the source of considerable uncertainty and debate. Implicit within current guidelines for physical activity and health is the observation that 75 minutes of weekly high intensity exercise is equivalent to 150 minutes of lower intensity exercise. Consequently the guidelines suggest that there are no added health benefits of high intensity exercise other than the shorter time frame needed to expend the appropriate amount of energy. In other words, the benefits of engaging in high intensity exercise are attributed to the greater amount of energy expenditure per unit time, and do not relate to intensity per se. The scientific committee report from which current guidelines were developed recognized that many unanswered issues exist in response to the question of how much of what type of activity is appropriate for a given health outcome and acknowledged that future investigations need to evaluate the effects of exercise intensity at fixed amounts of energy expenditure. In this presentation emerging evidence regarding the separate effects of exercise intensity and amount on cardiorespiratory fitness and related cardiometabolic risk factors will be considered. Major gaps in knowledge will be identified and the quality of evidence upon which exercise intensity has independent effects will be scrutinized. Finally, the inter-individual response for selected cardiometabolic risk factors in response to standardized exercise will be considered.

#### A ROLE FOR EXERCISE AFTER WEIGHT LOSS FROM GASTRIC BYPASS SURGERY

COEN, P.M.

*Florida Hospital*

Obesity predisposes an individual to type 2 diabetes (T2D), cancer, and cardiovascular disease and places a massive strain on healthcare providers. Bariatric surgery is the most effective therapeutic option for obesity and provides significant weight loss and diabetes remission to a larger percentage of patients. However, the long term efficacy for bariatric surgery is not clear and there is evidence that weight regain and T2D relapse are problems for some patients. Exercise is also a therapeutic option for obesity that greatly improves metabolic health including peripheral insulin sensitivity and is important for maintenance of weight loss following diet induced calorie restriction. Recent evidence indicates that following significant weight loss, bariatric surgery patients remain relatively sedentary. Recent studies also indicate that exercise is a feasible and clinically effective adjunct therapy for bariatric surgery patients leading to additional improvements in metabolic health. We extend these recent findings to hypothesize that exercise is likely a critical factor for long term weight loss maintenance and lasting remission of T2D in bariatric surgery patients. We will draw on evidence from exercise and diet induced calorie restriction studies which support this hypothesis. Finally, we will outline the future studies needed to generate evidence for contemporary exercise guidelines for this unique patient population.

## Oral presentations

### OP-BN13 Running Biomechanics 2

#### MECHANICAL WORK EXPLAINS THE HIGH METABOLIC COST OF SHUTTLE RUNNING

PAVEI, G.1, MONTE, A.2, NARDELLO, F.2, MINETTI, A.E.1, ZAMPARO, P.2

1. Università degli Studi di Milano; 2. Università degli Studi di Verona

**Introduction** Shuttle running (SR) is a common activity in field sport (e.g. soccer and basket) and differs from linear running (R) by the presence of accelerations, decelerations and changes of direction (CoD). Previous studies have shown that the metabolic cost (C, J kg<sup>-1</sup> m<sup>-1</sup>) of SR is up to 7 times larger than in R and that the difference decreases by increasing the SR length (Zamparo et al. 2014). The work done by muscles to accelerate the body centre of mass (BCoM), the external work (W<sub>ext</sub>), and the work to accelerate limbs with respect to BCoM, the internal work (W<sub>int</sub>), have been previously shown to account for most of the cost of locomotion (Minetti et al. 1993). The aim of this study was to calculate the mechanical work in SR to understand the determinants of its larger metabolic cost compared to R. **Methods** Twenty trained males (22.6±2.4 years, 77.6±9.9 kg, 1.82±0.06 m) performed SR (5+5 m with a 180° CoD) at low, moderate and maximal speed; three trials were performed for each speed. The 3D position of 18 markers was recorded by 14 Vicon cameras at 100 Hz in order to compute the BCoM trajectory and the related values of W<sub>EXT</sub>, W<sub>INT</sub> and total work (W<sub>tot</sub> = W<sub>ext</sub> + W<sub>int</sub>). Based on the C vs. v relationship reported by Zamparo et al. (2015) in SR over this same distance (5+5 m with a 180° CoD), metabolic cost was estimated as  $C = 11.94 \cdot v_{\text{mean}} - 12.82$ . **Results** In the speed range analysed (2.0-3.5 m s<sup>-1</sup>) mechanical work (J kg<sup>-1</sup> m<sup>-1</sup>) increased linearly with speed,  $W_{\text{ext}} = 1.388 + 0.337 \cdot v_{\text{mean}}$  ( $P < 0.001$ );  $W_{\text{int}} = -1.002 + 0.853 \cdot v_{\text{mean}}$  ( $P < 0.001$ );  $W_{\text{tot}} = 1.329 \cdot v_{\text{mean}}$  ( $P < 0.001$ ,  $n = 180$ ) where  $v_{\text{mean}}$  is mean speed (m.s<sup>-1</sup>). Locomotion efficiency ( $W_{\text{tot}} / C$ ) was  $19.7 \pm 2.4\%$  when considering, as in R, only positive work; when including also negative work, efficiency became 21.3%. **Discussion** Mechanical work in SR is larger than in R; this supports its role as a determinant of the increased C, particularly when considering that elastic energy in SR is much lower than in R, as witnessed by the obtained efficiency (within the 'just' muscle efficiency range). SR shows two acceleration and deceleration phases, where the work done to accelerate the limbs with respect to the BCoM is largely involved. At high speeds W<sub>int</sub> values are equal to W<sub>ext</sub> values and thus could not be neglected in the mechanical analysis. Moreover, braking can be substantial in SR, thus the analysis of mechanical work performed by muscles to move BCoM and limbs should consider both positive and negative work in order to better understand the determinants of the metabolic demand in SR. **References** Minetti AE, Ardigo LP, Saibene F. J Physiol 1993;471:725-35 Zamparo P, Zadro I, Lazzar S, Beato M, Sepulcri L. Int J Sport Physiol Perform 2015;9:1033-9 Zamparo P, Bolomini F, Nardello F, Beato M. Eur J Appl Physiol 2015; 115: 1985-1994

#### TIME-CONTINUOUS KINEMATIC ASSESSMENT OF THE DIFFERENCES BETWEEN BAREFOOT AND SHOD GAIT

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To protect the calcaneus at ground contact during barefoot walking and running, humans tend to plantarflex the ankle to prepare for a forefoot strike (Lieberman et al., 2010). Accordingly, the literature has shown that several other kinematic parameters are also adjusted during the gait cycle to achieve the forefoot strike. The kinematic variables reported in the literature, however, are chosen at discrete events in the gait cycle to allow statistical analyses (Tam et al., 2016). The purpose of the current study was to test the hypothesis that discrete mediolateral ankle and knee angle values characterize the differences between barefoot and shod gait completely. Thirty-eight participants walked and ran for 30 s at two leg length normalized speeds ( $M = 1.78$  m/s, and  $2.53$  m/s, respectively) in shod and barefoot conditions. Data were collected at 100 Hz using a ten-camera Vicon system. Ankle and knee Cardan angles were calculated in Visual3D. Statistical parametric mapping (SPM; Pataky, 2010) was used to assess the differences in knee and ankle flexion throughout the gait cycle when walking and running shod compared to barefoot. The t statistic was computed at each time frame, forming a single 't' trajectory. The significance of the t trajectory was assessed by computing a critical t threshold that smooth Gaussian trajectories would reach in only  $\alpha = 5\%$  of many repeated experiments. Our results confirm that the following discrete values reported in the literature (Franklin et al., 2015) were contained within the time frames at which the t trajectory exceeds the  $p = 0.05$  threshold: increased knee flexion at ground contact and decreased ankle dorsiflexion at ground contact when barefoot for walking and decreased knee flexion during stance and early swing as well as decreased dorsiflexion at ground contact when barefoot for running. Additionally, knee flexion was reduced during the swing phase, plantarflexion onset was earlier in late stance, which also lead to earlier dorsiflexion in early swing when walking barefoot; during running the ankle was less dorsiflexed during stance, but more dorsiflexed during early swing when barefoot. The SPM analysis showed that the differences between barefoot and shod gait are not solely key events such as foot strike. None of the discrete variables from the literature persisted to be significantly different for less than 10% of the gait cycle with many persisting longer than 20% of the gait cycle. This suggests that discrete variables may have limited sensitivity in biomechanics without associated exploratory analysis using tools such as SPM. **References** Franklin S, et al. (2015). Gait Posture, 42(3), 230-239. Liebermann D, et al. (2010). Nature, 463(7280), 531-535. Pataky T (2010). J Biomech, 43(10), 1976-1982. Tam N, et al. (2016). Gait Posture, in press.

#### ACUTE EFFECTS OF MINIMAL SHOES OR BAREFOOT INTERVENTION ON FOOT STRIKE PATTERN WHEN RUNNING IN NORMAL RUNNING SHOES AGAIN

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**Introduction** Most recreational runners use rearfoot strike pattern when running in shod conditions (de Almeida et al., 2014). Switching from rearfoot strike to forefoot strike increase lower limb loading and should be done gradually (Ridge et al., 2013). There is lack of data what happens with foot strike pattern when runners experience short barefoot or minimal shod intervention and switch back to normal running shoes. Therefore, the aim of this study was to analyse acute effects of minimal shoes or barefoot conditions on foot strike pattern when running in normal running shoes again. **Methods** Nineteen subjects (age =  $33.5 \pm 6.7$  years, height =  $173 \pm 9$  cm, mass =  $73.5 \pm 13.9$  kg), randomly divided into two groups participated in this experiment. Subjects in the group1 ran barefoot, while subjects in the group2 ran in minimalistic shoes (Altra, model Zero Drop The ONE). Both groups got information about forefoot strike pattern and were encouraged to use it. The initial and the final state of the foot strike patterns was measuring in classic running shoes. Protocol of the



experiment was describe in details in Dolenec et al. (2015). Results Only the group2 changed the foot placement on the ground significantly ( $p = .028$ ). 38% of the subjects in this group changed foot placement on the ground from the heel strike to the forefoot strike in all 18 analyzed steps. Still half subjects in the group2 did 90 % of all steps with heel strike pattern. Discussion Only subjects in the group2 significantly changed to forefoot strike pattern when using normal running shoes again. This was rather surprise since barefoot running force runners to switch from rearfoot to forefoot strike pattern (Lieberman et al., 2010) and consequently it was expected that barefoot running might play important experience for switching from rearfoot strike to forefoot strike pattern. Fatigue might play important role on our results since barefoot running represent higher lower limb loading than shoed conditions (Paquette et al. 2013) and consequently higher fatigue than minimalistic shoes with certain cushioning properties. Due to high fatigue, subjects of group1 might rather choose comfortable rearfoot strike than high demanding forefoot strike when running in shoed conditions again. References de Almeida M, Saragiotto B, Yamato T, Loper AD. (2014). *Phys Ther Sport*, 16(1), 29-33. Dolenec A, Radi P, Strojnik V. (2015). *Coll Antropol*, 39(1 suppl), 147-151. Lieberman DE, Venkadesan M, Werbel WA, Daoud AJ, D'Andrea S, Davis IS, Mang'Eni RO, Pitsiladis Y. (2010). *Nature*, 463(7280), 531-535. Paquette M, Zhang S, Baumgartner L. (2013). *Footwear Sci*, 5(1), 9-18. Ridge S, Johnson A, Mitchell U, Hunter I, Robinson E, Rich BSE, Brown SD. (2013). *Med Sci Sports Exerc*, 45(7), 1363-1368. Contact ales.dolenec@fsp.uni-lj.si

## THE RUNNING BIOMECHANICS AND ECONOMY OF SOUTH EAST ASIANS: WE DO NOT ALL RUN THE SAME

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Introduction There are numerous running biomechanical and physiological studies; however, few of these involve well-trained South East Asian (SEA) runners. Knowledge on the biomechanical and physiological characteristics of SEA runners and how these differ from non-SEA runners could inform on exercise prescription and the potential for cross-ethnic study inference. Hence, our aims were to compare the biomechanics and running economy of well-trained long-distance runners from SEA to those from outside of SEA (non-SEA). Methods Seventeen SEA distance runners were matched based on sex, age, and running performance level to seventeen non-SEA runners. Baseline anthropometric and running history characteristics were collected first. Thereafter, running economy and biomechanics were assessed for all subjects ( $n = 34$ ) running on a treadmill at 10, 12, and 14 km/h using a metabolic cart and an 8-camera 3D motion system, respectively. Data were analyzed using mixed effects models that considered group (SEA vs. non-SEA), speed (10, 12, and 14 km/h), and group-speed interaction effects. Results The SEA runners were shorter, lighter, and had smaller body mass indexes. Despite similar weekly mileage, race performance, and ratings of perceived exertion during the economy test, SEA runners were significantly less economical than non-SEA runners at the three examined speeds (10-12%). The SEA runners employed shorter and quicker steps, striking the ground closer to their center of mass and more frequently with their midfoot or forefoot (55%) than non-SEA runners (5%). The former group also exhibited less hip and knee extension at push-off. Discussion Despite similar performance levels, our SEA runners were less economical than non-SEA runners and demonstrated different movement patterns. The SEA runners relied on a higher cadence to compensate for their smaller stature. The footstrike and push-off mechanics of SEA runners were also remarkably dissimilar from non-SEA runners, suggesting differences in muscle recruitment patterns and foot-ground interactions. Previously published research in the field has mainly focused on Caucasian or East African runners; but based on our current findings, the generalization across ethnic groups may not apply. Exercises that focus on the leg extensors and horizontal force application might benefit the running performance of well-trained SEA runners. Contact Kim Hébert-Losier, PT, PhD: hl.kim@isn.gov.my

## Oral presentations

### OP-BN06 Balance Strategies

## HEAD FLEXION IN OLDER ADULTS DURING WALKING HAS NO EFFECT ON GAIT PATTERN

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Introduction Older adults are known to adopt a greater head flexion during walking when compared to young adults (Marigold and Patla 2008). Although head flexion may provide a better visual field during locomotion, stability could be threatened. Buckley et al. (2005) reported that head flexion is destabilising in older adults during quiet standing, however the effect head flexion has on gait stability has not been examined. The purpose of the study was to investigate whether gait patterns differed between a naturally adopted head position and an instructed fixed head position, at different walking intensities, in young and older adults. Methods 15 young ( $23 \pm 4$  years) and 16 older ( $76 \pm 6$  years) healthy females walked along a 9m flat walkway at three different walking intensities (slow, comfortable and fast) under two head positions (natural and fixed (focusing on an eye level visual target)). Gait parameters (step length, double support time, step time and gait stability ratio) were recorded using Optojump, while head angular displacement in the sagittal plane was assessed using 2D video analysis. A mixed design ANOVA was performed for each variable, with age as a between-subject factor and walking intensity and head position as within-subject factors. Results While walking with natural head position, older adults displayed greater head flexion at all walking intensities ( $p < 0.05$ ) when compared to young. With regards to walking intensity, older adults had greater head flexion during slow walking compared to comfortable ( $p < 0.01$ ) while young showed no difference between walking intensities. The fixed head position reduced the head flexion at all walking intensities ( $p < 0.05$ ) in the older group, but not in the young. Modifying the head position between natural and fixed position had no effect on gait variables at any of the walking intensities. Discussion The greater head flexion seen in older adults when walking at different walking intensities, appeared to have no effect on gait patterns. Findings suggest that head flexion may be a behavioural adaptation to increase the feeling of stability due to a greater footfall visibility however this adaption does not appear to affect gait stability. References Marigold DS, Patla AE. (2008) *Exp Brain Res*, 188, 23–31. Buckley JG, Anand V, Scally A, Elliott DB. (2005) *Gait Posture*. 21, 59–64 Contact Susan.dewhurst@cumbria.ac.uk

## DIFFERENCES IN HEAD MOVEMENT BETWEEN YOUNG AND OLDER FEMALES ARE NOT REFLECTED IN WHOLE BODY MOVEMENT DURING GAIT INITIATION

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**Introduction** Older adults are at an increased fall risk during transition tasks such as gait initiation (Melzer, Kurz, Shahar, Levi, & Oddsson, 2007). Differences found in head stability between young and older adults have been suggested to threaten balance thus increasing such risk in older adults (Laudani, Casabona, Perciavalle, & Macaluso, 2006). To identify the role of head movement on balance, we examined the effect of upper body segments acceleration and their displacement variability on whole body movement and its variability (an indicator of balance), during gait initiation. **Methods** Eleven young ( $23 \pm 1$  yrs) and 12 older ( $75 \pm 2$  yrs) females initiated gait at a self-selected, comfortable speed. Acceleration root mean square (RMS) values were calculated for the pelvis, trunk and head in the antero-posterior (AP), mediolateral (ML) and vertical (V) plane. Attenuation coefficients of acceleration were calculated for pelvis-head (CPH), pelvis-trunk (CPT) and trunk-head (CTH) segments in the AP and ML plane. Total linear displacement was measured for centre of mass (COM) in the AP and ML plane. Finally, angular displacement variability of the pelvis, trunk and head, and linear displacement variability of the COM were evaluated by calculation of the average standard deviation (AvgSd). Results AP RMS values were higher for the head for older compared to young ( $3.9 \pm 1.9$  m/s<sup>2</sup> and  $2.4 \pm 1.5$  m/s<sup>2</sup> [ $P=0.023$ ], respectively). Young were able to attenuate acceleration for AP CTH whilst older were not able to ( $0.83 \pm 6.44\%$  and  $-19.33 \pm 7.14\%$ , [ $P=0.02$ ], respectively). Young had a larger total AP COM displacement compared to old ( $408.2 \pm 86.7$  mm and  $313.3 \pm 33.5$  mm, [ $P=0.004$ ]); however, there were no differences in total ML COM displacement. AvgSd of angular displacement of the head was higher in older compared to young in the AP plane ( $3.7 \pm 1.5^\circ$  and  $1.5 \pm 0.6^\circ$  [ $P=0.004$ ], respectively), but similar for the pelvis and trunk. Finally, there was no difference in COM AvgSd between young and older in the AP and ML plane. **Discussion** Despite older demonstrating greater acceleration of the head, dampened ability to attenuate acceleration between the trunk and head, and greater variability in the movement of the head, there was no effect in the ML displacement or variability of COM in the AP and ML direction between age groups. This may be due to the head mass not being sufficiently large enough to alter COM pattern during a dynamic movement. Head instability did not appear to cause reduced balance during gait initiation in older. **References** Laudani L, Casabona A, Perciavalle V, Macaluso A. (2006). J Electromyogr Kinesiol, 6, 603–610. Melzer I, Kurz I, Shahar D, Levi M, Oddsson L. (2007). Age Ageing, 36, 532–537. Amy.maslivec@cumbria.ac.uk

## IS DYNAMIC BALANCE RELATED TO STATIC BALANCE IN HEALTHY ACTIVE OLDER WOMEN?

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**Introduction** Both static and dynamic balance are impacted by vision, vestibular sense, proprioception, muscle strength and reaction time; both are associated with fall risks and each may be enhanced as a result of exercise (Lelard & Ahmaidi, 2015). We examined whether static balance components, representing the multisensory perturbation approach, are related to dynamic balance measures. **Methods** Healthy active women ( $N=78$ ; age  $73.5 \pm 5.9$ ) were assessed during quiet standing in eight positions: Eyes open – NO; eyes closed – NC (manipulating visual input); on a pillow with eyes open – PO (manipulating the somatosensory input); and eyes closed – PC (manipulating both the visual input the somatosensory input); and the next four positions with eyes closed, all challenging the vestibular system – Head turned to the right – HR; turned to the left – HL; bent forward – HF; bent backwards – HB. Measures in each position included stability indices (ST) examining the amount of sway, and the Fourier spectrum of sway (F1-F8) examining sway intensities at different frequency ranges – F1 sensitive to visual control, F2-F4 to vestibular stress, F5-F6 to somatosensory feedback, and F7-F8 to neuropathology. Dynamic balance measures included the Time Up & Go (TUG) and a 10m walk at two speeds – one normal and one fast (time, velocity, number of steps, stride length), both of which require change of base of support, and the Functional Reach (FR) (distance) – reaching forward while maintaining a fixed base of support. Results As almost all balance variables are significantly correlated with age ( $p < .05$ ), we performed age controlled partial correlations. Results showed: 1) no correlations between static and dynamic balance in most cases; 2) few correlations of TUG with F2-F4 on NC, PO, HR, HL, and HB ( $r = .21-.29$ ); of FR with ST on HR, HL, and HF ( $r = .20-.27$ ); of FR with F4 on NC, HR, HL, HF, and HB ( $r = .22-.28$ ), with F5 on HF ( $r = .33$ ), and with F7 on PC, HR, HF ( $r = .28-.34$ ); 3) high correlations among the dynamic balance measurements – TUG and 10m walks ( $r = .53-.63$ ); 4) no correlation between FR and TUG ( $r = -.17$ ). **Discussion** Static and dynamic balance are independent of each other in healthy active older women (Muehlbauer et al., 2012), as are dynamic balance tasks performed with (TUG) and without (FR) changing the base of support. Possibly, in healthy older women important balance capacities are unrelated and should be trained in a complementary agenda to prevent falls. However, selected static balance components are correlated with dynamic balance measures, all of which are sensitive to the functioning of the vestibular system. More studies considering the unique role of the vestibular system in both static and dynamic balance are needed (Anson & Jeka, 2016), as well as exercise programs enhancing this system. **References** Anson E, Jeka J. (2016). Front Neurol, 6. Lelard T, Ahmaidi S. (2015) Clin Neurophysiol, 45, 357-369. Muehlbauer T, Besemer C, Wehrle A, Gollhofer A, Granacher U. (2012). Gerontology, 58, 504-512.

## EFFECT OF JAW CLENCHING ON DYNAMIC STABILITY AFTER FORWARD LOSS OF BALANCE

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**Introduction** Postural control is crucial for most tasks of daily living, delineating postural orientation and balance. Nevertheless, falls are common and serious events, and have been associated with deficits in muscle strength and dynamic stability (Blake et al., 1988). Recent studies reported that rate of force development (Ebben et al., 2008) and static postural control (Ringhof et al., 2015) were improved in response to concurrent jaw clenching activities. However, as there are no studies describing the influence of jaw clenching on dynamic postural control, the present study aimed to investigate the effects on recovery behavior after forward loss of balance. **Methods** Participants were twelve healthy young adults, who were instructed to recover balance from a simulated forward fall while either force-controlled biting (FB) at a submaximum level or keeping the mandible at rest, i.e. non-biting (NB). Bite forces were measured by means of hydrostatic splints, whereas a 3D motion capture system was used to analyze spatiotemporal parameters and joint angles, respectively. In addition, dynamic stability was quantified by the extrapolated CoM concept, designed to determine postural stability in dynamic situations (Hof et al., 2005). Results Statistical analyses (paired t-tests) revealed that spatiotemporal parameters and joint kinematics were both not significantly influenced by FB. Furthermore, there were no significant effects on dynamic stability in terms of the extrapolated CoM

( $p=0.100$ ,  $d=0.17$ ) and the margin of stability ( $p=0.701$ ,  $d=0.06$ ) at touchdown. Interestingly, bite forces under both conditions significantly increased from initiation of the forward fall until touchdown of the recovery limb. Discussion The results indicate that reductions in postural sway evoked by submaximum biting are not transferable to recovery behavior as it was assessed in the present study. It is suggested that these contradictions are the result of different control strategies associated with the abovementioned tasks. Furthermore, floor effects and the sample size might be discussed as potential reasons for the absence of significances. Notwithstanding this, the present study also revealed that clenching the jaw seems to be part of a common physiological repertoire used to improve motor performance. Future studies, therefore, should contrast the effects of jaw clenching activities in different populations, and under conduction of random perturbations. References Blake AJ, Morgan K, Bendall MJ, Dallosso H, Ebrahim SB, Arie TH (1988). Age Ageing, 17, 365-372. Ebben WP, Flanagan EP, Jensen RL (2008). J Strength Cond Res, 22, 1850-1854. Hof AL, Gazendam MGJ, Sinke WE (2005). J Biomech, 38, 1-8. Ringhof S, Stein T, Potthast W, Schindler HJ, Hellmann D (2015). J Oral Rehabil, 42, 173-184. Contact steffen.ringhof@kit.edu

### INFORMATICS PROVISION OF SIGHT INFLUENCE MUSCLE ACTIVITIES OF TRUNK AND LOWER LEG DURING DYNAMIC BALANCE CONTROL

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Introduction The purpose of this study was to investigate the changes of electromyogram activity of trunk and lower leg muscles during dynamic balance control in 20 healthy adult subjects when various experimental visual conditions were applied. Methods Surface electromyography system was used for recording of any signals produced by muscles. Muscle activity was recorded from muscles, of which left and right sides of rectus abdominis, external obliques, longissimus thoracis, multifidus, vastus medialis, biceps femoris, gastrocnemius, and tibialis anterior, and then normalized as percentage of maximum voluntary isometric contraction. All data obtained from experiment were analyzed using SPSS ver. 20.0, and TWOWAY analysis of variance were used to determine statistical significance between two factors (3 visual conditions x 2 leg conditions). Statistical significance levels were set at  $\alpha = .05$ . Results There were significant different in biceps femoris and external obliques muscle's activities between right and left leg, showing more prominent reduction in left leg when blind vision condition was given. Significantly higher muscle activities were shown in both sides of multifidus ( $p<.05$ ), vastus medialis ( $p<.001$ ), tibialis anterior ( $p<.001$ ) and gastrocnemius medialis ( $p<.05$ ) with sighted vision and blanking vision compared to the condition of blind vision. Conclusions These results confirmed that muscle activity is prominently stimulated by visual information provision, and this implies that visual input may be a major factor for maintaining of the body's balance control.

### LOCAL STABILITY AND KINEMATIC VARIABILITY OF WALKING VS. POLE WALKING AT DIFFERENT SPEEDS

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INTRODUCTION During walking (W) the body balance is maintained by muscle tone adjustments (Rose et al., 2006). Previous research reported that the use of poles can improve W stability (Jacobson et al., 1997); however, there are no direct dynamic stability comparisons between W and pole walking (PW). Accordingly, the present study aimed to compare both the dynamic stability and the variability of kinematic parameters during W and PW at different speeds. METHODS 21 adults were enrolled. 2 accelerometers were secured at C7 and S2 level. 3 bouts of 1 min each of W and PW were performed respectively at 60, 80 and 100% of the walk-to-run preferred transition speed (i.e. PTS-60, PTS-80 and PTS-100). Medio-lateral (ML), vertical (VT) and anterior-posterior (AP) accelerations were collected over 40 strides per trial. Stride time median absolute deviation (STV) was calculated as measure of gait cadence control, and the stride-to-stride variability (SSV) was quantified by the median of the point-by-point median absolute deviations of the cubic spline interpolated (101 points) stride pool for each accelerometer axis. The dynamic stability was assessed by maximum Lyapunov exponents (LE) for each accelerometer data pool (LE-C7 and LE-S2) and spatial direction (LE-ML, LE-AP, LE-VT). The speed and type (W or PW) effects on the calculated parameters were tested by generalized estimating equations and pairwise contrasts with Holm correction for multiple comparisons. RESULTS W and PW (all speeds) yielded similar STV, while PW resulted in lower LE-C7 than W ( $p<.01$  at all speeds). Compared to W, at C7 level PW increased SSV-ML ( $p<.01$  at PTS-80 and PTS-100) and reduced both LE-AP ( $p<.01$  at PTS-60 and PTS-100) and LE-ML ( $p<.01$  at all speeds). Speed increments decreased STV in W ( $p<.01$ ) and PW ( $p<.05$ ), LE-ML and LE-C7 (W only – all  $p<.05$ ). Higher speeds increased SSV-ML in PW (all  $p<.05$ ), SSV-AP in W (all  $p<.01$ ) and SSV-VT in both W and PW (all  $p<.01$ ). DISCUSSION Poles use improves LE at the shoulders level despite the corresponding increments in SSV. Conversely, W and PW show similar LE and SSV at the sacrum level. LE, SSV and the required control of the gait cadence generally increase at high speeds, but LE was speed-independent during PW. These findings suggest that walkers may benefit from using poles while exercising because of the lower LE, especially at those speeds where LE is higher during W. REFERENCES Rose J, Gamble JG. (2006). Human Walking, 55, Lippincott Williams & Wilkins, Philadelphia, Pennsylvania. Jacobson BH, Caldwell B, Kullig FA. (1997). Percept Mot Skills, 85(1), 347-50. CONTACT luca.zoffoli@uniurb.it

## Invited symposia

### IS-BN09 BIOMECHANICAL AND PHYSIOLOGICAL ASPECTS OF INCLINED WALKING

#### BIOMECHANICAL AND PHYSIOLOGICAL ISSUES OF INCLINED WALKING , RUNNING AND SKIPPING.

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Literature regarding human locomotion on gradients classically focused on walking and running (at Earth gravity). Within pendulum-like gaits, walking with poles (sometimes referred to as Nordic Walking) recently expanded the ancient Alpenstock (single pole) concept and added comfort to mountain trekking, making humans go back to quadrupedalism. That motion pattern shares some biomechanics with the skating technique of cross-country skiing, which is also meant to work on gradients. Among bouncing gaits, 'skipping' (or bipedal 'gallop') and hopping have been more recently studied, the first one being used by joyful kids and by adults during stairs descending and cornering, the two of them having relevance for space exploration at different gravity. Although some important aspects remain a mys-

tery, the economy and biomechanics of gradient walking and running are quite well established. For instance, the partitioning between positive and negative mechanical external works, combined with muscle efficiency for concentric and eccentric activity, explained the metabolic optimum gradient of walking and running (Minetti et al. 1993, 1994). The other two gaits, mentioned above, represent an almost uncharted territory, particularly when adopted on gradients. Walking with poles, despite the gain in comfort, is associated to a higher metabolic cost than normal walking, particularly at level and negative slopes. Mechanical analysis of the dynamics of body centre of mass shows, though, an increased exchange between potential and kinetic energies, with the latter displaying a smoother time course as an effect of poles. Other influences could regard the trajectory of the centre of pressure and the moment that trunk muscles have to generate to balance the upper body in uneven, inclined terrains. Metabolic experiments on level walking, running and skipping at simulated Lunar gravity revealed that the cost of transport is very similar for all gaits (about 1.9 J/kg/m) and almost speed independent (hopping is metabolically impractical on Earth, but becomes the most economic gait on the Moon, Pavei et al. 2015). Gradient skipping has already been studied at Earth gravity, showing a monotonical decrease in cost at steeper downhill gradients (Minetti et al 2012), but only preliminary data is available at Moon gravity. The study of a variety of gaits at different gravity levels seems to offer potential insights to better understand the mechanical and metabolic determinants of level and gradient locomotion on Earth. References Minetti AE, Ardigo LP, Saibene F. *J Physiol* 1993; 471:725-35 Minetti AE, Ardigo LP, Saibene F. *J Exp Biol* 1994; 195: 211-225 Pavei G, Biancardi C, Minetti AE. *J Appl Physiol* 2015; 119(1): 93-100 Minetti AE, Pavei G, Biancardi C. *Planetary and Space Science* 2012; 74: 142-145

## **INFLUENCE OF TENDON COMPLIANCE ON MUSCLE-TENDON INTERACTION DURING INCLINED WALKING AND STAIR DESCENT**

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Influence of tendon compliance on muscle-tendon interaction during inclined walking and stair descent It is well accepted that tendon mechanical properties influence the function of the entire muscle-tendon unit. Those properties do not only affect force transmission but also have an important implication on energy storage and recovery. Additionally, the mechanical properties of the tendons are essential for the function of muscles during locomotion as they are acting in-series. The compliance of the tendon and aponeurosis allows an independent behavior of the muscle fascicles enabling those to contract at different shortening velocities than the entire muscle-tendon unit [1]. Studies with hopping wallabies or running turkeys, where tendon force and muscle fascicles length could be directly measured, gave evidence, that during steady state hopping and running most of the positive work done by the entire muscle-tendon unit comes from the recoil of the tendon and, that muscle fascicles change length only marginally [2, 3]. Metabolic energy is still required to generate muscle force, needed to operate tendons as springs. In contrast to the conservation of energy during steady state running, muscle-tendon units must have the ability to produce and absorb energy during walking on gradients or on stairs [1, 3, 4]. Energy absorption is generally realized by active lengthening of muscle fascicles, but they are particularly susceptible to damage when active lengthened [4, 5]. It was shown in animal studies that, the rate of fascicle lengthening can be reduced if the rapid stretch applied to the muscle-tendon unit can first be taken up by lengthening of the tendon [1, 6]. Ultrasonography provides the possibility to directly observe human muscle and tendon behavior during different locomotor activities in vivo [7-10]. Thus, this presentation will summarize current knowledge of human triceps surae muscle-tendon function during tasks that require energy generation or absorption e.g., locomotion on gradients or stairs and, will attempt to discuss the functional consequences of altered muscle-tendon properties due to training, ageing or injury. [1] T. J. Roberts, E. Azizi, *J Exp Biol*, 214 (3), 353-361, 2011. [2] A. A. Biewener, D. D. Konieczynski, R. V. Baudinette, *J Exp Biol*, 201(11), 1681-94, 1998. [3] T. J. Roberts, R. L. Marsh, P. G. Weyand, C. R. Taylor, *Science*, 275(5303), pp. 1113-5, 1997. [4] A. M. Gabaldon, F. E. Nelson, T. J. Roberts, *J Exp Biol*, 207(13), 2277-88, 2004. [5] U. Proske, D. L. Morgan, *J Physiol*, 537 (2), 333-45, 2001. [6] N. Konow, M. Azizi, T. J. Roberts, *Integr Comp Biol*, 50, E93-E93, 2010. [7] N. Aggelousis, E. Giannakou, K. Albracht, A. Arampatzis, *Gait Posture*, 31(1), 73-7, 2010. [8] T. Fukunaga, K. Kubo, Y. Kawakami, S. Fukushima, H. Kanehisa, C. N. Maganaris, *Proc Biol Sci*, 268(1464), 229-33, 2001. [9] G. A. Lichtwark, A. M. Wilson, *J Exp Biol*, 209 (21), 4379-4388, 2006. [10] M. Spanjaard, N. D. Reeves, J. H. van Dieen, V. Baltzopoulos, C. N. Maganaris, *J Appl Physiol*, 102(4), 1618-23, 2007.

## **JOINT LOADING IN SLOPED WALKING COVERING DIVERSE SETTINGS**

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Walking on sloped surfaces has been shown to be a challenging task for the locomotor system and requires specific modifications during gait. Swing limb trajectories, foot placement and other gait parameters like step length, step frequency and step width have to be adjusted for safe toe clearance and joint loading control (Prentice et al., 2004). Research groups analyzed the effect of sloped walking on postural adaptations (McIntosh et al., 2006), muscle activity (Franz and Kram, 2012; Lay et al., 2007), joint kinematics and joint kinetics (Lay et al., 2006) and joint loading (Schwameder et al., 2005) and found substantial adaptations when walking on sloped surfaces compared to level walking. In downhill walking joint moments at the ankle, knee and hip are affected by inclination with knee extension moments showing large increases relative to increased downward inclination (Lay et al., 2006). During uphill walking an increased hip extensor moment occurs with increasing inclination (Lay et al., 2006). The challenges of sloped walking are even more pronounced during hiking and mountaineering and specifically in patients with lower extremity injuries or amputees. Several studies have been executed by the authors' research group in order to specifically investigate the effect of the gradient in uphill and downhill walking in diverse settings. Beside young and healthy males and females also obese children and youth, ACL-patients and amputees have been studied. The participants walked on a ramp (6 m x 1.5 m) with two imbedded force plates, both in self-selected and pre-set speed conditions at different inclinations up to +/- 18°. Kinematics was measured using an eight camera Vicon system. Muscle activity of selected lower limb muscles was measured. Inverse dynamics approaches based on the musculo-skeletal modelling software AnyBody – validated for sloped walking (Alexander & Schwameder, 2015) – were used to calculate joint forces (Alexander & Schwameder, 2016a) and muscle forces (Alexander & Schwameder, 2016b). Furthermore, the aspects of interest were gait parameters (step length, step frequency, step width), joint kinematics, joint kinetics, lower extremity muscle activity, joint forces and muscle forces with respect to laterality, functional issues and recommendations for training regimes and rehabilitation programs for the several groups investigated in the studies. Alexander, N., Schwameder, H., 2015. *J Appl Biom*, doi:10.1123/jab.2015-0021. Alexander, N., Schwameder, H., 2016a. *Gait & Posture*, 45, 137-142. Alexander, N., Schwameder, H., 2016b. *Gait & Posture*, [in press]. Franz, J., Kram, R., 2012. *Gait & Posture*, 35, 143-147. Lay, A., Hass, C., Gregor, R., 2006. *J Biom*, 39, 1621-1628. McIntosh, A., Beatty, K., Dwan, L., Vickers, D., 2006. *J Biom*, 39, 2491-2502. Prentice, S., Hasler, E., Groves, J., Frank, J., 2004. *Gait & Posture*, 20, 255-265. Schwameder, H., Lindenhof, E., Müller, E., 2005. *Sports Biom*, 4, 227-243.



## Oral presentations

### OP-PM59 Exercise in Rheumatology & Cancer

#### MAXIMAL VOLUNTARY STRENGTH AND RATE OF FORCE DEVELOPMENT BEFORE AND 6 MONTHS AFTER TOTAL HIP ARTHROPLASTY

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**Introduction** Patients suffering from hip osteoarthritis (OA) and concomitant hip pain show compensatory gait patterns, which may lead to asymmetries in lower extremity muscle function. Besides maximal voluntary contraction (MVC) strength, the rate at which force is developed (RFD) is highly important during daily-life situations related to balance, such as fall prevention. It is however unknown whether RFD recovers similarly to MVC strength asymmetries after total hip arthroplasty (THA). The aim of this study was to investigate the bilateral asymmetries in MVC strength and RFD for hip and knee muscles in patients with symptomatic hip OA before and 6 months after THA. **Methods** Twenty-one patients (65±5 yrs, 174±8 cm, 77±14 kg, 9 women) with unilateral primary hip OA were tested before and 6 months after THA. Hip flexion, extension, abduction and adduction as well as knee flexion and extension MVC strength and RFD200 (i.e., the average rate of force developed from contraction onset to 200 ms thereafter) were evaluated in isometric conditions. 2-way repeated measures ANOVAs ( $\alpha = 0.05$ ) were used to compare data between the involved and uninvolved limbs before and after surgery. Results Compared to the uninvolved limb, pre-operative MVC strength of the involved limb was significantly lower for hip flexion (-16%), hip extension (-13%) and knee extension (-11%). Similarly, pre-operative RFD200 was significantly lower for hip flexion (-16%), hip extension (-20%), hip abduction (-11%), hip adduction (-12%) and knee extension (-17%). Six months after surgery, no significant asymmetries remained, except of hip flexion MVC strength (-12%). **Discussion** Patients with symptomatic hip OA displayed considerable asymmetries in both MVC strength and RFD200 for both hip and knee muscle groups before surgery. RFD200 corresponded to MVC strength findings and in addition showed asymmetries in hip abductor and adductor muscles. As RFD is considered to be influenced by neural factors (Aagaard et al., 2002), we assume that patients with hip OA have a reduced neural drive, which may have a larger impact on certain muscle groups (hip abductors and adductors) compared to muscular factors. Most asymmetries resolved 6 months after surgery, while hip flexion MVC strength remained lower in the involved limb, possibly due to the surgical procedure (minimally invasive anterior approach). RFD asymmetries before surgery may put hip OA patients at a higher risk of falling and emphasize the importance of preventive strength training, predominantly for muscles crossing the hip and knee joints. **References** Aagaard P, Simonsen EB, Andersen JL, Magnusson P, Dyhre-Poulsen P. (2002). *J Appl Physiol*, 93, 1318-1326. Contact frbe@kws.ch www.lifelongjoints.eu

#### CITIUS-FORTIUS? DOES MUSCLE STRENGTH IMPAIRMENT PREDICT RUNNING PERFORMANCE IN ATHLETES WITH POLIOMYELITIS?

BECKMAN, E.M., CONNICK, M.J., BUKHALA, P., TWEEDY, S.M.

*University of Queensland*

**Introduction:** Classification in Paralympic Sport aims to minimise the impact of impairment on the outcome of competition. Impaired muscle strength is an eligible impairment type in Paralympic Athletics and may result from range of health conditions, including poliomyelitis. To allow athletes who experience similar degrees of activity limitation as a result of their strength impairment to be placed in the same class, research is required to determine the relationship between muscle strength and running performance. This study aimed to investigate muscle strength impairments in athletes with polio when compared to non-disabled athletes. **Methods:** Fifteen athletes with polio were assessed in Nairobi, Kenya. A non-disabled sample of 28 athletes (NDA), were assessed in Brisbane, Australia. Athletes performed isometric strength tests (lower limb extension and isolated plantar flexion), and a running performance test (maximal 60m sprint). Sub-group analysis was performed to compare athletes with polio who were able to run with a definitive flight phase, to athletes who were not able to achieve a flight phase during their running gait, on measures of strength and performance. **Results:** Independent t-tests showed significant differences between groups in running performance and strength. Non-disabled athletes were faster over 60m with a mean (SD) of 8.39 seconds (0.54) when compared to athletes with Polio who ran 60m in a mean (SD) of 16.01 seconds (4.34). Pearson's correlations showed weak relationships between lower limb extension strength and running performance in NDA ( $r=0.16$ ), compared to a strong, significant relationship in runners with Polio ( $r=0.67$ ). Significant differences in sprint times were seen in athletes who could achieve a running gait compared to those who could not, and significant differences in the combined strength of the leg extension and plantarflexion tests were seen between runners and non-runners. **Conclusions:** The results of this study indicate that as impairments to muscle strength increase in severity, running performance is more affected. The results also give a preliminary insight to the amount of muscle strength that is required in the lower limbs to achieve a running gait that includes a flight phase. While proximal and distal muscle strength individually did not predict the ability to run in this sample, severe impairments at the proximal and distal level combined did have an impact. This study provides preliminary evidence for the strength of association between lower limb strength and running performance and a key step towards evidence-based systems of classification.

#### ASSOCIATION OF PHYSICAL ACTIVITY AND FITNESS WITH SYMPTOMS AND IMPACT OF FIBROMYALGIA IN FEMALE PATIENTS.

SEGURA-JIMÉNEZ, V., ESTÉVEZ-LÓPEZ, F., ÁLVAREZ-GALLARDO, I.C., SORIANO-MALDONADO, A., BORGES-COSIC, M., HERRADOR-COLMENERO, M., RUIZ, J.R., APARICIO, V.A., DELGADO-FERNÁNDEZ, M.

*University of Cadiz*

Segura-Jiménez, V.1, Estévez-López, F.2, Álvarez-Gallardo, I.C.2, Soriano-Maldonado, A.2, Borges-Cosic, M.2, Herrador-Colmenero, M.2, Ruiz, J.R.2, Aparicio, V.A.2, Delgado-Fernández, M.2. 1: FES (Cádiz, Spain), 2: FSC (Granada, Spain). **Introduction** Maintaining appropriate physical fitness (PF) levels through exercise training in patients with fibromyalgia has shown to be a beneficial treatment, however, these patients seem susceptible to an inactive lifestyle (Segura-Jiménez et al., 2015). It is of interest to investigate whether objectively measured physical activity (PA) and PF are independently and jointly associated with fibromyalgia symptomatology. **Methods** This cross-sectional study comprised 386 women with fibromyalgia aged 51.5±7.6 years. PA was measured with triaxial accelerometry and PF with the

Senior Fitness Test. We used the Short-Form health survey-36 pain sub-scale and the Multidimensional Fatigue Inventory to assess pain and multiple dimensions of fatigue, respectively. The impact of fibromyalgia was studied with the Revised Fibromyalgia Impact Questionnaire. Results A stepwise regression model showed that diverse fitness components and light and vigorous PA were independently associated with pain, fatigue and the impact of fibromyalgia ( $R^2$  between 0.15 and 0.29, all  $P < 0.05$ ). Both, total PA and global PF showed an independent association with all the studied variables ( $R^2$  between 0.15 and 0.29, all  $P < 0.05$ ), except with mental fatigue. The associations between total PA and symptoms were weaker than those observed between global PF and symptoms. Overall, unfit patients with low total PA showed a worse profile than fit patients with high PA (all,  $P < 0.01$ ). Discussion To our knowledge, we showed for the first time that higher light and vigorous PA and diverse PF components are independently associated with lower pain, fatigue and the overall impact of the disease in women with fibromyalgia. Patients who were fit and physically active displayed a better profile than those who were unfit and physically inactive. Furthermore, patients unfit should be physically active to avoid a greater deleterious impact. This is consistent with previous literature, which showed that physically active women with fibromyalgia have increased ability to modulate their pain than those physically inactive (Ellingson et al., 2012). We cannot establish causal relationships: physical inactivity and low PF might lead to fatigue and pain, but equally, fibromyalgia could accentuate fatigue and have detrimental effects on aerobic and muscle performance. Reluctant to conclude on causality, our results seem to encourage the inclusion of both regular PA as well as maintaining adequate PF levels as a major part of fibromyalgia women's lifestyle. References 1. Ellingson LD, Shields MR, Stegner AJ, Cook DB. J Pain. 2012;13(2):195–206. 2. Segura-Jiménez V, Álvarez-Gallardo IC, Estévez-López F, et al. Arthritis Rheumatol. 2015;67(11):3047–57. Contact victor.segura@uca.es

## EFFECTS OF PROPRIOCEPTIVE EXERCISES ON RHEUMATOID ARTHRITIS POSTMENOPAUSAL WOMEN

ALEIXO, P.1, VAZ PATTO, J.2, ABRANTES, J.1

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Introduction Rheumatoid arthritis (RA) may lead to damage joints and the occurrence of cachexia. Women are more predispose than men to develop RA and the peak incidence coincides with menopause. A lower ankle moment of force during gait was associated to falls in elderly (Lee & Kerrigan, 1999). RA patients showed lower ankle power peak (APP) and ankle moment of force peak (AMP) during gait (Barn et al, 2013; Weiss et al, 2008). A systematic review (Sherrington et al, 2008) provided strong evidence that proprioceptive exercises are effective to reduce falls in elderly. Proprioceptive exercises also enhanced gait biomechanical variables in elderly (Shin & An, 2014). Present study aimed to assess the effects of proprioceptive exercises on AMP and APP during gait and lower limb muscle mass (LLMM) of RA postmenopausal women. Methods Prospective, controlled but nonrandomized trial. 26 RA postmenopausal women assigned to exercise group (EG;  $n=14$ ) or placebo exercise group (PEG;  $n=12$ ). In EG was performed a 12-week proprioceptive exercises program (3 individualized sessions/week; 30 minutes/session). In PEG was performed a 12-week program of stretching exercises for trunk and upper limbs (1 individualized session every two weeks; 30 minutes/session). LLMM was assessed by bioelectrical impedance analysis (InBody 720). A three-dimensional motion analysis system (Vicon® Motion Capture MX System; 9 cameras; 200 Hz) synchronized with a force plate (AMTI BP400600-200; 1000 Hz) were used to analyse gait. The PlugInGait biomechanical model determined mechanical segments and joint centres, which were based in anthropometric measurements and placement of reflective markers. Subjects walked barefoot at natural and self-selected speed performing 7 valid trials for the contact of each foot on force plate. Results After program, EG showed higher APP (2.33 W/kg vs 2.60 W/kg; 12%,  $p < 0.001$ ); no changes were observed in AMP (1.12 Nm/kg vs 1.16 Nm/kg) and LLMM (6.00 kg vs 6.01 kg). PEG showed no differences after program (APP - 2.27 W/kg vs 2.27 W/kg; AMP - 1.08 Nm/kg vs 1.09 Nm/kg; LLMM - 5.70 kg vs 5.80 kg). Discussion A 12-week individualized proprioceptive exercises program enhanced ankle power of RAPW during the propulsive phase of gait; however had no evident statistical effects on LLMM and AMP. According to these results, we suggest that proprioception and motor control will be behind of the better performance during the propulsive phase of the gait, which may have been enhanced after the proprioceptive exercise program. References: Barn,R et al (2013).Arthritis Care Res,65(4),495–502 Lee,L & Kerrigan,D (1999).Am J Physical Med Reh,78(3),242–46 Sherrington,C et al (2008).J American Geriat Soc,56(12),2234–43 Shin,S & An,D (2014).J Physical Therapy Sci,26(3),359–61 Weiss,R et al (2008).Gait Posture,28(2),229–34

## WAND EXERCISE TO IMPROVE PHYSICAL FUNCTION AND DECREASE PAIN IN PERSONS WITH RHEUMATOID ARTHRITIS: A PROSPECTIVE EXPERIMENTAL STUDY

NUALNETR, N.

Khon Kaen University

Introduction It is well known that exercises are essential for persons with rheumatoid arthritis (RA). Presently, wand exercise is popular among community-dwellers in Thailand. There were reports on the beneficial effects of wand exercise on cardiovascular health, muscle strength, range of motion and flexibility in adults. However, there was no study in persons with RA. This study aimed to evaluate the effects of a wand exercise program on physical function and pain in persons with RA. Methods Forty-five persons with RA in low or moderate severity level (average age 57.3 years) participated in a wand exercise program of 20 minutes/day, 3 days/week for 6 weeks. Outcome measures were physical function and pain assessed by the Health Assessment Questionnaire and Visual Analog Scale, respectively. Before exercising, the participants underwent pre-exercise assessment. They were reassessed immediately after the completion of the 6-week program and at week 9 of the follow-up period. Wilcoxon Signed Rank test and paired t-test were applied to analyze the results of physical function and pain, respectively. A value of  $p < 0.05$  was used to decide the significance for all analyses. Results When compared with baseline, assessments at weeks 6 and 9 revealed that the wand exercise significantly improved physical function and decreased pain of the participants ( $p < 0.001$ , median difference of physical function = -0.5 points, mean difference of pain level = -20.1 mm). No significant differences in both outcome measures were found when compared between the scores obtained from the assessments at weeks 6 and 9. Discussion Wand exercise is a combination of flexibility, balance, endurance and diaphragmatic breathing exercises (Wichitsranoi et al., 2011). It emphasizes smooth movements with full range of motion of the trunk and extremities (Peungsuwan et al., 2008) which should help increase blood circulation. Therefore, wand exercise was possible to improve physical function and decrease pain in persons with RA, as shown in this study. The current finding was consistent with that reported in previous studies (Baillet et al., 2009; Neuberger et al., 2007). To reveal further benefits of wand exercise in persons with RA, future studies with a comparison group and/or longitudinal design are recommended. References Baillet A, Payraud E, Niderprim VA, Nissen MJ, Allenet B, Francois P, Grange P, Casez P, Juvin R, Gaudin P. (2009). Rheumatology, 48, 410-415. Neuberger GB, Aronson LS, Gajewski B, Embretson SE, Cagle PE, Loudan LK, Miller PA. (2007). Arthritis Rheum, 57, 943-952. Peungsuwan P, Promdee K, Sruttatubul W, Na Nagara R, Leelayuwat N. (2008). Chula Med J, 52: 107-121. Wichitsranoi J, Pilarit J, Klomkamonl W, Ploynamngern N, Wongsathikun J. (2011). JPBS, 24, 64-69. Contact nomjit@kku.ac.th

**IMPROVED PHYSICAL ACTIVITY LEVEL IN CANCER PATIENTS PARTICIPATING IN A 12-MONTH LIFESTYLE INTERVENTION WHILE UNDERGOING PALLIATIVE CHEMOTHERAPY**

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 1) Southern Hospital Trust; 2) University of Agder

**Introduction** Despite a growing body of evidence presenting associations between physical activity (PA) and improvements in patient-reported outcomes, recurrence and mortality in cancer patients, few cancer patients are able to meet the American Cancer Society PA guidelines of >150 min.wk<sup>-1</sup> of moderate PA. Previous PA interventions in cancer patients commonly offer a one-size fits all-approach in selected samples of the fittest and most motivated patients; often after the completion of adjuvant treatment. Few studies have offered PA interventions in cancer patients undergoing oncologic treatment, specifically with palliative intent. The objective of the present study was to describe self-reported PA changes in cancer patients participating in a comprehensive lifestyle intervention while undergoing chemotherapy with curative or palliative intent. **Methods** The present study was part of a 12-month individualized lifestyle intervention focusing on diet, PA, stress management and smoking cessation in 100 cancer patients during chemotherapy. Participants completed the short form of the International Physical Activity Questionnaire (IPAQ-sf) during monthly counseled sessions with a lifestyle supervisor at the cancer center. End of study (EOS) versus baseline changes in moderate-to-vigorous intensity PA (MVPA) were reported as min.wk<sup>-1</sup>. Walking was included in MVPA. **Results** 59 of 100 participants (21 palliative) completed IPAQ-sf both at baseline and EOS. A non-significant but higher level of self-reported MVPA was observed at baseline in curative (1027, 95% Confidence Interval 700, 1354 min.wk<sup>-1</sup>) vs. palliative (900, 364, 1436 min.wk<sup>-1</sup>) patients ( $p = 0.197$ ). Self-reported MVPA in curative patients was relatively constant throughout the 12-month intervention. Opposing, palliative patients increased their PA levels to similar levels as curative patients after two months, before slowly decreasing at EOS. A linear regression model revealed significant pre-post differences in MVPA level between treatment intent groups ( $p = 0.006$ ) and the PA developed significantly different in curative vs. palliative patients. **Discussion** Self-reported PA during a 12-month lifestyle intervention developed differently in curative vs. palliative patients. Our findings show that participating in a lifestyle intervention may affect self-reported PA in palliative but not curative patients. These findings should be considered when implementing PA interventions in cancer patients with different treatment intents. Further, our findings are promising with regard to future interventions in palliative cancer patients.

**Invited symposia****IS-SH09 INCLUSIVE PHYSICAL ACTIVITY IN PHYSICAL EDUCATION, SPORT, AND REHABILITATION****THE ROLE OF REHABILITATION TO ENHANCE AN ACTIVE LIFESTYLE & SPORT PARTICIPATION IN PEOPLE WITH A DISABILITY**

DE GROOT, S., VALENT, L., HOEKSTRA, F., VAN DER WOUDE, L.

*Reade*

Rehabilitation professionals should play a role in assisting people with disability to enroll into physical activities and sports to prevent long-term deconditioning and health problems. Sports is an integral part of Dutch rehabilitation treatment protocols. In a multi-center study, people with spinal cord injury (N=158) indicated at discharge of inpatient rehabilitation that they tried handcycling (77%), archery (28%), wheelchair basketball (25%), table tennis (18%), wheelchair tennis (11%) or other sports. One year after discharge, 98% of this group (N=153) indicated to have handcycled in the past three months and 37% indicated to have participated in another sport than handcycling, with fitness (14%) as the most mentioned sport. Prevention of health problems due to inactivity has to continue after discharge of rehabilitation. Therefore, a sports desk is implemented in Dutch rehabilitation practice. Persons with a disability get a personal advice and support by a sports and movement consultant using a motivational interviewing approach. Furthermore, ex-patients are stimulated to participate in the HandbikeBattle, a mountain time trial among teams from 11 Dutch rehabilitation centers in the Alps of Austria. The main goal of the HandbikeBattle is to stimulate handbike training and as a result to become physically and mentally fit. Multi-center prospective cohort studies investigate these active lifestyle and sports stimulation programs in all participating rehabilitation centers. The Dutch association of physiatrists has initiated an official working group on 'Exercise and sports' to further implement methodologies for active lifestyle and sports stimulation.

**PROMOTING PARTICIPATION IN PHYSICAL ACTIVITIES FOR CHILDREN WITH DISABILITIES**

KLAVINA, A.

*Latvian Academy of Sport Education*

Physical education (PE) and sport is considered as a growing social phenomenon that makes an important contribution to inclusion. However, ensuring that students with disabilities benefit fully from learning and social opportunities available through PE and sport programs remains an important challenge. This presentation will focus on part of the large scale project outcomes investigating evidence-based strategies for promoting access to the participation in sport and physical education activities for children with disabilities. Several research outcomes have presented relation between the fundamental movement skills (FMS) proficiency and the time allocated to daily physical activities (Lin et al., 2005; Rimmer et al., 2007; Zwier et al., 2010). Furthermore, the relationship of FMS with physical activities can be understood through the International Classification of Functioning, Disability and Health (ICF) model for children and youth. In this study the body movement functions, physical skills and cognitive ability were presented as quantitative health indicators for participation in physical activities (WHO, 2007). The bi-directional relationship of ICF components suggests that targeting the movement functional and cognitive proficiency of children could generate positive effects on their physical activity engagement. Considering the impact of disability on movement functional and cognitive development and furthermore on physical activity participation, the interdisciplinary assessment package was developed and validated across four groups of children with different disabilities, n=116 (visual, physical, hearing and intellectual), including: (1) fundamental skill assessment (TGMD-2), (2) four physical skill assessments (strength, balance, flexibility and speed), and (3) physiological skill assessment including the three assessment packages to measure the postural stability and physical fitness condition parameters (e.g., muscle force, endurance and electromyographic response to muscle fatigue). The cognitive test pack-

age included the six subtests of the Vienna Test System. The outcomes of validation studies across the four disability groups will be presented during the session. References Lin, J.D., Yen C.F., & Wu J.L. (2005). Patterns of obesity among children and adolescents with intellectual disabilities in Taiwan. *Journal of Applied Research Intellectual Disabilities*, 18, 123-9 Rimmer, J. H. & Rowland, J.L. (2007) Physical activity for youth with disabilities: A critical need in an underserved population, *Developmental Neurorehabilitation*, 11(2), 141-148. Zwier, J.N., Schie, P.E.M., Becher, J.G., Smits, D.W., Gorter, J.W., & Dallmeijer, A.J. (2010) Physical activity in young children with cerebral palsy. *Disability and Rehabilitation*, 32(18): 1501 -1508. WHO (2007). *International classification of functioning, disability and health: children and youth version: ICF-CY*. Geneva: World Health Organization.

## ACCESSIBILITY IN SPRTS FACILITIES

KILPELÄ, N.

*The Finnish Association of People with Physical Disabilities*

The presentation is a conclusion of accessibility work of the Finnish Sports Association of Persons with Disabilities funded by the Finnish Ministry of Education and Culture and executed in co-operation with disability organizations during 2009–2014. The purposes of the projects were to evaluate accessibility of sports facilities, collect sports specific accessibility information and develop existing accessibility information as well as accessibility audit methods in sports facilities. The projects included an analysis of existing guidebooks as well as an internet survey. Sports specific guidelines for accessibility auditors were developed and 14 accessibility audits in training centres (sports academies) were put into practice. Both the social model of disability and UN Convention on the Rights of Persons with Disabilities emphasize accessible environment. The analysis of guidebooks revealed the inexistence of sports specific guidelines among accessibility information. Accessibility must be observed comprehensively as an integral concept related to moving, seeing, hearing, and understanding. There is a need for co-operation between the disability sport actors, disability advocates, accessibility specialists, architects, designers, builders and developers. The objective accessibility audit method was a useful tool when supplemented with disability sports specific information and used by trained auditors.

## Oral presentations

### OP-PM66 Sports Medicine: Heart Rate Variability

#### MORNINGNESS/EVENINGNESS EFFECTS ON AUTONOMIC FUNCTION DURING A HIGH INTENSITY INTERVAL TRAINING PROTOCOL IN SOCCER PLAYERS. A RANDOMIZED CROSS-OVER STUDY

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**Introduction** The 4x4 min of interval running proposed by Helgerud et al., (2001) is one of the widely used methods that have been demonstrated to improve soccer performance. For this reason, monitoring the effects of this type of training could provide useful information to make evidence based decisions on appropriate loading schemes to enhance team performance and reduce injuries. Therefore, the aim of this study was to assess the acute effects on heart rate variability (HRV) of this training protocol performed at different times of the day (8.00 am vs 8.00 pm). **Methods** In a cross-sectional study, 30 male recreational soccer players, age 20±2 y-o, were randomized to morning (MG=15) or evening group (EG=15). Subjects performed an aerobic interval training protocol consisted of four times 4 min at 90–95% of maximal heart rate (assessed during a Yo-Yo IR1 test) with a 3-min jog in between. HRV was measured at REST, PRE, POST-12h and POST-24h the 4x4 protocol. HR variability indexes in time, Root Mean Square of the Successive Differences (RMSSD) and the standard deviation of NN intervals (SDNN), frequency (Low Frequencies, between 0.04 and 0.15 Hz [LF], and High Frequency, between 0.15 and 0.40 Hz [HF], in normalized unit) were calculated. **Results** One-way ANOVA showed that both morning/evening aerobic interval training protocol significantly increased the parasympathetic cardiac tone POST-12h ( $p<0.05$ ) which returns to baseline level POST-24h. Un-paired t-test detected significant difference in PRE aerobic training in LnRMSS ( $p=0.049$ ), LnSDNN ( $p=0.043$ ), HF n.u. ( $p=0.021$ ), showing that in evening conditions subjects have an increased parasympathetic activity. In POST-12h subjects that trained during the evening have an increased LnRMSS ( $p=0.043$ ), LnSDNN ( $p=0.032$ ), HF n.u. ( $p=0.024$ ), maybe due to a reduced recovery. No differences in POST-24h both in sympathetic and parasympathetic activity were detected. **Discussion** The 4x4 protocol seems to influence the parasympathetic tone in the same way both in morning and evening conditions. On the other hand, in PRE conditions people that train in the evening showed an increased parasympathetic cardiac tone. Because soccer players have often to train twice a day during the season, with morning and evening training sessions, monitoring HRV is a useful and non-invasive method to detect the effects of high intensity interval training, with the aim to facilitate a more efficient planning and manipulation of training sessions. **References** Helgerud et al. *Med Sci Sport Exerc.* 2001 Contact [matteo.bonato@unimi.it](mailto:matteo.bonato@unimi.it)

#### USEFULNESS OF MONITORING RESTING HEART RATE VARIABILITY DURING A FOUR-WEEK PRE-SEASON PREPARATION PERIOD IN INTERMITTENT SPORT ATHLETES

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**Introduction** Measuring heart rate (HR) variability (HRV) is suggested to be of high value in monitoring training by offering insights into mechanisms of cardiac autonomic nervous system activity and modulation. Aim of the study was to evaluate whether HRV monitoring is able to display fatigue and recovery dynamics as well as performance adaptations during four-weeks of high-intensity interval training. **Methods** Twelve intermittent sport athletes ( $VO_{2peak}$   $55.6 \pm 4.4$  ml/min/kg) completed a periodised four-week high intensity interval training program based on three sessions per week. Maximal and submaximal endurance performance capacity was conducted using an incremental treadmill test prior to (baseline) as well as two (post 1) and nine days (post 2) following the training cycle. Overall recovery was assessed using the short recovery stress scale (SRSS) at the beginning of both training and testing sessions. HRV was measured daily upon awakening for six minutes under supine conditions two weeks preceding, during and two weeks following the intervention period. HRV was calculated using a rolling seven-day average. Data were analysed for practical relevance using magnitude-based



inferences on both group and individual level. Results Maximal running performance was likely to most likely increased at post 1 and post 2 (Cohen's  $d=0.20-0.41$ ), whereas submaximal capacity was possibly increased at post 2 ( $d=0.21-0.23$ ). Overall recovery (SRSS) was likely to most likely decreased in training weeks 1 and 3 ( $d=1.12-1.25$ ) compared to baseline. There were no relevant HRV changes between the tests or during the training period, as well as no relevant correlations between changes in HRV and performance. Single-case analysis displayed substantially diverging HRV kinetics, e.g. opposed trends in three athletes with similar above-average performance enhancements. Discussion HRV monitoring based on daily resting measures and analysis of rolling seven-day averages was neither able to track the observed alterations in fatigue and recovery, nor the performance adaptations on group level. When using single-case research methods, HRV monitoring seems to provide valuable information on individual responses and adaptations, which might enable program adjustments for further training optimization and individualization. However, the enormous amount of effort required, seems not to be justifiable regarding the possible benefits. Therefore, monitoring HRV in comparable settings using currently established methods is not recommended. References Buchheit M (2014) *Front Physiol*, 5(73). Hopkins WG (2004) *Sportscience*, 8, 1-7. Hopkins WG (2006) *Sportscience*, 10, 46-50. Kellmann M et al (in press) *The Acute and Short Recovery and Stress Scale for Sports – manual*. Sportverlag Strauß, Köln. Contact christoph.schneider-a5c@rub.de

## HYPOXIC HIGH-INTENSITY INTERVAL EXERCISE ALTERS HEART RATE VARIABILITY AND SUBSTRATE OXIDATION DURING RECOVERY

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**INTRODUCTION** The beat-by-beat change in heart rate, the so-called heart rate variability (HRV), is dependent on the cross-talk between sympathetic and parasympathetic nervous systems (SNS and PNS) (Yamamoto et al., 1996). HRV is affected by several factors such as exercise intensity, training status, health condition, gender, and environmental conditions, to name a few (Darr et al., 1988). However, no study has examined the cumulative effect of exercise and hypoxia on the sympathovagal balance and its potential association with the change in substrate partitioning during recovery. The purpose of this study was, therefore, to examine the effect of hypoxic exercise on HRV, and its association with change in substrate oxidation. **METHODS** Eight active healthy males (age:  $31 \pm 11$  years; height:  $180 \pm 7$  cm; weight:  $83 \pm 8$  kg; BMI:  $25 \pm 1$  kg·m<sup>-2</sup>;  $\dot{V}O_{2\max}$ :  $4.4 \pm 0.6$  L/min) were subjected to a 45-minute high-intensity interval (HII) cycling protocol in normoxia ( $FiO_2 = 0.2093$ ) and hypoxia ( $FiO_2 = 0.15$ ), respectively. In addition, a basal metabolic rate (BMR) and three 30-minute post-exercise metabolic rates over a 3-hour period were recorded in normoxia. Maximal oxygen uptake and peak power output were determined using a ramp cycling test in normoxia. HII consisted of alternating 3 minutes at 70% and 3 minutes at 35% PPO in both conditions. ECG, RPE, and blood lactate were recorded during exercise while substrate oxidation was measured pre- and post-exercise along with ECG and blood lactate. **RESULTS** During exercise, RPE was higher ( $p < 0.01$ ) and lactate increased ( $p = 0.001$ ) at each point of time in hypoxia, with no change in normoxia. After hypoxic exercise, SNS/PNS ratio was significantly higher ( $p < 0.01$ ) and significantly decreased through time in both conditions ( $p < 0.01$ ). In addition, a significant interaction between time and conditions ( $p < 0.02$ ) showed a decrease in lactate concentration through time post-hypoxic exercise. **DISCUSSION** The findings showed that a single bout of hypoxic exercise alters the autonomic nervous system activity post-exercise along with shifting substrate partitioning from glycolytic to lipolytic energy production. The significant decrease in blood lactate concentration post-hypoxic exercise supports the notion that hypoxic HII induces a greater muscle glycogen depletion leading to increased fat oxidation to sustain glycogenesis and gluconeogenesis to maintain blood glucose level during recovery. **REFERENCES** Darr KC, Bassett DR, Morgan BJ, Thomas DP. (1998). *Am J Physiol Heart Circ Physiol*, 254, 340-343 Yamamoto Y, Hoshikawa Y, Miyashita M. (1996). *J Appl Physiol*, 81, 1223-1229 CONTACT fbasset@mun.ca

## CAN IANT BE DETERMINED BY HEART RATE VARIABILITY IN OVERWEIGHT SUBJECTS?

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**Introduction** Numerous studies reported that the heart rate variability (HRV) may be used to determine the aerobic-anaerobic thresholds (IANT) in healthy trained participants (1,2,3). The aim of this study was to assess if the IANT may also be determined in overweight and obese subjects utilizing the non-linear response of HRV. **Methods** 28 overweight and obese participants (age:  $38.5 \pm 13.1$  yrs; Wt:  $96.4 \pm 16.7$  kg; BMI:  $30.9 \pm 4.4$  kg·m<sup>-2</sup>; %body fat:  $29.2 \pm 4.3$ ; waist circumference:  $107.8 \pm 10.9$  cm) completed a two stage incremental test on cycle ergometer followed by continuous performance test to determine and validate the lactate thresholds and IANT. The examination of individual HRV variables and associated HRV thresholds were determined via continuous 12-lead ECG monitoring and recordings. The agreement of resulting power output thresholds expressed in Watts (W) in the region of IANT and those determined from HRV recordings were ascertained via Bland-Altman plots and correlation analysis. **Results** The calculated thresholds generated from HRV recordings were above those performed in IANT (W:  $126 \pm 30.7$ ; utilizing the Pointcare Chart variability, SD1 of  $144.8 \pm 32.9$  = standard deviation of the short-term RR interval variability of transverse axis; SD2 of  $146.1 \pm 30.5$  = standard deviation of the long-term RR interval variability of longitudinal axis; SD1/SD2 ratio of  $145.2 \pm 27.8$ ; SD1/HR ratio of  $144.4 \pm 32.2$ ). The results revealed agreements in IANT determination that were confirmed via Bland-Altman Plots as well as significant correlation coefficients generated from the cycle ergometer power output (SD1 = 0.69; SD2 = 0.61; SD1/SD2 = 0.66; SD1/HR = 0.68). **Discussion** The results of this study yielded moderate to strong associations between HRV threshold data and results determined via IANT power output on cycle ergometer. In our overweight and obese participants, the response in HRV variability was present and possible only during the short-term analysis. **References** 1. Di Michele R, Gatta G, Di Leo A, Cortesi M et al (2012) *J Strength Cond Res* 26, 3059-3066 2. Karapetian GK, Engels HJ, Gretebeck RJ (2008). *Int J Sports Med* 29, 652-657 3. Simoes RP, Mendes RG, Castello V, Machado HG et al (2010) *J Strength Cond Res* 24, 1313-1320 Contact ruediger.reer@uni-hamburg.de

## PREDICTING MATCH OUTCOME USING WEEKLY HEART RATE VARIABILITY RECORDINGS

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**Introduction** Monitoring workloads, well-being and performance is common practice for elite athletes and coaches. However, the optimal measure to assist preparation for competition remains to be identified. Heart rate (HR) variability (HRV), a simple non-invasive measure of cardiac autonomic modulation, has attracted interest as a monitoring tool for elite sporting teams but its ability to predict performance has not been well established. The aim of this study was to examine whether weekly HRV assessments could predict match outcome for

elite, rugby league athletes. Methods Thirty-two athletes volunteered for this study and undertook weekly recordings of HR, regular exercise training and competitive matches during the 2014 National Rugby League season. Supine recordings of resting HR (5-mins) were obtained each week, ~4 days before competitive matches. All recordings were analysed for time- and frequency-domain, and non-linear measures of HRV using specialist software (Kubios v2.1). Match performance/outcome was documented as team win or loss. Between group differences for each HRV measure were established via independent t-tests for the main effect of match outcome. Binary logistic regression models were built to investigate the association between match outcome (response variable) and each HRV measure (explanatory variables). The most parsimonious model was identified using the "dredge" function within the MuMin package in the R statistical computing environment v3.1.3. Results Athletes exhibited a significantly greater, resting HR ( $61.8 \pm 8.8$  vs.  $59.1 \pm 8.4$  bpm,  $p < 0.01$ ) and short-term HRV (standard deviation of successive RR interval differences,  $8.0 \pm 3.7$  vs.  $7.2 \pm 3.3$  ms,  $p < 0.05$ ) prior to wins. All other weekly HRV measures were similar prior to wins and losses. The following frequency-domain and non-linear measures of HRV were identified as significant ( $p < 0.05$ ) independent predictors of match outcome: very low frequency (absolute units), and recurrence plot analysis (RPA) – mean diagonal line length and Shannon information Entropy of line length distribution. The most parsimonious model retained these three predictors (Akaike's information criterion delta weight of 0.014). Discussion Prior to successful match outcomes, elite rugby league athletes exhibited enhanced short-term HRV with specific frequency-domain and non-linear measures of HRV successfully predicting match outcome. Assessment of weekly HRV measures may provide prognostic indication of future success for team sport athletes. Future studies may clarify the significance of non-linear RPA and measures of HR complexity for sporting performance to assist coaches and athletes. Contact Anthony.Leicht@jcu.edu.au

## Oral presentations

### OP-PM32 Cycling Tests

#### EFFECTS OF TRIAL DURATION ON ESTIMATES OF CRITICAL POWER AND TIME-TRIAL PREDICTION DURING FIELD CYCLING

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**Introduction** The hyperbolic response between power and duration is characterised by an asymptote (critical power; CP), which theoretically represents the maximum rate of work that can be maintained for a very long time without fatigue and a finite amount of work that may be performed above CP ( $W'$ ). Traditionally CP and  $W'$  are estimated from 3-5 constant power ergometer trials leading to exhaustion within 1-12 min. It has been shown that the range of duration can affect estimates of CP. Therefore, the aim of this study was to determine the effect of trial-duration on estimates of CP in field conditions. In addition, the accuracy of CP to predict 20-min time-trial power (TT20) was assessed. We hypothesised that different trial-duration result in similar CP estimates and accurately predict TT20. **Methods** Ten male endurance trained cyclists (mean  $\pm$  SD, age:  $31.4 \pm 5.8$  years, body mass:  $76.8 \pm 6.0$  kg,  $VO_{2max}$ :  $60.0 \pm 4.1$  ml/kg/min) completed three maximal-effort sessions on flat roads, on a racing bike equipped with a mobile power-meter (SRM). To estimate CP, trials of 1, 4, and 10 min (CP1), and 2, 7, and 12 min (CP2) interspersed by 30 min, were performed during session one and two, respectively. During session three, the TT20 was conducted. CP1 and CP2 were modelled using the linear work/time relationship. In addition, a third set consisting all trials from 1-12 min (CP3) was used to estimate CP. Repeated measure ANOVA was used to compare CP and TT20 across the trials. The standard error of estimate (SEE) from linear regression analysis was used to assess prediction accuracy. **Results** There were no significant differences between CP1 ( $305 \pm 38$  W), CP2 ( $298 \pm 35$  W), CP3 ( $301 \pm 35$  W) and TT20 ( $317 \pm 31$  W) ( $F_{3,7} = 3.1$ ;  $p = 0.1$ ). Strong correlations were found between TT20 and CP (0.86, 0.82 and 0.86, all  $p < 0.001$  for CP1, CP2 and CP3, respectively). The SEE was 17 W, 19 W and 17 W for CP1, CP2 and CP3, respectively. **Discussion** In the present study no significant differences in CP were observed when estimated from different trial durations. Irrespective of trial duration, accuracy to predict TT20 was approximately 5%. In accordance with previous studies where TT20 was not significantly different to ventilatory and lactate thresholds, no significant differences were found with CP. This suggests, that TT20 can serve as a surrogate for different thresholds such as ventilatory and lactate thresholds or CP. From a practical point, the use of shorter trial durations does not affect estimates of CP.

#### TIME OF DAY DOES NOT INFLUENCE PACING AND PERFORMANCE IN A 4 KM CYCLING TIME TRIAL

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**Introduction:** Time of day has been shown to impact athletic performance with increases of 10% observed when competing between the hours of 1600 to 2000 h, or within an athlete's circadian peak window [1]. Physiological factors such as body temperature and hormonal responses display individual circadian rhythms and are believed to be associated with alterations in performance. These factors are also likely to influence the distribution of pace throughout an event, however, we are aware of only one study that has investigated the influence of time of day on pacing [2]. Therefore, the aims of the present study were to investigate the influence of time of day on pacing selection within a 4 km cycling time trial. **Methods:** Fourteen trained male cyclists (age:  $38.9 \pm 10.7$  y, weight:  $77 \pm 9$  kg, height:  $181 \pm 7$  cm,  $VO_{2max}$ :  $64.5 \pm 8.0$  ml.kg<sup>-1</sup>.min<sup>-1</sup>) performed five 4 km cycling TTs on their own bicycle fitted to a cycle trainer (KICKR: Wahoo Fitness, Atlanta, GA) over five different times of the day (0830, 1130, 1430, 1730 and 2030 h). All trials were completed in a randomised order with each trial separated by a minimum of two and a maximum of seven days. Pacing was assessed through the collection of power, cadence, heart rate and oxygen consumption at 1 km averages throughout each TT. Ratings of perceived exertion (RPE: 6-20) and effort (VAS: 0-10) were collected immediately post TT. Power, cadence, heart rate and oxygen consumption were analysed using two-way repeated measures analysis of variance (Time of Day x distance). RPE and effort were analysed using a repeated measures analysis of variance. **Results:** No differences in overall average power output, cadence and total time were observed between time trials performed at 0830, 1130, 1430, 1730 and 2030 h ( $p > 0.05$ ). Average heart rate and oxygen consumption remained similar and showed no significant differences between trials ( $p > 0.05$ ). No differences in pacing were observed between the 4 km time trials when performed at 0830, 1130, 1430, 1730 and 2030 h ( $p > 0.05$ ). **Conclusion:** When assessed at 0830, 1130, 1430, 1730 and 2030 h, the time of day did not influence pacing and performance within a 4 km time trial. The findings from this study may have implications for the testing and monitoring of athletic performance using trials of a similar distance. **References** 1. Reilly T, Waterhouse J. Sports performance: Is there evidence that the

body clock plays a role? Eur J Appl Physiol. 2009;106(3):321-332. 2. Fernandes, A.L., et al., Effect of time of day on performance, hormonal and metabolic response during a 1000-M cycling time trial. PLoS One, 2014. 9(10): p. e109954. Contact: Emma.Zadow@utas.edu.au

### EFFECT OF PEDAL RATE DURING TIME TRIAL ON OXYGEN UPTAKE KINETICS IN A SUBSEQUENT RUNNING TASK

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**Introduction** Previous studies reported an increase in running time-to-exhaustion after 30 min cycling at a cadence of 75 rpm compared with 95 and 109 rpm (Vercruyssen et al. 2005). The aim of the present study was to analyze whether the pedal rate in cycling time trial affects parameters of oxygen uptake kinetics in a subsequent running task under laboratory conditions. **Methods** Ten male endurance trained subjects (mean $\pm$ SD, age: 27.5 $\pm$ 4.8yr, body mass: 76.2 $\pm$ 8.8kg, VO<sub>2</sub>max: 62.1 $\pm$ 6.0ml/kg/min) performed three laboratory trials. The subjects completed a graded exercise test (GXT) on a treadmill and two trials consisting of a time trial (360 kJ) and a running task. The time trials were conducted at a cadence of 60 and 90 rpm in the linear mode of the Lode Excalibur ergometer. Immediately after the time trials the subjects were asked to change into their running shoes and to complete a 6-min running task on the treadmill at an intensity of the respiratory compensation point obtained from the GXT. Oxygen uptake was measured breath-by-breath using a Cortex gas analyser. Nonlinear least square regression analyses were used to resolve the time constant, the amplitude and the time delay of the primary phase. A paired-samples t-test was used for statistical analyses. **Results** The time to complete the time trials were 1153 $\pm$ 141s and 1201 $\pm$ 179s at 60 and 90 rpm, respectively (t (9) = -2.88, p = 0.018). There were no significant differences between the 60 and 90 rpm for the time constant (31.3 $\pm$ 6.8s vs. 33.3 $\pm$ 5.8s; t (9) = -2.1, p = 0.066), the amplitude (2.59 $\pm$ 0.37 L/min vs 2.56 $\pm$ 0.36 L/min; t (9) = 0.82, p = 0.433), the time delay (17.9 $\pm$ 4.9s vs. 16.6 $\pm$ 4.2s; t (9) = 0.90, p = 0.391) and the end-exercise oxygen consumption (4.29 $\pm$ 0.56L/min vs. 4.28 $\pm$ 0.63L/min) during the 6-min treadmill running task. **Discussion** The results of the present study support previous findings where improvements in power output and gross efficiency during cycling at 60 compared with 90 and 100 rpm have been reported (Nimmerichter et al. 2012; Nimmerichter et al. 2015). The significantly faster time to complete a 360 kJ time-trial at 60 compared with 90 rpm, does not affect parameters of oxygen uptake kinetics in a subsequent running task. Although the improvement in cycling time-trial performance does not impair the initial oxidative response during submaximal running, the effects on subsequent performance during a running time-trial, remains to be shown. **References** Nimmerichter A, Eston R, Bachl N, Williams C (2012) Effects of low and high cadence interval training on power output in flat and uphill cycling time-trials. Eur J Appl Physiol 112 (1):69-78. Nimmerichter A, Prinz B, Haselsberger K, Novak N, Simon D, Hopker JG (2015) Gross Efficiency During Flat and Uphill Cycling in Field Conditions. Int J Sports Physiol Perform 10 (7):830-834. Vercruyssen F, Suriano R, Bishop D, Hausswirth C, Brisswalter J (2005) Cadence selection affects metabolic responses during cycling and subsequent running time to fatigue. Br J Sports Med 39 (5):267-272. Contact felix.waldhuber@fhwn.ac.at

### OXYGEN UPTAKE KINETICS DURING FLAT AND UPHILL CYCLING AT HIGH-INTENSITY EXERCISE IN FIELD CONDITIONS

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**Introduction** Oxygen uptake kinetics are the principal means by which the human organism generates energy to do work. Oxygen uptake kinetics are investigated by a number of studies in laboratory conditions. Few studies, however, have analysed oxygen uptake kinetics in field conditions. The aim of this study was to analyse the effect of gradient and cadence on the primary response of oxygen uptake kinetics in field conditions. **Methods** Thirteen trained cyclists (mean  $\pm$  SD: age 23  $\pm$  4.7 years; stature 178.5  $\pm$  5.2 cm; body mass 69  $\pm$  7.8 kg; VO<sub>2</sub>max 68.2  $\pm$  4.7ml/min/kg) performed a laboratory incremental graded exercise test (GXT) and on a separate day four 6min field-trials, two on level ground (gradient 1.5%, flat) and two uphill (gradient 5%, climb). The two trials were conducted at a cadence of 60 and 90 rev/min (rpm) and at the work rate corresponding to 70% ( $\Delta$ 70) between the power at ventilator threshold and Pmax of the GXT. Throughout each trial gas exchange was continuously measured with a portable gas analyser (MetaMax3B, CORTEX, Germany) and power output was measured with a SRM mobile power crank (Schoberer Rad-Messtechnik, Juelich, Germany). The V O<sub>2</sub> breath-by-breath data were interpolated at 1-second intervals and the time constant and the amplitude of the exponential primary phase were resolved by least square regression (GraphPad Prism 6.0, GraphPad Software, USA). A factorial ANOVA with cadence and inclination as model factors was used for statistical analyses. **Results** The amplitude was significantly affected by cadence (F<sub>1,12</sub> = 39.3, P < 0.001; 60 rpm: 2573  $\pm$  53 mL, 90 rpm: 2887  $\pm$  47 mL) but not by inclination (F<sub>1,12</sub> = 0.002, P = 0.967; flat: 2731  $\pm$  172 mL, climb: 2728  $\pm$  272 mL). Time constant was not significantly affected by cadence (F<sub>1,12</sub> = 1.7, P = 0.213; 60 rpm: 21.4  $\pm$  2.7 sec, 90 rpm: 23.2  $\pm$  2.2 sec) and inclination (F<sub>1,12</sub> = 3.9, P = 0.073; flat: 24.0  $\pm$  1.1 sec, climb: 20.5  $\pm$  1.5 sec). The end-exercise oxygen uptake was significantly affected by cadence (F<sub>1,12</sub> = 55.3, P < 0.001; 60 rpm: 4054  $\pm$  125 mL, 90 rpm: 4324  $\pm$  28 mL). No significant difference was observed between flat (4243  $\pm$  142 mL) and uphill cycling (4134  $\pm$  239 mL) (F<sub>1,12</sub> = 1.5, P = 0.245). **Discussion** Our findings indicate that the parameters of oxygen uptake kinetics are not influenced by inclination. This is supported by previous studies who investigated the influence of inclination in treadmill running. Based on these findings we assume that measuring the primary response of oxygen uptake kinetics is independent of inclination. However, time constant is not influenced by cadence which is in contrast to the higher amplitude and end-exercise oxygen uptake at 90 rpm. Contact bernhard.prinz@fhwn.ac.at Do not insert authors here

### ECCENTRIC VERSUS CONCENTRIC INCREMENTAL MAXIMAL CYCLING TEST

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**Introduction** Eccentric cycling (EC) is less metabolically demanding than concentric cycling (CC) at the same power output (I). To determine eccentric cycling intensity, previous studies have used either a percentage of age-predicted maximum heart rate (2) or maximal power output obtained from a concentric incremental cycling test (I). Maximal power output during eccentric cycling was not assessed in the previous studies, and oxygen consumption (VO<sub>2</sub>) and heart rate (HR) responses in incremental eccentric exercise have been not investigated. Thus, this study compared changes in VO<sub>2</sub> and HR in relation to power output between concentric and eccentric incremental maximal cycling test. **Methods** Eleven healthy participants (9 men, 2 women, 33.2  $\pm$  9.2 y) performed two incremental maximal cycling tests on separate days; first on a concentric cycling ergometer (Velotron, Washington USA) then on an eccentric cycling ergometer (Cyclus 2 Eccentric Trainer, Germany). Cycling intensity started at 75 W and increased by 25 W every minute until exhaustion. Participants were instructed to cycle above 60 rpm during CC, and to maintain the same cadence as CC during EC. When the target rpm could not be maintained for more than 30 s, the test was terminated. Gas exchange, heart rate and power output were measured continuously dur-

ing cycling, and compared between EC and CC by a t-test and Cohen's effect size (dz). Results Maximal power output was 53% greater ( $P<0.001$ ;  $dz=2.11$ ) for EC ( $438 \pm 110$  W) than CC ( $286 \pm 55$  W). Maximal HR during CC ( $182 \pm 13$  bpm) was not different ( $P>0.05$ ;  $dz=0.49$ ) from that of EC ( $176 \pm 20$  bpm). Peak  $\dot{V}O_2$  was 39% ( $P<0.001$ ;  $dz=1.14$ ) greater during CC ( $43.2 \pm 6.8$  ml/kg/min) than EC ( $31.0 \pm 5.8$  ml/kg/min). Discussion In spite of the 53% greater power output during EC than CC, peak  $\dot{V}O_2$  was 39% lower for EC than CC, yet maximal HR was similar between EC and CC. Thus, the relationship between  $\dot{V}O_2$  and HR in EC was different from that in CC. It has been shown that the magnitude of increase in adrenaline and noradrenaline is similar between EC and CC (3). It has also been reported that eccentric contractions increase muscle temperature more than concentric contractions (4). These differences may explain why HR responses were similar between EC and CC. In conclusion, the different relationship between maximal power output,  $\dot{V}O_2$ , and HR should be considered when prescribing EC. An incremental protocol utilizing eccentric cycling may be more appropriate to determine exercise intensity in future investigations. References 1) Penailillo et al. Med Sci Sport Exerc, 9, 1773-81, 2013 2) Elmer et al. Scand J Med Sci Sports Exerc, 22, 653-61, 2012 3) Dufour et al. Am J Physiol Regul Integr Comp Physiol, 4, 1641-48, 2007 4) Nadel et al, J Appl Physiol, 33, 553-558, 1972 Contact m.lipski@ecu.edu.au

## Oral presentations

### OP-PM31 Strength Training - Assessment

#### 1 RM DETERMINATION: A NOVEL APPROACH BASED ON THE FORCE-VELOCITY RELATIONSHIP

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**INTRODUCTION** Issues related to the direct determination of one repetition maximum (1RM) have led to the development of a variety of indirect approaches which make use of regression models to predict 1RM either from the capacity of lifting a submaximal load until failure or from strength-related variables collected during lifting increasing submaximal loads (Rontu et al., 2010; Jidovtseff et al., 2011). In both cases, accuracy of prediction is affected by all those factors that were involved in the construction of the model (i.e. exercise typology, age, gender, training level, number and cadence of performed repetitions) (Reynolds et al., 2006). Aim of the present paper is to assess the accuracy of 1RM as assessed by a novel, subject- and exercise-specific, methodology based on the force-velocity and the load-velocity relationships. **METHODS** The estimate of 1RM relied on the very definition of 1RM and consisted in identifying the intersection between the force-velocity and the load-velocity curves where the gravitational force exceeds the force that the subject can apply to the load. Force applied to the load and lifting velocity were collected in correspondence of at least three increasing loads by using an inertial sensor fixed on the load. The proposed force-velocity-based approach (FVM) was tested on 27 males (age:  $23.9 \pm 3.1$ ) with no particular experience with resistance training in a leg-press (LP) and chest-press (CP) exercises. Agreement and association with respect to the direct measure of 1RM (DM), as determined in a separate session, were assessed using Bland-Altman's analysis and Pearson's correlation coefficient, respectively. **RESULTS** The means ( $\pm$ SD) of DM and FVM for CP were respectively 112 Kg ( $\pm 18.1$ ) and 113 Kg ( $\pm 18.6$ ). The means ( $\pm$ SD) of DM and FVM for LP were respectively 271 Kg ( $\pm 51$ ) and 273 ( $\pm 51$ ). The mean absolute percentage error was 1.2% for CP and 1.8% for LP. A high correlation between DM and FVM was found for both CP (0.998;  $p < 0.001$ ) and LP (0.999;  $p < 0.001$ ). A good level of agreement between DM and FVM was found for both CP (bias: -1.29, 95% CI: 0.95 to -3.54) and LP (bias: -1.80, 95% CI: 2.69 to -6.28). **DISCUSSION** Results suggest the proposed methodology as an accurate and safer alternative to the direct determination of 1RM. The mathematical construct is simply based on the definition of the 1RM and it is fed with subject's muscle strength capacities measured during a specific exercise. For this reason, its reliability is not prone to be affected by those factors that typically jeopardize regression-based approaches. **REFERENCES** Rontu JP, Hannula MI, Leskinen S, Linnamo V, Salmi JA. (2010). J Strength Cond Res, 24, 2018-2025. Jidovtseff B, Harris NK, Crielaard JM, Cronin JB. (2011). J Strength Cond Res. 25, 267-270. Reynolds JM, Gordon TJ, Robergs RA. (2004). J Strength Cond Res, 18, 227-235. CONTACT [pietro.picerno@uniecampus.it](mailto:pietro.picerno@uniecampus.it)

#### STRENGTH TRAINING: 10 RM VS 30 RM – TRAINING LOAD DOES MATTER

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**Strength training: 10 RM vs 30 RM – training load does matter** **Introduction** To maximize muscle hypertrophy and strength, heavy loads are often recommended (e.g. Ratamess et al., 2009). However, recent studies have challenged this view and claim that low loads can promote adaptations similar to high-load training, as long as it is performed to volitional fatigue (Burd et al. 2012; Mitchell et al., 2012). In the present study, we investigate the effect of high-load (H) vs. low-load (L) strength-training on maximal strength and lean body mass (LBM), as well as on performance in rapid movements such as counter-movement jump (CMJ) and during an agility test. **Method** Twenty-seven military students ( $20 \pm 1$  years,  $75 \pm 13$  kg,  $\dot{V}O_{2max}$   $58 \pm 6$  ml·kg<sup>-1</sup>·min<sup>-1</sup>) with similar circadian rhythm, activity level, and nutrition intake were randomly assigned to high-load (H;  $3 \times 10RM$ ,  $n=14$ ) or low-load (L;  $3 \times 30RM$ ;  $n=13$ ) strength training regimes. Both groups trained the same seven exercises (3 lower body and 4 upper body) twice a week for 9 wks. The effects of the different strength protocols were measured in 1RM (leg press, bench press and biceps curl), agility, CMJ, and dual-energy X-ray absorptiometry assessments of LBM. **Results** There were no differences between the groups at baseline. H increased overall 1RM ( $\Sigma leg$ -, bench-press and biceps curl) significantly more than L ( $17 \pm 9\%$  vs.  $10 \pm 6\%$ , respectively,  $p \leq 0.05$ ). H had also a larger performance improvement than L in both CMJ ( $11 \pm 7\%$  vs.  $5 \pm 7\%$ , respectively,  $p \leq 0.05$ ) and agility ( $2.1 \pm 3.9\%$  vs.  $-1.2 \pm 2.9\%$ , respectively,  $p \leq 0.05$ ). H had a tendency towards larger increase in LBM of the lower- and upper extremities than L ( $5.0 \pm 3.7\%$  vs.  $2.4 \pm 3.3\%$ , respectively,  $p=0.056$ ). Effect size (ES) analyzes revealed moderate effects in favor of H vs L in 1RM, CMJ, agility and LBM (ES: 0.79, 0.78, 0.97, and 0.74, respectively). **Discussion** The main finding was that the H protocol improved 1RM, CMJ and agility more than the L protocol and tended to induce a superior increase in LBM, despite both protocols being performed to volitional fatigue, supported by moderate ES in favor of H vs L on all variables. This is in agreement with similar studies (e.g. Campos et al., 2002) and somewhat contrary to other studies (e.g. Mitchell et al. 2012). Indeed both protocols induced strength-training adaptations, but when the aim is to maximize performance in rapid movements such as CMJ and agility tests, H training seems



to be beneficial. References Burd et al. (2012) Appl Physiol Nutr Metab, 37, 551-554. Campos et al. (2002) EJAP, 88, 50-60. Mitchell et al. (2012) J Appl Physiol, 113, 71-77. Ratamess et al. (2009) Med Sci Sports Exerc, 41, 687-708. Contact bent.ronnestad@hil.no

### EFFECTIVENESS OF AN OPTIMIZED TRAINING USING FORCE-VELOCITY PROFILE ANALYSIS

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**AIM:** Ballistic performances, notably jumping, are key factors in many sport activities. They are mostly determined by the maximal power (Pmax) that lower limbs can generate but also by the individual Force-velocity (F-v) mechanical profile characterizing the ratio between maximal force and maximal unloaded extension velocity capabilities. An individually optimal F-v profile has been shown to characterize the best balance between force and velocity capabilities (Samozino et al 2012, 2013). A F-v imbalance ([Fv]\_IMB) being associated to lower performances. The F-v profile could be sensitive to specific and optimized training in order to improve ballistic performances. So training has to aim at increasing Pmax and/or optimizing the F-v profile. Thus, the aim of this study was to determine the effects of an individual specific force-velocity profiling based-training. **METHODS:** Sixty-three subjects were assigned to three groups according to [Fv]\_IMB classification: a velocity and a force imbalance deficit groups and a control group (no consideration of [Fv]\_IMB). Mean push-off force, velocity and power were calculated from jump height (Samozino's method, 2008). From this data, actual and optimal F-v profiles were computed for each subject to quantify [Fv]\_IMB and organize groups accordingly. Participants underwent a 9-week specific resistance training program designed according to [Fv]\_IMB classification to reduce imbalances for the intervention groups versus a one-size-fits-all program with no [Fv]\_IMB consideration for the control group. **RESULTS:** A greater increase in jump performance (16.6% and 13.3% in force and velocity groups, respectively) was observed in the intervention group, with a decrease in [Fv]\_IMB (-38.3% and -83.2% in force and velocity groups, respectively) compared to controls. **CONCLUSION:** An optimized and individualized training program specifically addressing the force/velocity imbalance is more efficient in improving jumping performance than a traditional resistance training common to all subjects, regardless of their force/velocity imbalance and optimal force-velocity profile. Thus, [Fv]\_IMB could be considered as a potentially useful variable for prescribing optimal resistance training to improve ballistic (e.g. jumping) performance. References Samozino P et al (2008) J Biomech 41(14):2940-5 Samozino P et al (2013) USM 35(6):505-10 Samozino P et al (2012) MSSE 44(2):313-22 Contact: peterjr49@hotmail.com

### MUSCLE ACTIVATION AND MAXIMAL REPETITIONS NUMBER AS AN INDICATOR FOR STRENGTH IMBALANCE DURING CHEST PRESS EXERCISE

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**Introduction** Muscle imbalance or bilateral asymmetry can be interpreted as imbalance in strength between 2 halves of the body (Croisier, 2004), and many researchers have tested strength imbalance using isokinetic testing (Rahnama et al, 2005; Siqueira et al, 2002). However, as isokinetic equipment is too expensive, maximum repetition number could be used instead and research which examined imbalance of upper limbs using electromyography (EMG) is needed to be studied. This study tested the hypothesis that muscle activation would be higher in non-dominant compared with dominant pectoralis major during two-arm chest press exercise, but maximal repetition number would be higher in dominant compared with non-dominant pectoralis major during one-arm chest press exercise. **Methods** Ten healthy, resistance-trained males were tested for 1-RM the chest-press exercise, Two-arm at 80% of 1-RM and one-arm at 40% of 1-RM in the pectoralis major were measured for the maximal voluntary contraction (%MVC) by the EMG and maximal number of repetitions during the chest press exercise. Exercise velocity was constantly 4 seconds (concentric: 2-s, eccentric: 2-s) per repetition (Gentil et al., 2007). **Results** The changes in %MVC were significantly higher in the non-dominant compared with dominant pectoralis major during two-arm chest press exercise ( $p < 0.05$ ). In contrast, the changes in maximal repetition number were significantly higher in the dominant compared with non-dominant pectoralis major during one-arm chest press exercise ( $p < 0.05$ ). **Discussion** In Previous studies, 41 English Premier League club soccer players found bilateral strength differences in preferred and nonpreferred legs, using isokinetic testing (Rahnama et al, 2005). In this study, we demonstrated that changes in muscle activation are influenced by changes in maximal repetition number during one-arm chest press exercise. It is considered that maximal repetition number can be used as an indicator of strength imbalance. References Croisier JL. (2004). Int Sport Med J, 5, 169-176. Rahnama N, Lees A, Bambaecichi E. (2005). Ergonomics, 48, 1568-1575. Siqueira CM, Pelegrini FR, Fontana MF, Greve JM. (2002). Rev Hosp Clin Fac Med Sao Paulo 57: 19-24. Gentil P, Oliveira E, de Araújo Rocha Júnior V, do Carmo J, Bottaro M. (2007). J Strength Cond Res, 21(4), 1082-1086. Contact lhoseh28@dankook.ac.kr

### OPTIMAL LOADING CONDITIONS FOR MAXIMIZING POWER IN SLED RESISTED SPRINTING

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**INTRODUCTION** Maximal power production (Pmax) is considered central to sprinting performance (Rabita et al. 2015). Power profiling during sprinting has occurred through several different methods (e.g. Samozino et al. 2015), allowing the magnitude and balance of mechanical capacities to be quantified and compared. However, no attempt has been made to profile the optimal conditions for maximal power during overground sprinting. We assessed whether a multiple trial method, using a common sprint sled to supply resistance, could be used to profile mechanical relationships and optimal loading conditions during overground sprinting. **METHODS** 27 healthy mixed-code athletes performed six to seven maximal velocity sprints towing a sled, loaded with a selection of masses (0-120% of body-mass), on an athletics track. For each trial, power was determined at maximum velocity (assessed via radar), from pre-determined friction force and aerodynamic drag. Individual composite linear force-velocity and parabolic power-velocity relationships, and associated mechanical variables and optimal loading conditions, were generated using variables from each trial. Least squares linear and quadratic regression fits, mean and the range of outcome mechanical variables were calculated. **RESULTS** Force-velocity and power velocity relationships were very well fitted with linear and 2nd order polynomial regressions, respectively ( $R^2=0.977-0.999$ ;  $P<0.001$ ). Mean Pmax was  $15.79 \pm 2.47$  W.kg<sup>-1</sup>, with theoretical maximum force and velocity as  $6.97 \pm 0.70$  N.kg<sup>-1</sup> and  $9.13 \pm 0.80$  m.s<sup>-1</sup>, respectively. The mean normal load (i.e. sled mass) that maximized power was  $75 \pm 7\%$  of body-mass (range=65-90%), representing an optimal force of  $3.5 \pm 0.34$  N.kg<sup>-1</sup> at a velocity of  $4.58 \pm 0.40$  m.s<sup>-1</sup>. **DISCUSSION** Power-force-velocity relationships can be accurately profiled using com-

mon sled training equipment and simple maximal speed data. Notably, the optimal conditions for maximizing peak power represented much greater resistance than that generally used in the literature (Petrakos et al. 2015), and appear to exist within wide ranges. This method has potential value in quantifying individualized training parameters for optimized development of horizontal power, which may reflect greater increases in applied performance measures than those currently used and recommended in practice. REFERENCES Rabita, G., Dorel, S., Slawinski, J., Saez-de-Villarreal, E., Couturier, A., Samozino, P., & Morin, JB. (2015). Scand J Med Sci Sports, 25(5), 583-594 Samozino, P., Rabita, G., Dorel, S., Slawinski, J., Peyrot, N., Saez de Villarreal, E., & Morin, JB. (2015). Scand J Med Sci Sports, in press. Petrakos, G., Morin, JB., & Egan, B. (2015). Sports Med, in press.

## MUSCULAR ACTIVITY IN CONVENTIONAL AND DIFFERENTIAL BACK SQUAT EXERCISE

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**Introduction** In conventional strength training, deviations from prescribed exercises are corrected and minimized. In comparison, the differential learning (DL) approach bases on movement variations and shows advantages for motor learning in sports and physical therapy (Schöllhorn et al., 2010). In comparison to conventional strength training, differential strength training is characterized by movement variations at lower external load. The application of the DL approach to strength training shows similar training effects as conventional training for the one repetition maximum (1RM) in back squats (Hegen et al., 2015). The aim of this study is to look for the effect of load and movement variations on the activity of selected leg muscles during the back squat exercise. **Methods** Seven healthy male subjects performed four sets of five back squats in each of three training conditions in a counterbalanced within-subject design. Differential back squat training based on movement variations at 60% 1RM (D60) and conventional back squat training on basis of movement repetitions at 60% 1RM (C60) and 85% 1RM (C85). Muscular activity of the dominant leg was measured using surface electromyography (Biovision, 4000 Hz) at gluteus maximus, vastus medialis, vastus lateralis, biceps femoris, gastrocnemius medialis, gastrocnemius lateralis and tibialis anterior. The raw signal was rectified, smoothed using a 150 ms window root mean square and normalized to the maximum. The mean activity and the coefficient of variation were determined. Differences between the training conditions were analyzed by means of repeated measures ANOVA. **Results** All muscles show significant differences with large effect sizes between the training conditions in mean activity ( $p \leq .020$ ;  $\eta^2 \geq .479$ ) and coefficient of variation ( $p = .000$ ;  $\eta^2 \geq .862$ ). Increased variation in muscular activity was obtained during back squats in D60 compared to C60 and C85. C85 is characterized by increased mean activity during back squats compared to C60 and D60. **Discussion** The results emphasize that the movement variations in back squat training lead to lower mean, but more variable activity of the leg muscles. The results indicate different underlying neuromuscular processes and adaptations in differential and conventional strength training. Therefore, performance improvement in the back squat through differential training (Hegen et al., 2015) can be explained by a combination of movement variations, intensity and time under tension. In contrast, effects of conventional strength training can only be explained by intensity. **References** Schöllhorn WI, Beckmann H, Davids K (2010). *Medicina*, 46(6), 365-73. Hegen P, Polywka G, Schöllhorn WI (2015). *Book of Abstracts - 20th Annual Congress of the ECSS*, 590. Contact horst@uni-mainz.de

## Oral presentations

### OP-PM61 Sports Medicine: Soccer

#### INJURY PATTERNS AMONG ELITE FOOTBALL PLAYERS: A MEDIA-BASED ANALYSIS OVER SIX SEASONS WITH EMPHASIS ON PLAYING POSITION

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The study objective was to describe types, localizations and severity of injuries among first division Bundesliga football players, and to study the effect of playing positions on injury incidence and severity based on information from public media. Information about exposure and injuries from 1673 players over 6.4 seasons were collected from a media-based register. The knee was the most frequent localization and had the longest recovery time ( $p < 0.001$ ). Recovery following ligament injuries was significantly longer than muscle injuries. Significant differences between the playing positions were found in injury incidence and injury burden (lay-off time per incidence-rate), with wing-defenders sustaining significantly lower incidence-rates of groin injuries compared to forwards (rate ratio: 0.46, 95% CI: 0.21-0.99). Wing-midfielders had the highest incidence-rate and injury burden from match injuries while centre-defenders sustained the highest incidence-rate and injury burden from training injuries. There were also significant differences in match availability due to an injury across the playing positions, with midfielders sustaining the highest unavailability rates from a match and training injury. Injury-risk and patterns seem to vary substantially between different playing positions. Identifying positional differences in injury-risk may be of major importance to medical practitioners when considering preventive measures.

#### EXAMINING THE ASSOCIATION BETWEEN LOWER-LIMB MUSCLE COMPLAINTS AND MUSCLE FUNCTION IN SOCCER PLAYERS.

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**Purpose:** Lower-limb power, flexibility and hamstring strength are risk factors for time-loss injury; however, Fuller's 2006 consensus statement highlights injury as any physical complaint. This study therefore examined the hypothesis that muscle complaints will negatively correlate with lower limb flexibility, power and hamstring strength. **Methods:** 19 semi-professional soccer players (Male,  $24 \pm 3.1$  yrs,  $75.5 \pm 9.5$  Kg,  $178.7 \pm 6.0$  cm) were recruited. Lower-limb power was assessed during 3 counter-movement jumps (Kistler portable force platform, CH-8408 Winterthur, Switzerland). Flexibility assessments of the hamstrings, quadriceps, calves and groin were performed using goniometry. Hamstring strength was assessed via maximum isometric (prone,  $30^\circ$  knee flexion) and isokinetic (prone,  $0$ - $135^\circ$  concentric/eccentric knee flexion  $60^\circ/\text{S}$ ) dominant limb contractions. Muscle complaints were recorded weekly (frequency), allocated a

numerical value from 0-3 (based on reduction of participation) and summed to calculate a severity score (Clarsen et al., 2013). Pearson's correlations ( $r^2$ ) were performed with significance set at  $p \leq 0.05$ . Results: 174 muscle complaints with a severity score of 190 were recorded. Hamstring complaints (47) were negatively associated with quadriceps flexibility ( $r^2=0.34$ ;  $p=0.0086$ ). Groin complaints (15;  $r^2=0.43$ ;  $p=0.0023$ ) and their severity (25;  $r^2=0.32$ ;  $p=0.0114$ ) were negatively correlated with adductor flexibility. No other relationships were observed. Discussion/conclusion: Flexibility measures were most associated to the frequency and severity of muscle complaints. The direct association between groin complaints and poor adductor flexibility is consistent with existing time-loss-groin injury reports (Ekstrand & Gillquist, 1982). Poor quadriceps flexibility has been shown to increase torque on the hamstring muscles during the late swing phase of sprinting, increasing hamstring injury risk (Gabbie et al., 2005). The effect of which could explain the indirect association we observed between hamstring complaints and poor quadriceps flexibility. In contrast to previous work, hamstring muscle strength assessments were not correlated with hamstring complaints. In summary, the results support a groin flexibility screening process to detect and prevent adductor injury. References: Clarsen B, Myklebust G, Bahr R (2013). *Br J Sports Med*, 47(8), 495-502 Ekstrand J, Gillquist J (1982). *Am J Sports Med*, 10(2), 75-78 Fuller CW, Ekstrand J, Junge A, Andersen TE, Bahr R, Dvorak J, Häggglund M, McCrory P, Meeuwisse WH (2006). *Br J Sports Med*, 40(3), 193-201 Gabbie BJ, Finch CF, Bennell KL, Wajswelner, H. (2005). *Sports Med*, 39, 106-110

## **SKELTAL MATURATION ASSOCIATED WITH LOWER LIMB MUSCLES FLEXIBILITY IN HIGHLY TRAINED YOUNG SOCCER PLAYERS**

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Introduction Flexibility has been shown to be a key factor for performing football-specific tasks (Garcia-Pinillos et al., 2015) in youth soccer. Yet, the understanding of changes in lower limb muscle flexibility during maturation, remain limited. This study examined the relationship between skeletal age and the flexibility of the lower limb muscle groups in young elite Qatari soccer players. It was hypothesized that skeletal maturity status influences the flexibility of the lower limb muscles. Methods 188 youth soccer players (Mean: age:  $14.4 \pm 1.5$  years; weight:  $50.7 \pm 10.9$  kg; height:  $162.5 \pm 10.7$  cm) were measured in pre-season screening over six consecutive years in six different age groups (U13 to U18). Flexibility of eight muscle groups (quadriceps, hamstrings, adductors, hip flexors, gastrocnemius, soleus, hip medial-, and hip lateral- rotators) were bilaterally and consistently measured using a reliable method (Fourchet et al., 2012). Skeletal age (SA) was estimated by an experienced observer using the Fels method. Linear mixed model analysis was used to compare the flexibility with maturity status (SA minus chronological age: Late (L):  $> -1$  year; Normal (N):  $\pm 1$  year; Early (E):  $< 1$  year) within each age group. Results Data from 852 limbs for each muscle group were available for analysis. Flexibility of all lower limb muscle groups decreased significantly with age. Substantial variations within identical age categories but different maturity status were reported, e.g. Quadriceps (U16:  $E: 128.2 \pm 0.9^\circ > N: 132.7 \pm 1.3^\circ > L: 141.7 \pm 4.5^\circ$ ,  $p < 0.05$ ); Gastrocnemius (U16:  $E: 11.4 \pm 0.7^\circ > N: 14.7 \pm 0.9^\circ$ ,  $p < 0.05$ ); Soleus (U16:  $E: 28.5 \pm 0.8^\circ > N: 33.7 \pm 1.1^\circ > L: 39.5 \pm 3.9^\circ$ ,  $p < 0.05$ ); Medial rotator (U16:  $E: 49.2 \pm 1.6^\circ > N: 54.9 \pm 1.6^\circ$ ,  $p < 0.05$ ); Hamstring (U14:  $E: 65.9 \pm 1.3^\circ > N: 67.8 \pm 1.3^\circ > L: 83.7 \pm 5.1^\circ$ ,  $p < 0.05$ ); Adductor (U15:  $E: 57.1 \pm 0.9^\circ > N: 60.1 \pm 0.8^\circ > L: 71.1 \pm 3.6^\circ$ ,  $p < 0.05$ ); Lateral rotator (U15:  $E: 36.4 \pm 1.2^\circ > N: 37.7 \pm 1.2^\circ > L: 49.7 \pm 4.9^\circ$ ,  $p < 0.05$ ). Hip flexors did not show any substantial difference between the maturity status in any age group. Conclusion This study revealed that lower limb muscle flexibility changes through skeletal maturation and appeared to be muscle group dependent. Such information will enhance the understanding of lower limb flexibility changes during maturation, and will help youth soccer academies to initiate appropriate developmental strategies. References Fourchet F, Materne O, Horobeanu C, Hudacek T, Buchheit M. (2012). *Physical Therapy in Sports*, 1-7. Garcia-Pinillos F, Ruiz-Ariza A, Moreno del Castillo R, Latorre-Roman P.A. (2015). *J Sports Sci* 33(12): 1293-1297. Contact Please include your email address at the very end of your abstract (olivier.materne@aspetar.com)

## **EVALUATION OF DEXTROSE PROLOTHERAPY INJECTIONS IN SOCCER PLAYERS WITH CHRONIC GROIN PAIN**

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Evaluation of Dextrose Prolotherapy Injections in Soccer Players with Chronic Groin Pain INTRODUCTION Groin pain is a very common problem in soccer. Among male soccer players, the incidence of groin pain is estimated at 10% to 18% per year (Holmich P et al). The most common causes of chronic groin pain in soccer players are adductor strain and osteitis pubis. One important disease to consider in the differential diagnosis of groin pain in athletes is osteitis pubis: a painful, inflammatory process involving the pubic symphysis and its surrounding structures such as the pubic rami, cartilage, musculotendinous and ligamentous structures of the pelvis (Batt ME et al 1995; Williams PR et al 2000). Our study is that chronic, overuse-related, and performance-limiting osteitis pubis in soccer players can be treated effectively using dextrose prolotherapy, despite failure of nonsurgical treatment for a minimum of 6 months. METHODS Most patients were referred by the orthopedic surgeon and team physician of the regional soccer team Turkey. Twenty patients were soccer players and 3 were regional endurance athletes. Dextrose prolotherapy injection sessions at occurred between three weeks (0-3-6 weeks). The solution used was a combination of 20% dextrose and 1% jetokain simplex. It was prepared by mixing 10mL of 1% preservative- and epinephrine-free jetokain simplex with 10mL of 20% dextrose solution in a 20mL syringe at pubic rim on either side of the symphysis pubis in 1-cm intervals, covering the pectineus origin and pyramidalis insertion, external oblique insertions, and the superior pelvic rim. RESULTS A pretreatment visual analog scale (VAS) for pain with exercise was administered, and each subject was asked to fill out the Nirschl Pain Phase Scale (NPPS) to determine his functional impairment level. Variables Pretreatment • Posttreatment • Mean Difference Before to After Treatment SEM Difference P†† VAS rating for sports pain  $6.7 \pm 1.4$   $1.2 \pm 2.0$   $-5.5$   $0.5$   $<.001$  NPPS score  $5.0 \pm 0.7$   $0.9 \pm 1.7$   $-4.1$   $0.5$   $<.001$  DISCUSSION Dextrose injection prolotherapy at 3-week intervals was highly clinically effective in the treatment of chronic groin pain in these soccer players. This pilot study suggests a new clinical frontier for physiatrists and other musculoskeletal physicians; however, larger controlled trials are needed to confirm our findings. REFERENCES Holmich, P., Uhrskou, P., Ulnits, L. et al. *Lancet*. 1999; 353: 439-443 Batt, M.E., McShane, J.M., and Dillingham, M.F. *Med Sci Sports Exerc*. 1995; 27: 629-633 Williams PR, Thomas DP, Downes EM. *Am J Sports Med*. 2000; 28: 350-355 Contact: dr.alieroglu@hotmail.com

## A GENETIC-BASED ALGORITHM FOR PERSONALIZED RESISTANCE TRAINING IN SOCCER PLAYERS

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**Introduction** Resistance training leads to increases in maximal running speed, acceleration, jumping abilities, force in kicking, tackles and headers and reduces the risk of injuries in soccer players. Association studies have identified dozens of genetic variants linked to training responses and sport-related traits. However, no intervention studies utilizing the idea of personalized training based on athlete's genetic profile have been carried out, especially in soccer. Here we propose an algorithm that allows achieving greater results in response to high- or low-intensity resistance training program by predicting an athlete potential for the development of power and endurance qualities with a panel of 15 performance-associated gene polymorphisms. These polymorphisms are located within the genes primarily involved in the regulation of muscle fibre type composition and muscle size, cytoskeletal function, muscle damage protection, metabolism, circulatory homeostasis, mitochondrial biogenesis, thermogenesis and angiogenesis. **Methods** Soccer players (n=39) completed an eight-week high- or low-intensity resistance training program, either matched or mismatched to their individual genotype. The high-intensity resistance training program consisted of ten sets of two reps over the eight-week study. The low-intensity resistance training program consisted of three sets of ten reps for first two weeks, three sets of fifteen reps for the next three weeks and three sets of twenty for the last three weeks. Two variables of explosive power and aerobic fitness, measured by the countermovement jump (CMJ) and aerobic 3-min cycle test (Aero3), were assessed pre and post 8 weeks of resistance training. DNA samples of athletes were genotyped for the ACE I/D, ACTN3 R577X, ADRB2 Gly16Arg and Gln27Glu, AGT M235T, BDKRB2 rs1799722 C/T, COL5A1 rs12722 C/T, CRP rs1205 A/G, GABPB1rs7181866 A/G, IL6 -174 C/G, PPARA rs4253778 G/C, PPARGC1A G482S, TRHR rs16892496 A/C, VDR rs1544410 A/G, VEGFA rs2010963 G/C gene polymorphisms by real-time PCR. The percentage power/endurance genotype score (P/E) ratio was determined for each athlete. **Results** Following the training intervention, players from the matched group (i.e. high-intensity trained with power genotype or low-intensity trained with endurance genotype) have demonstrated significantly greater ( $P < 0.0001$ ) performance changes in both tests compared to mismatched group (i.e. high-intensity trained with endurance genotype or low-intensity trained with power genotype). CMJ improved by 7.1% in the matched group, compared to 2.4% in the mismatched group. Improvements in Aero3 were 7.7% in the matched vs 1.9% in the mismatched group. **Conclusion** Our results indicate that matching the individual's genotype with the appropriate training modality leads to more effective resistance training. The developed algorithm may be used to guide individualized resistance-training interventions.

## SUGAR AND MICRONUTRIENT INTAKE WITHIN ELITE YOUTH BRITISH SOCCER PLAYERS: THE NUTRITIONAL TRANSITION FROM SCHOOLBOY TO FULLTIME SOCCER PLAYER

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**Introduction** It is recommended that soccer players consume a diet high in carbohydrate to augment performance. However, growing evidence suggests there is a link between high free-sugar intake (>5% total energy intake (TEI)) and some metabolic diseases (1). Additionally, recent data has found that soccer players are at risk of oral caries, which was linked to free-sugar intake (2). Little is currently known about the free-sugar intake within elite British youth soccer players and, consequently, their risk to adverse health conditions. We therefore tested the hypothesis that elite British youth soccer players consumed above the current UK DRV (5% TEI) for free-sugars. **Method** Players from an English Premier League academy under (U) 18 (n = 13); U15/16 (n = 25); U13/14 (n = 21) completed a 7-day food diary over a training period in which no competitive games took place. Upon analysis, using dietary analysis software (Nutritics Ltd, Ireland), these data were compared to the current UK DRV for free-sugar via a t-test. Intakes between squads was analysed using a one-way ANOVA. All data are expressed as means (SD), statistical significance  $p < 0.05$ . **Results** The U13/14s (TEI, 10.0 17.7%) and U15/16s (TEI, 11.2 30.0%) both consumed higher amounts of free-sugar in comparison to the UK DRV of TEI 5% ( $P < 0.01$ ), conversely, the U18s (TEI, 5.1 12.7%) were no different from the DRV. Furthermore, the free-sugar intake of the U18s was significantly lower than that of the U13/14s and U15/16s ( $P < 0.01$ ). **Discussion** Our data provides novel evidence on the free-sugar intake across a range of ages within an elite youth British soccer academy. It would appear that there is a shift in nutritional habits from when a player transitions to fulltime (U18s) from schoolboy (U13-U16s). However, it may be put forward that as the tested population are athletes they may have need for a higher carbohydrate intake in comparison to the UK DRV, which may lead to higher free-sugar intake than the general population. Further research is needed to establish if there is any health risk to this population as a result of an increased free-sugar intake (>5% TEI). **References** 1 Stanhope. (2015). Crit. Rev. Clin. Lab. Sci. 1-16. 2 Freeman. (2014). Evid. Based. Dent. 15(4):98-99.

## Oral presentations

### OP-PM70 Children & Adolescents

#### TRACKING OF TELEVISION VIEWING FROM YOUNG ADULthood TO MIDLIFE OVER 25 YEARS

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**Introduction** Despite the increase in television (TV) viewing tracking research on young people, no study has shown whether the specific sedentary behavior persists from young adulthood to middle age. The aim of the study was to examine the tracking of TV viewing from young to middle adulthood over 25 years. **Methods** A random sample of 3082 participants aged 9-24 years participated in the Young Finns Study in 1986. The follow-up measurements were repeated in 2001, 2007 and 2011. TV viewing during leisure time was measured with a single self-report question for 18-49 year olds. Tracking of TV viewing was analyzed using Spearman's rank order correlation and a simplex-model. Baseline status (level) and overall growth (slope) for TV viewing was also analyzed via latent growth model in the multi-level context. **Results** TV viewing at age 18 to 24 in 1986 significantly predicted TV viewing in young and midlife adulthood. There was a significant indirect effect of TV viewing in the younger cohorts from young to midlife adulthood in both genders. Simplex models that fitted the data very well produced higher stability coefficients than the Spearman rank order correlations showing moderate or high tracking. The levels of TV viewing appeared to be significantly affected by gender and age over time. **Discussion** This study has shown that the



daily amount of TV viewing is stable during adulthood and that the stability of TV viewing is predominantly moderate or high throughout adulthood. However, the stability varies in magnitude between men and women in different age groups. Future studies may need to investigate how this changes, if at all, with the changing nature of TV provision and access, and associated ubiquitous provision of screen-based media. Contact: xiaolin.yang@likes.fi

### **DETERMINANTS IN EARLY ADULTHOOD OF LEISURE-TIME PHYSICAL INACTIVITY STABILITY AND CHANGE IN MID-LIFE**

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**Background:** Physical inactivity has a high prevalence and associated disease burden. Knowledge is needed of influences that change or sustain inactive lifestyles. We aimed to establish whether factors in early adulthood predict subsequent inactivity patterns after accounting for influences from earlier life. **Methods:** Leisure time inactivity (frequency <1/wk) was assessed at 33y and 50y in the 1958 British Birth cohort (N=12,271). Early adult factors (23-33y) were grouped in physical and social domains. We assessed associations of factors within domains separately and combined with four 33-50y inactivity patterns (never inactive, persistently inactive, deteriorating or improving) using multinomial logistic regression and adjusting for factors from early life. **Results:** Approximately 31% of the population were inactive at 33y and 50y; 35% changed their inactivity status 33-to-50y with 17% deteriorating and 18% improving. In analyses of physical and social domains combined, factors associated with inactivity persistence vs never inactive were physical limiting illness (21% higher risk/duration exposed), obesity (30% higher/duration exposed), perceived underweight (31% higher vs 'right weight'), height (7% lower/5cm), depression (32% higher/duration exposed); education (30% higher/reduction on 5-point scale) and neighbourhood, i.e. suburbs and service centres, rural areas and seaside resorts or growth areas (32%, 38% and 16% lower vs stable industrial areas respectively). Associations were broadly similar for inactivity deterioration. Factors associated with improvement were suburb and service centre neighbourhood (36% higher vs stable industrial areas) and number of children, although the association varied by age with a lower risk at 23y and higher risk at 33y of approximately 13%/child. Associations remained, albeit attenuated, after adjustment for early life factors. **Conclusions:** Both physical and social factors in early adulthood predicted inactivity persistence and deterioration, while only social factors predicted improvement. In particular, the neighbourhood in which individuals lived in young adulthood had long-lasting associations with inactivity patterns.

### **EATING BEHAVIOUR AND NUTRITIONAL KNOWLEDGE IN ELITE ADOLESCENTS PRACTISING SYNCHRONISED SWIMMING. A NUTRITIONAL INTERVENTION**

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**Introduction** Synchronized swimming combines speed, power and endurance with precise synchronized movements and high-risk acrobatic manoeuvres. Because of the aesthetic nature of the sport, which prioritizes leanness, the risks of energy and macronutrient deficiencies are a significant concern. Relative Energy Deficiency in Sport (RDA-s) and disordered eating/eating disorders are also of concern for these female athletes (Robertson et al., 2014). The aim of this study was to check whether a group of elite adolescent practising synchronised swimming had a proper diet matching the Italian nutritional advices, and to program a nutritional intervention for the athletes and their families and coaches. **Methods** 13 elite adolescents synchronized swimmers (age 15±1.0 years, BMI 21±2.4, fat mass 26.7 ±8.4%) participated in the study. They attended an interview about their life style and their training and a validated dietary questionnaire on food habits, eating behaviour and nutritional knowledge of adolescents (Turconi et al., 2003). Then data were compared with the nutritional advices from the Italian Government and some nutritional interventions were made to help the athletes to reach a better nutritional status. For each subject fat mass was detected by means of plicometry method (Slaughter et al., 1988). **Results** The processing of the questionnaire evidenced a lack in the consumption of carbohydrates, fruits and vegetables. Moreover, 17% of the athletes had the habit of totally skipping breakfast and all of them reported inadequate daily distribution of meals. Finally, questionnaire highlighted serious problems with the lunch management because their daily training in the swimming pool was too close to lunchtime. **Discussion** Disordered eating behaviour and eating disorders are of great concern because of their associations with physical and mental health risks and, in the case of athletes, impaired performance. To prevent RDA-s, aquatic athletes have to practice healthy eating behaviour, and coaches and athletes' health care teams must be conscious that early interventions are needed to prevent this kind of problems especially in adolescents athletes (Melin et al., 2014). **References** Robertson S, Benardot D, Mountjoy M. (2014) *JSNEM*, 24, 404 -413 Turconi G, Celsa M, Rezzani C, Biino G., Sartirana M A, Roggi C. (2003). *Eur J Clin Nutr*. 57, 753-763. Slaughter, M H, Lohman, T G, Boileau, R A, Horswill, C A, Stillman, R J, Loan, M. D. Van;Bemben, D A. (1988). *Human Biology*; Oct 1. Melin A, Klungland Torstveit M, Burke L, Marks S, Jorunn Sundgot-Borgen. (2014) *JSNEM* 24, 450 -459.

### **OBJECTIVELY-MEASURED SLEEP PATTERNS DURING SCHOOL AND NON-SCHOOL DAYS IN ICELANDIC ADOLESCENTS**

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**Introduction** Sleep plays an important role in adolescents' health. Short sleep and poor sleep quality are associated with obesity, low physical fitness and academic performances in adolescents. Actigraphy has been used as an objective method for assessing patterns and estimating general qualities of sleep in free-living conditions. In this study, sleep and activity was continuously monitored for one week using actigraphy in a group of primary-school adolescents. **Methods** A cross-sectional cohort of 301 tenth-grade students from six elementary schools in Reykjavik, Iceland was studied in the spring of 2015. Free-living sleep and physical activity were measured with wrist-worn raw signal accelerometers (ActiSleep by Actigraph). Total sleep time (TST), sleep efficiency (SLE), number of awakes (NOA), sleep fragmentation index (SFI), waking after sleep onset (WASO), bed time (BT), midpoint of sleep (MS) and rise time (RT) were computed for school days (SchD) and non-school days (NSchD). Averages of daily sleep parameters ( $\geq 3$  SchD and  $\geq 1$  NSchD was considered valid) were compared using paired and group t-tests as appropriate. **Results** 93.4% of the students (114 boys and 167 girls) had valid sleep data. Only 23.4% of the girls and 20.2% of the boys met the sleep recommendation of 8 hours per night (time in bed) on average for the week, and even less on SchD. On SchD, mean TST per night was 6.2±0.7 hours, with SLE of 87.9±4.4%, and no differences between the sexes. On NSchD, TST significantly increased to 7.3±1.1 hours ( $p < 0.001$ ) for the whole group resulting from significant delays in BT and RT on NSchD compared to SchD (1.3 and 2.7 hours respectively,  $p < 0.001$ ). Boys had later BT than girls on NSchD (about 27 min,

$p=0.003$ ) but not on SchD and their RT was also later than girls on NSchD (35 min,  $p<0.001$ ) and on SchD (10 min,  $p<0.001$ ). Despite of longer TST on NSchD, actigraphy markers (SLE, WASO, NOA and SFI) indicated significantly lower sleep quality on NSchD than SchD ( $p's<0.005$ ). Discussion Our data indicates that the majority of Icelandic adolescents do not get the recommended amount of sleep on school days and may need to "recover" by sleeping longer on the non-school days. The pattern of going to bed late (especially for boys) is the major contributor. The effect of insufficient sleep on adolescents' health and well-being may be serious. However, sleep in adolescent is modifiable, which hopefully raise the attention for parents, educators, society, and policy makers. Support Icelandic Centre for Research, National Institute of Diabetes and Digestive and Kidney Diseases. Contact vakar@hi.is

### HIGH LEVELS OF PHYSICAL ACTIVITY DOES NOT IMPAIR SLEEP QUALITY IN ADOLESCENTS: DADOS STUDY

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**INTRODUCTION:** Adequate sleep is an essential health aspect during youth for optimal physical, psychosocial and cognitive development (Shochat T et al., 2014). Physical activity (PA) has been highlighted as a useful tool to improve sleep disturbances in adolescents, but results are not conclusive (Lang C et al., 2016). The aim of our study was to analyze the association between objectively measured PA and sleep quality in adolescents. **METHODS:** A total of 205 adolescents aged 13y.o. from the DADOS study (86 girls, 119 boys) were included in the analysis. PA was assessed by a wrist-worn GENEActive accelerometer (Activinsights Ltd, Kimbolton, UK) and expressed as min/day of sedentary, light, moderate, vigorous and moderate and vigorous PA (MVPA) (Schaefer CA et al., 2014). PA values were dichotomized into  $<60$  min/day and  $\geq 60$  of MVPA. Sleep quality was evaluated with the Spanish version of Pittsburgh Sleep Quality Index (PSQI) (Royuela & Macías 1997). PSQI values were dichotomized into  $>5$  (poor quality) or  $\leq 5$  (good quality). **RESULTS:** None of the PA variables were associated with sleep quality. Achieving PA recommendations of at least 60 min/day of MVPA was not associated with presenting poor (PSQI  $>5$ ) or good (PSQI  $\leq 5$ ) sleep quality. **DISCUSSION:** Our results support those reported by Lang C et al. (2013) showing that, in adolescents, objectively measured PA is not associated with sleep quality. **CONCLUSION:** High levels of PA do not impair sleep quality in adolescents. Further studies are required to clarify the relationship between PA and sleep patterns in adolescents. **REFERENCES:** 1.Lang C, Kalak N, Brand S, et al. Sleep Med Rev. 2016;28:28-41. 2.Lang C, Brand S, Feldmeth AK, et al. Physiol Behav. 2013;120:46-53. 3.Royuela A & Macías JA. Vigilia-Sueño. 1997; 9 (s2): 81-4. 4.Schaefer CA, Nigg CR, Hill JO, et al. Med Sci Sports Exerc. 2014;46(4):826-33. 5.Shochat T, Cohen-Zion M, Tzischinsky O. Sleep Med Rev. 2014;18(1):75-87. **CONTACT:** vallsm@uji.es

### EPIDEMIOLOGY OF INJURIES IN CHILDREN PARTICIPATING IN NATIONAL LEVEL KARATE COMPETITION

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**Introduction** Although several prospective studies have investigated the injury problem in elite karate competition for seniors to date, there is very limited data regarding younger karate athletes (e.g. cadets and juniors). Children and adolescents are increasingly taking part in organized training and competition in combat sports, which are promoted as safe and healthy activities. The purposes of this study, therefore, were to determine the injury incidence, describe the injury pattern, and identify potential risk factors for injury in modern children competitive in national level karate competition. **Methods** Prospective injury surveillance were undertaken at two consecutive national karate competitions in Slovakia (Slovak Cup, April 2015 and Slovak Championships, May 2015). Data were collected in situ using checklists following the same protocols used in previous investigations at the World Karate Championships (Arriaza et al., 2016). Collected injury data included body region, type of injury, mechanism of injury, severity, and treatment. Injuries were classified according to the Orchard Sports Injury Classification System version 10. The injury incidence rate (IIR) was calculated both per 1000 exposures and per 1000 exposure-minutes using standard methods. Rate ratios (RR) were calculated with 95% confidence intervals (95% CI) to identify potential risk factors. **Results** The sample consisted of 472 karate athletes (344 boys and 128 girls) with an age range of 6–11 years. The athletes competed in a total of 216 bouts, and sustained a total of 33 injuries, none of which resulted in time-loss from play. The overall IIR was 95.93 (95% CI: 66.03–134.72) per 1000 exposures and 77.37 (95% CI: 53.26–108.66) per 1000 exposure-minutes. The most commonly injured anatomical regions were the head (60%) and trunk (20%), while the most common types of injury were contusion (88%) and epistaxis (6%). **Discussion** The present study reveals that the IIR for young karate athletes competing at national level in Slovakia is similar to that of young athletes competing in the Open Dutch Karate Championship (Pieter, 2010) but greater than that of elite athletes competing at the World Karate Championships (Arriaza et al., 2016). Further efforts are required to prevent and control injuries in karate. **References** Arriaza R, Inman D, Arriaza A, Saavedra MA. Low risk of injuries in young adolescents participating in top-level karate competition. Am J Sports Med 2016;44:305-8. Pieter W. Competition injury rates in young karate athletes. Sci Sports 2010; 25:32-8.

## Oral presentations

### OP-PM74 Mental Disabilities: Paralympics

#### LEVELS OF ADIPOSITY AND OTHER ANTHROPOMETRIC PARAMETERS IN SOCCER PLAYERS WITH INTELLECTUAL DISABILITY PARTICIPANTS IN ADAPTED SPORT COMPETITIONS.

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**Introduction** Obesity and/or overweight in adolescents and adults with intellectual disabilities (such as Down syndrome) are well described in the literature (González-Agüero et al., 2011). There are few data on body composition in athletes with intellectual disabilities participating in competitive sports (Pitetti et al., 2013). The aim of this work was to determine the anthropometric characteristics and body composition of a group of soccer players with intellectual disabilities, with special reference to the levels of adiposity. **Methods** The study sample consisted of 38 adolescents and young adults with mental disabilities enrolled in competitive sport (soccer): 24 suffered consequences of infantile cerebral palsy (CP) and 14 had Down syndrome (DS). The average age was  $25.4 \pm 8.6$ . Anthropometric measurements

including skinfold thickness (biceps, triceps, subscapular, abdominal, suprailiac, thigh and leg) were performed following the ISAK recommendations. The percentage of body fat (%BF) was calculated from measurements of skinfold equations as proposed by Faulkner, Reilly et al., and Yuhasz. The somatotype was assessed by the technique of Carter and Heath. Differences were established by groups of etiology of disability. Results As compared to subjects with CP, individuals with DS were smaller ( $158.3 \pm 7.7$  vs.  $168.5 \pm 9.4$  cm,  $p < 0.01$ ), and had an increased %BF (Yuhasz:  $18.7 \pm 7.8$  vs.  $13.5 \pm 5.0\%$ ,  $p < 0.01$ ) (Faulkner:  $20.9 \pm 7.8\%$  vs.  $16.8 \pm 6.2\%$ ,  $p < 0.01$ ). The skinfolds of the leg, thigh and abdomen were also significantly thicker in patients with DS than patients with CP. Muscle weight was higher in subjects with CP ( $55.2 \pm 10.2$  kg) than with DS ( $48.8 \pm 13.9$  kg), but without statistically significant differences. Regarding somatotype, there were only significant differences between the two groups in the endomorphic component, being higher in subjects with DS ( $6.24 \pm 2.46$  versus  $4.54 \pm 2.16$ ,  $p < 0.05$ ). Discussion This research shows for the first time evidence that adolescents and young adults with Down syndrome involved in competitive sport have higher levels of total and regional fat (trunk and lower extremities) than the disabled athletes with cerebral palsy. This high adiposity together with the lower levels of cardiovascular and strength capacities describes in this population (Guerra et al., 2003), can result in a high risk of adverse events when performing competitive sports. Particular attention could be considered in future research to the limits and implications for their health and possible intervention through sport. References González-Agüero A, Ara I, Moreno LA, Vicente-Rodríguez G, Casajús JA. (2011). Research in Developmental Disabilities, 32, 18685-1693. Guerra M, Pitetti K, Fernhall B. (2003). Adapted Phys Activity Quart, 20, 70–79. Pitetti K, Baynard T, Agiovlasitis S. (2013) J Sports and Health Sci, 2:47-57.

## THE EFFECT OF HYDROTHERAPY IN THE TREATMENT OF BEHAVIORAL ASPECT OF CHILDREN WITH AUTISM SPECTRUM DISORDERS

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Introduction Hydrotherapy is used as a treatment for children with disabilities and motor delays. The purpose of this study was to determine the effectiveness of a 4 week swimming program guided by Halliwick method on children with ASDs on behavior and aquatic skills. Methods 32 children with ASDs were included in this study, which are diagnosed by the Diagnostic and Statistical Manual of Mental Disorders (4th Edition, DSM-IV) of United States. They are mild-to-moderate degree classified by Children Autism Rating Scale (CARS). They were divided into experimental group and control group at randomly. Experimental group did four weeks swimming learning program guided by Halliwick conception, 5 days every week, 1.5 hours every day. The control group just did in routine life; Before and after the experiment, do the behavior evaluation by the Autism Behavior Checklist (ABC) and aquatic skills evaluation by the Humphries Assessment of Aquatic Readiness (HAAR). Results 1. There were significant differences of HAAR between the two groups after experiment in stage II (water entry), stage III (rotation) and stage V (water independence movement) ( $p < 0.05$ ). And no differences in other phases ( $p > 0.05$ ). 2. There were significant differences of ABC scores between the two groups after experiment in B (body), and S2 (self-care) area ( $p < 0.05$ ), there were no significance in S (feeling), R (skills) and L (language) areas ( $p > 0.05$ ). 3. After experiment, in the experimental group, there were significant differences of ABC scores in B (body) and S2 (self-care) ( $p < 0.05$ ) and no significant difference in S (feeling), R (skills) and L (language) ( $p > 0.05$ ). There was no significant difference of ABC scores in the control group Discussion Children with ASDs present with impairments in social interactions; communication; restricted, repetitive, and stereotyped patterns of behavior, interests, or activities; as well as motor delays. Hydrotherapy is used as a treatment for children with disabilities and motor delays. In this study, the results shown that adapted aquatic guided by Halliwick method can improve autistic children's body movement and self-care ability. Halliwick methods are based on sound hydrodynamic principles. Its aim is to help individuals with disabilities become independent swimmers. Based on the adaptation of scientific and hydrodynamic principles to the behavior of the human body in water, The Halliwick Method emphasizes the goal of individual independence. No buoyant aids are used during Halliwick activities. An individual learns natural, self-initiated motor control. Group activities, logical extensions of one on one progression, are emphasized, with groups made up of student/instructor pairs. All components are based on McMillan's original ten-point program. In conclusion, the Halliwick method is an ideal therapeutic intervention of behavioral aspect for individuals with ASDs.

## GAIT IN ADULTS WITH INTELLECTUAL DISABILITIES AND ITS ASSOCIATION WITH PHYSICAL FITNESS

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Aims: Gait is a highly relevant and complex aspect of motor functioning. Poorer gait is a predictor for future disability, cognitive impairments, institutionalization and mortality. Since gait can be considered a complex cognitive task, and motor and cognitive functioning are fundamentally interrelated, it is not surprising that gait disturbances and delayed motor development are often seen in people with intellectual disabilities (ID). In the general population, physical fitness is an important aspect for gait. However, it is not known if physical fitness is related to gait in people with ID, because the impaired motor development in itself may alter that relationship. In this study, gait characteristics of people with ID were investigated, along with the association between gait and physical fitness. Methods: A cross-sectional study was performed to assess spatial and temporal gait characteristics of 31 adults ( $42.77 \pm 16.70$  years) with mild to moderate ID without Down syndrome. Gait was assessed with the GAITrite, at comfortable and fast walking speed. With regard to physical fitness we measured body composition (height, weight, BMI, waist circumference), muscular endurance (chair stand test), grip strength (hand dynamometer), and balance (four stances). Differences between gait characteristics at comfortable and fast walking speed were analyzed, along with associations between gait characteristics and physical fitness results. Results: An overview of the gait characteristics of adults with ID at comfortable and fast walking speed is provided. Most gait characteristics were significantly different between walking at comfortable and fast speed, except for base of support, toe in/ toe out and the within-subjects standard deviations of the gait variables. The physical fitness tests were associated with some of the gait variables. Conclusion: This study provides an overview of the gait characteristics of adults with ID, which were comparable to those found in a large study in community-dwelling adults of the general population ( $n = 1500$ ) who were on average 20 years older, thereby representing an older gait pattern. The differences between walking at comfortable and fast speed do imply a physical reserve of adults with ID to alter their gait. The associations between physical fitness and gait provide directions for further research regarding possible interventions to improve gait of adults with ID. To understand the relationship between the gait characteristics of adults with ID and health outcomes, future studies should focus on the relationship between gait characteristics and negative health outcomes in this specific population, such as higher energy expenditure, falls, and future disability.

## CARDIOVASCULAR RISK FACTORS AMONG ATHLETES WITH INTELLECTUAL DISABILITY PARTICIPATING IN THE BAVARIAN SPECIAL OLYMPICS GAMES

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**Introduction** Obesity in early life seems to be a predictor of various secondary health conditions (Kelsey et al. 2014). For this reason the high prevalence of cardiovascular risk factors especially in young people with intellectual disability (ID) demands alertness (Wallén et al. 2009). The aim of this cross sectional study was to determine the prevalence of cardiovascular risk factors in people with ID participating in the Health Promotion Program during the Bavarian Special Olympics Summer Games 2013. **Methods** Out of 213 athletes (9-66 years) anthropometric data, blood pressure (SBP, DBP), % body fat and number of foot-tappings were gathered. Statements concerning health conscious behavior (smoking, physical activity, media consumption) were collected using interviews. Overweight and obesity, arterial hypertension, BMI, waist to hip (WHR) and waist to height (WHtR) ratios were defined using standard international criteria. **Results** More than every second athlete (56.3%) was either overweight or obese (average BMI: adults  $27.98 \pm 7.03$ , adolescents  $23.28 \pm 5.22$ ) with a significantly higher prevalence in adult than in young athletes ( $\chi^2(3)=9.193$ ;  $p=0.027$ ). Average WHtR exceeded critical values for adults ( $\sigma$   $0.542 \pm 0.083$ ,  $\varphi$   $0.574 \pm 0.110$ ) as well as for adolescents ( $\sigma$   $0.487 \pm 0.063$ ,  $\varphi$   $0.487 \pm 0.071$ ) indicating an increased health risk. One out of five athletes (22.2%) showed arterial hypertension. Significant correlations could be found between blood pressure and WHR (SBP:  $r(196)=0.271$ ,  $p<0.001$ ; DBP:  $r(196)=0.238$ ,  $p=0.001$ ) as well as WHtR (SBP:  $\rho(197)=0.218$ ,  $p=0.001$ ; DBP:  $\rho(197)=0.305$ ,  $p<0.001$ ). Number of foot-tappings ( $41.17 \pm 15.18$ ) was inversely correlated with WHtR ( $\rho(191)=-0.155$ ,  $p=0.016$ ) and % body fat ( $\rho(189)=-0.258$ ,  $p<0.001$ ). There was no association between mentioned physical activity and health risk factors (arterial hypertonia, overweight or obesity) or media consumption. **Conclusions** An increased number of foot-tappings was associated with favorable results of the analyzed cardiovascular risk factors, indicating the beneficial influence of physical fitness. However, the prevalence of overweight and obesity as well as arterial hypertension was already high in young athletes. It's alarming and underlines necessity for both, more screening programs for persons with ID like the Special Olympics Health Promotion Program as well as specific intervention programs to countersteer cardiovascular disease related health risks already at an early age. **References** Kelsey MM, Zaepfel A, Bjornstad P, Nadeau KJ. (2014). *Gerontology*, 60, 222-228. Wallén EF, Müllersdorf M, Christensson K, Malm G, Ekblom O, Marcus C. (2009). *Acta Paediatr*, 98(5), 853-859.

## WORK RATES IN A WHEELCHAIR BASKETBALL GAME

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**Introduction** Work rates in wheelchair basketball have received little attention in the scientific literature. Average speeds and mobility movement remain the most studied parameters (Spornier et al, 2009; de Witte et al, 2015). However, how these metrics change over the course of the game remain unknown. The purpose of this study is to characterize the distance travelled, average speed, and high intensity efforts produced over the course of a wheelchair basketball game. **Methods** Distance travelled (DIST) and average speed (V) for 12 players was determined over 4 games during a Paralympic qualifying event, using the Catapult ClearSky system. High intensity efforts (HIE) were counted when athletes reached speeds above 60% maximal speed. Video analysis was performed, using SportsCode to track the time of every possession (POSS), and when the game clock was running (CLOCK) or stopped (DEAD) for 4 quarters (Q1, Q2, Q3, Q4). Timeframes from Catapult and Clearsky were merged, and only information for athletes on the court at any one time were tracked. Values displayed are averages of the 5 players on court. One way ANOVA, t tests, and pearson correlations were used for statistical analysis. **Results** Over the 4 games, DIST, V, and HIE was 5582 (328) m, 1.11 (0.03) m/s, and 273 (19) respectively. DIST is correlated to POSS ( $r=0.8$ ,  $p<0.05$ ), with average DIST per POSS equal to 37 (1) m. V and HIE was 100% and 180% greater during CLOCK than DEAD ( $p<0.05$ ). V and HIE for each POSS was 1.41 (0.04) m/s and 2 (0.5) respectively. There was no difference from Q1 to Q4 for DIST, V, and HIE. The amount of time spent in CLOCK is 6% ( $p<0.05$ ) lower than time spent in DEAD. **Discussion** The total work rates of wheelchair basketball players is strongly correlated to the number of possessions during a game. Further, work rates are stable over each quarter, suggesting the team is able maintain consistent efforts over the course of a game. This may be a result of increased rest time, with most of the game duration occurring with the game clock stopped. **References** de Witte AM, Hoozemans MJ, Berger MA, van der Woude LH, Veeger DH. (2016). *J Sports Sci*. 34. 811-820. Spornier ML, Grindle GG, Kelleher A, Teodorski EE, Cooper R, Cooper RA. (2009). *Prosthet Orthot Int*. 33. 210-217.

## Oral presentations

### OP-SH24 Statistics, Computer Analysis & Simulation

#### DEMANDS OF COMPETITIONS OF ELITE WOMEN WORLD CUP CYCLING RACES

SIAS, M., LA TORRE, A., MENASPÄ, P.

*University of Milan*

**Introduction.** Competition data are important to identify unique characteristics associated with successful performances. Elite women road cycling is a fast growing sport, however there is a lack of recent research (last 10 years) focusing on performances at International level. The aim of this study was to compare the physiological demands of recent women's World Cup races (2012-15) finishing with top 10 (T10) and out of top 10 (N-T10) results. **Methods.** Seven female professional cyclists (mean $\pm$ SD; age:  $28.5\pm2.9$  years; body mass:  $55.7\pm3.9$  kg; height:  $165\pm4$  cm) participated to this study. The participants' bikes were fitted with SRM powermeters. Forty-nine road World Cups (WC) were analysed, with 25 top T10 and 24 N-T10 race results. Race files were analysed with the open-source software GoldenCheetah. Descriptive statistics were used to report race characteristics such as length, duration and elevation gain. Maximal Mean Power curves (Quod et al. 2010) and % of total time spent in different power to weight bins (Martin et al. 2001) were compared in T10 and N-T10 with unpaired t-tests. Effect sizes were calculated and presented to allow a better interpretation of the results. The values 0.2, 0.5 and 0.8 were considered respectively small, medium and large (Sullivan et al. 2012). Statistical significance was set at  $P<0.05$ . **Results.** World Cups' average distance was  $128\pm7$  km, with a duration of  $3h20min\pm16$  min and a total elevation gain of  $998\pm551$  m. The average power



recorded was similar with  $184 \pm 22$  and  $185 \pm 16$  W for T10 and N-T10, respectively. Maximal Mean Powers for durations between 10 and 600 s were significantly higher in T10 than in N-T10 ( $P < 0.05$ ), with a large effect size for durations between 20 and 300 s. There was no difference in the % of total time spent below  $0.75$  W/kg ( $21 \pm 4$  and  $19 \pm 4$  min for T10 and N-T10, respectively) ( $P = 0.23$ ). T-10 spent significantly more time above  $7.5$  W/kg when compared to N-T10 ( $6 \pm 2$  and  $4 \pm 2$  min, respectively) ( $P = 0.005$ ), with a medium effect size. Discussion. In WC races Maximal Mean Power between 20 and 300 s were the main performance discriminant differentiating T10 and N-T10. Maximal Mean Power data found in this study were comparable to the data reported by Ebert et al. (2005) in top 20 WC races. The average power output found in this study was 10% higher than the power recorded in a previous study on domestic Australian competitions (Abbiss et al. 2010). Cyclists achieving T10 results spent more time above  $7.5$  W/kg when compared to N-T10, which seems to be a key factor determining the demands of T10 WC competitions. The findings of the present investigation should be considered for training prescription and selection purposes. Contact marco.sias@studenti.unimi.it

## MODELLING PROFESSIONAL CYCLISTS' CAREERS WITH UCI POINTS

FILIPAS, L., GIORGI, H., LA TORRE, A., MENASPÀ, P.

*University of Milan*

**Introduction.** Retrospective analysis of road cycling race results can support long-term planning and be useful in the development of peak performances (Schumacher et al. 2006). To date, it is unclear when successful General Classification (GC) contenders achieve their first top 5 (T5) or top 10 (T10) result in the context of their cycling career. The main aim of this longitudinal analysis was to compare the careers of GC contenders before and after achieving a T5 versus T10 result using the Union Cycliste Internationale (UCI) point scoring system. **Methods.** Professional cyclists who achieved their first T10 GC result in a Grand Tour (Giro, Tour and Vuelta) between 2009 and 2014 were included in the analysis. This time frame was selected because it followed the introduction of the biological passport in 2008 and allowed for the inclusion of the UCI points scored during the year following each cyclist's first T10 performance. A period of 5 years, which included 3 years before and 1 year after the year of the first T5 or T10, was considered for the analysis. UCI points are available online and were collected at the end of 2015. Descriptive statistics were used to report demographic information, and t-tests were used to compare annual points aggregates, previous GT history and number of seasons as a pro cyclist in T5 and T10. Data were reported as mean  $\pm$  SD, and alpha was set to  $< 0.05$  a priori for differences. **Results.** Riders achieved their first GC result at  $28.5 \pm 5.2$  and  $27 \pm 3.8$  years of age for T5 and T10, respectively. T5 group consisted of 71% Europeans, 18% South Americans and 12% North Americans; T10 group consisted of 83% Europeans, 9% South Americans and 9% North Americans. Riders scored more points in the season of a T5 finish ( $192 \pm 73$ ) than a T10 ( $146 \pm 77$ ) ( $p < 0.05$ ). For both T5 and T10 the seasonal points were significantly lower in each previous seasons ( $p < 0.05$ ). There were no differences in the number of GT participations ( $5.2 \pm 3.9$  and  $3.5 \pm 3.0$  for T5 and T10, respectively), nor in the number of seasons as a pro cyclist ( $5.8 \pm 3.7$  and  $4.7 \pm 2.9$  for T5 and T10, respectively). **Discussion.** Most of the subjects were European, which is unsurprising given that all the races and most of the teams were European. The average age at which cyclists achieved their first T5/T10 result is similar to other endurance sports (Allen & Hopkins, 2015). Professional cyclists usually ride 3 Grand Tours before reaching a T10 finish. Interestingly, the seasonal progression to a top result was not gradual. After achieving the top result, riders maintained a stable level of performance and accumulated a similar number of UCI points during the following season. **References.** Allen SV, Hopkins WG (2015). Sports Med. Schumacher YO et al. (2006). J Sports Sci. Contact luca.filipas@studenti.unimi.it

## COMPUTER SIMULATION MODELLING OF THE INFLUENCE OF DRAFTING ON COLLECTIVE BEHAVIOUR IN AN ELITE 10KM COMPETITIVE RUNNING EVENT

RENFREE, A.1, TRENCHARD, H.2, PETERS, D.M.1,3

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**Introduction** Drafting in cycling has been shown to influence the collective behaviour of pelotons during competition (Trenchard, 2015). Whilst some evidence for collective behaviour in competitive running events exists (Hanley, 2015), it is not clear as to the extent to which this is determined by energetic savings conferred by drafting. **Methods** Using performance data from a men's elite championship 10k track running event, computer simulations were constructed using Netlogo 5.1 to test the effects of three different drafting quantities on collective behaviour: no drafting, drafting to 3m behind with up to ~8% energy savings (a realistic running draft); and drafting up to 3m behind with up to 38% energy savings (a realistic cycling draft). Three measures of collective behaviour were analysed in each condition; mean speed, mean group stretch (distance between first and last placed runner), and Runner Convergence Ratio (RCR) which represents the degree of drafting benefit obtained by the follower in a pair of coupled runners. **Results** Mean speed in the cycling draft condition ( $6.32 \pm 0.28$  m.s<sup>-1</sup>) was higher than in the other conditions, but no significant differences were found between no draft ( $5.51 \pm 0.13$  m.s<sup>-1</sup>) and runner draft conditions ( $5.57 \pm 0.18$  m.s<sup>-1</sup>). Likewise, RCR was lower in the cycling draft condition, but did not differ between the other two. Mean stretch did not differ between conditions. **Discussion** It is suggested that collective behaviours observed in running events may not be fully explained through energetic savings conferred by realistic drafting benefits. They may therefore result from other, possibly psychological, processes. **References** Hanley B. (2015). Journal of Sports Sciences, 33(11), 1189-1195. Trenchard H. (2015). Applied Mathematics and Computation, 270, 179-192. Contact a.renfree@worc.ac.uk

## COMPARISON OF THE STANDARD ERROR OF THE ESTIMATES WHEN ESTIMATING CRITICAL POWER IN LABORATORY AND FIELD CONDITIONS

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*1: University of Vienna (AUT); 2: University of Applied Sciences Wr. Neustadt (AUT); 3: University of Greenwich (UK)*

Previous studies (2,3) have documented that Critical Power (CP) can be estimated validly and reliably under laboratory and field conditions. Under laboratory conditions, studies commonly employ time to exhaustion (TTE) tests using constant workloads. Contrary, field conditions commonly use time trials (TT), reversing dependent and independent variables. Several studies (e.g. 1) have shown that TTE have a lower reliability than TT. A recent study (3) demonstrated a high level of random of variations despite non-significant differences between the two conditions. This variation might have been caused by applying two methods (TTE vs. TT). The standard error of the estimate (SEE) of a regression that is used to estimate CP is a measure of accuracy. Therefore, the aim of this study was to compare the SEE between TTE estimated CP and TT estimated CP. After an initial graded maximal exercise test, ten participants ( $\text{VO}_{2\text{max}} 63.2 \pm 5.5$  mL/min/kg;  $\text{Pmax } 382 \pm 38$  W) performed three maximum effort prediction trials under both conditions using a single-visit protocol. In the laboratory, work rates leading to TTE within 2-15 min were estimated to be at 70%Delta, 98%Pmax and 110%Pmax. Under field

conditions participants had to produce highest possible power outputs over 12, 6, and 2 min. CP was estimated using a non-linear regression power vs. time (HYP) and two linear regressions work vs. time (LIN) and power vs. 1/time (INV). SEE between the conditions were compared using Wilcoxon signed rank tests. Descriptive results are presented as median (min; max) and statistical significance was set at  $P < 0.05$ . SEE values under laboratory condition were 1.45% (0.01; 7.60), 2.50% (0.01; 16.14), and 3.94% (0.01; 10.96) for HYP, LIN, and INV, respectively. SEE values under field conditions were 2.29% (0.59; 9.93), 1.38% (0.99; 11.63), and 3.12% (1.11; 11.7) for HYP, LIN, and INV, respectively. No significant differences were found for HYP, LIN and INV between the conditions ( $Z = -0.178$ ;  $P = 0.859$ ;  $Z = -0.059$ ;  $P = 0.953$ ; and  $Z = -0.533$ ;  $P = 0.594$ ). The results of this investigation show that the SEE is not influenced by the method chosen to estimate CP. Although the literature states that TTE are less reliable than TT, we conclude that estimating CP in a cohort of trained cyclists does not produce significantly different values of SEE. 1. Costa VP, Matos DG, Pertence LC, Martins JAN, & Lima JRP (2011). Cesar, M. C., 14(1), 28-34 2. Karsten B, Jobson SA, Hopker J, Jimenez A, & Beedie C. (2014). International Journal of Sports Medicine, 35(4), 298-303. 3. Triska C, Tschan H, Tazreiter G, & Nimmerichter A. (2015). International Journal of Sports Medicine, 36(13), 1063-1068. christoph.triska@univie.ac.at

## INDIVIDUALIZED REFERENCE RANGES FOR THE ASSESSMENT OF FATIGUE AND RECOVERY IN COMPETITIVE ATHLETES

HECKSTEDEN, A., PITSCH, W., MEYER, T.

Saarland University

Introduction Assessment of fatigue and recovery is essential for the daily fine-tuning of training load in competitive sports. However, large interindividual variability severely impedes on the diagnostic accuracy of fatigue indicators [1]. Individualization of reference ranges and joint consideration of selected parameters seem pertinent solutions to this dilemma. Therefore, we developed and evaluated an individualization algorithm based on a similar Bayesian rationale as the Athlete Biological Passport [2]. Beyond individualizing reference ranges for separate parameters, this procedure may also be generalized to the multivariate case. Method Urea and creatine kinase (CK) were selected as exemplary fatigue indicators [1]. Prior distributions and repeated measures standard deviations were characterized based on data of 883 squad athletes from different sports. Equations for the individualization procedure were adapted from previously published material [3,4] to allow for discrimination of 2 physiological states and ensure gradual approximation of intraindividual variability. Evaluation was carried out using data from 5 consecutive fatigue-recovery cycles in 14 elite junior swimmers and triathletes. Group-based reference ranges were derived from that same dataset to ensure a best possible group-based reference for comparison. Results Sensitivity was significantly higher with individualized reference ranges for CK ( $p = 0.013$ ) while a tendency towards significance could be demonstrated for urea ( $p = 0.068$ ). Numerical improvements in specificity failed to reach statistical significance in both cases. The success of individualization differed widely between athletes depending on the mean difference between fatigue states and intraindividual variability ('individual effect size'). Visualization of measured values together with the development of reference ranges over successive measurements offers an intuitive plausibility control for the individualization procedure and ensuing classifications. Discussion Assessment of fatigue and recovery based on individualized reference ranges for CK and urea offers higher diagnostic accuracy as compared to even a sample specific group-based approach. Additional benefit from multivariate applications and transferability to other parameters remains to be established. References 1. Hecksteden A, Skorski S, Schwindling S, Hammes D, Pfeiffer M, et al. (2016) Blood-borne Markers of Fatigue in Competitive Athletes - Results from Simulated Training Camps. PLoS One in press. 2. Sottas PE, Vernec A (2012) Current implementation and future of the Athlete Biological Passport. Bioanalysis 4: 1645-1652. 3. Aitken C.G. (2004) Statistics and the Evaluation of Evidence for Forensic Scientists: John Wiley & Sons. 4. Sottas PE, Baume N, Saudan C, Schweizer C, Kamber M, et al. (2007) Bayesian detection of abnormal values in longitudinal biomarkers with an application to T/E ratio. Biostatistics 8: 285-296. Contact a.hecksteden@mx.uni-saarland.de

11:30 - 12:45

## Plenary sessions

### PS-PL04 Crossing cultures and nations – interculturality and transnational mobility as challenges for sport and sport science

#### INTERCULTURALITY IN SPORTS AS SOCIAL CHALLENGE – AN OVERVIEW OF THEORETICAL FOUNDATIONS AND EMPIRICAL RESULTS

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TU Dortmund University

As sports is considered as one of the key motors of integration, sports organizations work since long time on concepts of integration of migrants into the existing sports system. Integration results in culturally heterogeneous groups that can be characterized by social hierarchies and social conflicts. To handle these social processes, an emancipatory, pedagogical approach is needed to create relationships between "the others" and "the us". Since long time, the concept of "Interculturality" is discussed as a possible approach to handle cultural diversity in social groups. The plenary session will give an overview of the theoretical foundations of this pedagogical concept, and will discuss its meaning for integration and intercultural processes in sports. The theoretical differentiation will show that "Interculturality" means more than just "integration in sports", as it reclaims equal participation and not only formal attendance. Thus, it may provoke conflicts and changes in the institutional context. To enrich the theoretical discussion, selected empirical studies of the research program "Interculturality in sports" (Gieß-Stüber & Grimminger) will be presented.

13:00 - 14:00

## Conventional Print Poster

## PO-CPP-04 Coaching &amp; Adapted Physical Activity

**THE RELATIONSHIP BETWEEN SPRINT PERFORMANCE AND VERTICAL AND HORIZONTAL PERFORMANCE TASKS IN FEMALE FIELD SPORT ATHLETES**

MONAHAN, M., PETRAKOS, G., EGAN, B.

*University College Dublin*

**Introduction** Sprint acceleration is a key determining factor of physical performance in field sports. This study primarily aimed to assess the relationship between 0-10 m (S10) and 0-20 m (S20) sprint acceleration and a range of vertical and horizontal performance tests. Secondly, the study aimed to assess if the strength of relationship between sprint acceleration and performance tests changed when just the fastest 10 participants were analysed. **Methods** Data was collected from female field sport athletes ( $n = 21$ ). Vertical performance tests included a countermovement jump (CMJ), CMJ loaded with 50% of body mass (CMJ50), drop jump reactive strength index (DJ RSI) and an isometric mid-thigh clean pull (IMTCP). Horizontal performance tests included a horizontal jump (HJ) and a 5-repeated alternate leg bound (5RB). **Results** When the full cohort were analysed, S10 held a 'very large' relationship with HJ ( $r = -0.73$ ) and 5RB ( $r = -0.70$ ), a 'large' relationship with CMJ variables ( $r = -0.61$  to  $-0.64$ ) and a 'moderate' to 'large' relationship with CMJ50 variables ( $r = -0.48$  to  $-0.62$ ). When the fastest 10 participants were analysed, the strength of the relationship for both horizontal performance tasks increased (HJ,  $r = 0.83$  and 5RB,  $r = 0.75$ ), whereas no correlations between vertical performance tasks and S10 reached significance ( $p > 0.05$ ). When the full cohort were analysed, S20 held a 'very large' relationship with HJ ( $r = -0.79$ ), 5RB ( $r = -0.75$ ) and CMJ variables ( $r = -0.71$  to  $-0.75$ ), a 'moderate' to 'large' relationship with CMJ50 variables ( $r = -0.44$  to  $-0.63$ ) and a moderate relationship with RSI ( $r = -0.48$ ). When the fastest 10 participants were analysed, the strength of the relationship increased between S20 and 5RB ( $r = -0.87$ ) and IMTCP rate of force development variables ( $r = -0.63$  to  $-0.64$ ). Furthermore, following assessment of just the 10 fastest players, HJ maintained a 'very large' relationship with S20 ( $r = -0.73$ ) but no significant relationships were evident between S20 and CMJ, CMJ50 or DJ variables ( $p > 0.05$ ). **Discussion** Horizontal jumping tasks are more predictive of sprint acceleration performance when compared to vertical jump and isometric force tasks. Furthermore, horizontal tasks are more predictive of sprint acceleration ability when just the fastest individuals are accounted for. Future research should investigate sprint acceleration and its longitudinal relationship with horizontal and vertical performance following training.

**COUNSELLING OF COACHES ENHANCED BY SPORTS SCIENCE**

WEBER, J., WEGNER, M., CHITTIBABU, B., FATULESCU, S.

*CAU of Kiel*

**Introduction** In sports games there is a frequent discussion how to transfer scientific findings into practice (Pfützner & Sell, 2007). Lemyre et al. (2007) state that formal programs are one way to develop coaching expertise while Cushion et al. (2003) name experience as a main source of coaches' knowledge. The aim of the study was to assess factors that enhance the coaches' expertise, research the coaches' rating of the playing-positions and additionally provide advice regarding position-specific performance of female elite handball players. **Methods** 52 coaches of female German have been questioned regarding their preference in developing handball-relevant performance factors (physical, technical, tactical, psychological) for position-specific performance and their coaching-biography while the corresponding players were tested in a complex test-battery concerning these factors. **Results** Coaches were only partially able to rate the position-specific demands for the tested factors. Coaches who formerly played as goalkeepers were able to rate the handball-specific demands for that particular position. In general, factors that enhance coaching expertise are positions formerly played, years spent playing and coaching, highest league played or coached and expertise as a former player. **Discussion** Coaching experience concerning position-specific demands can enhance practice and solve problematic decisions in everyday-training, e.g. to put inexperienced players on the wing player-position, to select halfbacks because of high body-height (Matthys, 2012) and selecting players for the goal because they lack physical fitness (Kajtna et al., 2011). A better knowledge of the position-specific demands based on scientific research and performance data are crucial to establish a recipient adjusted model to enhance practice and performance in handball teams. **References** Cushion, C., Armour, K. M., Jones, R. L. (2003). Education and Continuing Professional Development: Experience and Learning to Coach. *Quest*, 55 (3), 215-230. Kajtna, T., Pori, M., Justin, I. & Pori, P. (2011). Psychological characteristics of Slovene handball goalkeepers. EHF Scientific Conference 2011. Haugsdorf: Hofer (p. 73-77). Lames, M. (2002). Evaluationsforschung für die Sportspiele. Presentation at the 3rd dvs-Sportspiel-Symposium 2002 in Bremen. Lemyre, F., Trudel, P., Durand-Bush, N. (2007). How youth-sport coaches learn to coach. *Sport psychologist*, 21 (2), 191. Matthys, S. (2012). Talent identification, development and selection in youth handball players: contribution of cross-sectional and longitudinal measures of anthropometry, physical performance and maturation. Dissertation, University of Ghent. Pfützner, A., Sell, G. (2007). Prozessbegleitende Trainings- und Wettkampfforschung - eine Standortbestimmung. *Leistungssport*, 37 (2), 9-13.

**DIFFUSION OF THE LONG-TERM ATHLETE DEVELOPMENT MODEL IN CANADIAN COACHES**

TRUDEAU, F.1, LAURENCELLE, L.1, BEAUDOIN, C.2, LAJOIE, C.1

*1Université du Québec à Trois-Rivières; 2Université d'Ottawa*

**Introduction** In 2005, Balyi and co-authors' Long term development of the athletes (LTAD) was integrated in the Canadian Sport Policy. Since then, more than 70 Canadian sport federations adapted LTAD to the reality of their sport and their athletes. The aim of this study was to document the process of adoption and implementation of LTAD by Canadian coaches. **Methods** We conducted an online questionnaire survey with Canadian coaches ( $n = 574$ ; aged  $35.2 \pm 10.6$  years) to understand the process of adoption and implementation of LTAD, we develop the questionnaire using the theory of diffusion of innovation (Rogers, 2003). Factors likely to influenced adoption and implementation of LTAD were studied (e.g. perception of knowledge, anticipation of benefits, complexity, organizational constraints, etc.).

Results Differences appeared when the sample was divided according to different sports with a sufficient number of coaches for further analyses. Cross-country skiing coaches had the perception of knowledge of the higher LTAD (fair to good 61.1%), while among figure skating and gymnastics coaches this percentage was 18.4% and 10%. Beliefs in the efficacy of LTAD or anticipation of benefits were high among coaches in all sports studied. In soccer, figure skating, ice hockey, cross-country skiing and gymnastics coaches such fairly high to high expectations from LTAD are respectively 90.9%, 68.9%, 88.9%, 86.9% and 71.5%. A fairly-good to good perceived capacity to apply the principles of LTAD was highest among cross-country skiing 69.5%, and respectively 56.2% and 50% in soccer and ice hockey. However, only 30% and 26.6% of the gymnastics and figure skating coaches felt the same degree of capacity to apply the LTAD principles. Again, cross-country skiing coaches were only 4.3% to see LTAD implementation as rather complex or complex compared to more than 20% in all other coaches studied. No differences were observed between sports for organizational constraints. Discussion The majority of coaches in studied disciplines believed in the benefits and efficacy of LTAD to improve the performance of their athletes. However, the perception of knowledge and ability to apply the principles of LTAD show differences between the disciplines. These differences could be due: 1) to the type of disciplines i.e. late vs. early development, 2) the compatibility of LTAD with knowledge and performance requirements in each sport, and 3) the timing of our survey with the sports federation has developed and published its own LTAD. References Balyi, I., et al. (2005). Long-term athlete development-Canadian Sport for life. Canadian Sport Centres. Rogers, E. M. (2003). Diffusion of Innovations. Simon and Schuster.

### **EFFECT OF A STATIONARY ARMCRANK PEDALING TRAINING PROGRAM ON THE LEVEL OF AUTONOMY , ANAEROBIC PERFORMANCE, SPIROMETRIC FUNCTION AND HEART RATE VARIABILITY IN PERSONS WITH TETRAPLEGIA**

SINZ, S., BRIZUELA, G., ARANDA-MALAVÉS, R., MARTÍNEZ-NAVARRO, I.

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Introduction It is accepted worldwide that physical exercise is good for everybody. But is it also good for persons with a high tetraplegia or would it harm them? And which sport would be good for them? Will it bring betterment to their physiological parameters or will it be detrimental to their health? Therefore, the aim of this study was to test handcycling as a suitable endurance sport and then analyze in a training program the parameters of spirometric function, heart rate variability and evaluate if there is any change to the level of autonomy. Methods The training consisted of a progressive arm crank pedaling (ACE) regimen twice weekly for 8 weeks with constant cadence and resistance of the participant's choice. We choose 11 participants (8 men, 3 women, 36,5 ± 10 years of age and BM 72,3±13,4kg) with traumatic origin tetraplegia (5 with SCI between C4-C5 and 6 between C6-C7, Asia levels A and B) who had functional biceps and deltoid muscles but no triceps function and no hand grip ability. They could bend their elbows but not extend them against gravity or opposition. One week before and one week after the training program a QIF questionnaire (Field-Fote, 2009) was filled in, to measure the level of personal autonomy. A stationary Arm Crank Ergometer (Monarch) provided measurements of heart rate, spirometric variables and maximum arm pedaling power output (PPower). Results The results showed that participants with lower level SCI (C6-C7) presented higher QIF, PPOWER and pulmonary parameters than those with higher level (C4-C5) ( $p < 0.05$ ). It also showed that the ACE training increased PPOWER, some spirometric variables and all indices of HRV. Nevertheless there was no significant change in the level of autonomy (QIF). In conclusion, an ACE short term training program is sufficient to meaningfully improve armcrank pedaling power, pulmonary function and heart rate variability in persons with cervical SCI, contributing to improve their muscular, pulmonary and cardiovascular function. Discussion We were able to conclude that over all the respiratory parameters have improved. And since respiratory problems are the primary cause for death of persons with a tetraplegia (Linn y cols, 2000) this is vital. Therefore persons with a tetraplegia should practice physical activity. Handcycling is a suitable physical activity for them which helps to improve respiratory values and therefore improves the live of persons with a tetraplegia. In our 8 week program we could not find changes in the level of their autonomy, but in a longer term study we could expect that participants gained more autonomy and positive experiences to joy up their lives through sport. References Linn, W.S.; Adkins, R.H.; Gong, H.; Waters, R.L. (2000). Pulmonary function in chronic spinal cord injury: A cross-sectional survey of 222 Southern California adult outpatients. Arch Phys Med Rehabil. 81: 757-763. Field-Fote, E. C. (2009). Promoting maximal restoration of function: Assessment of function. Spinal Cord Injury Rehabilitation, p.115-116. Contact: sandra.sinz@gmx.net

### **BODY COMPOSITION ASSESSMENT IN SPINAL CORD INJURED WHEELCHAIR ATHLETES**

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Introduction Adverse alterations in body composition (BC) are a potential risk for the health of subjects with spinal cord injury (SCI) and relevant to sport performance in wheelchair athletes (WA). This study investigated whole-body and regional BC in WA to assess differences between a) tetraplegic and paraplegic WA and b) WA and a larger sample of healthy males athletes. Methods Twenty-seven male WA aged  $30.0 \pm 9.4$  years with chronic SCI underwent dual-energy X-ray absorptiometry (DXA). One operator measured subtotal (total-body less head) and regional (arms, legs and trunk) body composition (lean mass [LM], bone mineral content [BMC], fat mass [FM] and fat mass percentage [%FM]). WA were split into two groups according to their level of injury as follows: tetraplegia (lesion above T1; Tetra,  $n=10$ ) and paraplegia (lesion at T1 and below; Para,  $n=7$ ). Each WA was carefully matched to three healthy males athletes ( $n=81$ ) on the basis of DXA area and BMI. The t-test for independent samples was used to assess differences in the DXA outcomes between Tetra and Para as well as Tetra and Para and their respective control. Alpha value was set at 0.05 and p-values (pc) corrected for multiple comparisons were obtained with the Benjamini and Hochberg procedure. Results Tetra showed significant higher %FM vs. Para at the subtotal and regional level (.024

### **ROLE OF ADAPTED PHYSICAL ACTIVITY IN QUALITY OF LIFE, MOOD, SOCIALIZATION, BODY PERCEPTION OF PEOPLE WITH MULTIPLE SCLEROSIS**

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Introduction The main aim is retrospectively evaluate the psychological and social benefits of an intervention of Adapted Physical Activity (APA) for people with multiple sclerosis (MS). Methods Thirteen patients with MS who walk independently or with support (EDSS 1÷6, autonomous in posture transition from the supine to the upright position and vice versa) have agreed to undergo a APA program for 10 lessons of 60 minutes, following AISM Guideline, and to perform a protocol of daily exercises at home. The assessment of the training



effectiveness was carried out with a retrospective questionnaire (42 Items - Likert scales 0 - 10). Results Most of the subjects (69.2 ±100%) reported medium or high improvements in the control of posture, in gait, in speed of locomotion, in joint mobility, in manipulation, in breathing, in balance, in coordination, in lymphedema and in bladder control. The 83,1% of them reported psychological and social benefits, improvements in the mood (average score for items 6,6/10), cheerfulness, well-being, self-esteem, body perception, quality of life. The 92,3% of the subjects reported high improvement in group socialization (score 8,1/10). The 76.9% said they had adopted a more active life style after training period; the 84.6% declared that they engage in daily physical activity and the 84,62% have increased physical activity after the lessons. Discussion/Conclusion Results tend to confirm the role of Adapted Physical Activity to improve quality of life, mood, socialization, body perception for people with MS. As they have a long life expectancy and high risk of depression, it is important for them and for their loved ones, to make it as good as possible. It is reasonable to hope that future research will have to focus on the quantitative and qualitative role of exercise, as it may increase exercise prescription. References Jack S. Burks, Kenneth P. Johnson Multiple sclerosis: diagnosis, medical management, and rehabilitation, 2000, Demos. Giesser BS., Exercise in the management of persons with multiple sclerosis. *Ther Adv Neurol Disord.* 2015 May;8(3):123-30. Motl R.W., McAuley E., Sandroff B.M., Hubbard E.A.: "Descriptive epidemiology of physical activity rates in multiple sclerosis" - *Acta Neurol Scand* 2015; 131: 422-425. Ensari Ipek, Motl Robert W., Piutti Lara A.: "Exercise training improves depressive symptoms in people with multiple sclerosis: Results of a meta-analysis" - *Journal of Psychosomatic Research* 2014; 7: 465-471. not insert authors here

## CARDIOVASCULAR ADAPTATION TO EARLY SPORT ACTIVITY IN RECENT SPINAL CORD INJURY SUBJECTS

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Introduction In recent spinal cord injury (SCI) the cardiovascular auto-regulation may be particularly challenging (due to peripheral blood pooling and the lack of communication between cardiovascular receptors and autonomic effectors), especially during exercise, in which heart rate (HR) must compensate for the reduction in stroke volume. Physical training is known to benefit resting HR and its adaptation to exercise, but such effects have been studied mainly on long-term stabilized SCI. As training is currently being proposed in early rehabilitation of SCI ("sport-therapy"), our aim was to study HR adaptation to a physical training program in recent SCI patients. Methods Resting HR, HR variability (HRV) and HR response to exercise (graded exercise test) were evaluated by ECG and HR monitor in a group of recent (<3 months, on average) SCI subjects (n=30; 23 males, age 35+/-12 yrs), further divided in 2 sub-groups, based on lesion level (higher than T6 [HT6, compromised sympathetic heart innervation], n=14; lower than T6 [LT6, intact heart innervation], n=16). Patients were evaluated: 1) at admission in the rehabilitation center; 2) after 2 months of training (resistance activity on adapted ergometers + aerobic sport activity, 3-4 sessions/wk); 3) 6 months after discharge. Results Resting HR showed different adaptations to training between groups, remaining stable in time in HT6 subjects (p=ns vs pre-training condition) and monotonically increasing in LT6 patients. Training significantly increased in all patients the maximal load achieved during the graded exercise (p<0.05 vs pre-training conditions). However, the HR/load relationship improved more efficiently in the LT6 group. As regards HRV, the typical parasympathetic HRV indexes (e.g. RMSSD, HF power, etc.) in time and frequency domains showed a reduction in time in LT6 patients only. The benefit of training on HR was lost after 6 months of follow-up in HT6 patients and maintained in LT6 individuals. Discussion The effect of recent SCI on resting morning HR differed with the lesion level, confirming previous data. Early after a SCI, HR, its autonomic control and its adaptation to exercise changed, probably due to a cardiovascular autonomic compensatory adaptation. An apparent regain of orthosympathetic system seemed to occur, which needs further elucidation. Early sport-therapy induced a better adaptation of HR to physical work in LT6 SCI patients, which remained stable after a 6-months follow-up. Particular attention may therefore be paid to follow and motivate the upper level SCI patients to practice over time. References Hopman M.T. et al. The effects of training on cardiovascular responses to arm exercise in individuals with tetraplegia. *Eur J Appl Physiol* 74: 172-179, 1996 Mathias C. et al. Cardiovascular control in spinal man. *Ann Rev Physiol* 50, 577-92 (1988). Hoffman, M.D. Cardiorespiratory fitness and training in quadriplegics and paraplegics. *Sports Med.* 3, 312-330 (1986). [giam-piero.merati@unimi.it](mailto:giam-piero.merati@unimi.it)

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### PO-CPP-08 Health & Fitness 5

## SECULAR TREND IN MENTAL HEALTH AMONG ADOLESCENTS IN NATURAL DISASTER AREAS

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Introduction The build environment related to physical activity in adolescents was drastically changed by The Great East Japan Earthquake in 2011. The Growth and Health Longitudinal Study in the town of Onagawa was begun six months after the Great East Japan Earthquake of 2011. The town of Onagawa suffered heavy damage from the earthquake and tsunami. Our study group has already reported on physical activity trends among children and adolescents in the town of Onagawa (Okazaki et al., *Prev Med Rep.* 2015; 2: 720-4). Numerous studies have also shown that exposure to disasters is correlated with mental health. A relatively small number of studies have employed longitudinal assessments enabling clarification of changes in mental health. The purposes of this study were 1) to clarify the secular trend of mental health among adolescents living in a town affected by the earthquake and tsunami in 2011, and 2) to examine differences of relations between the mental health and physical activity profiles of each year. Methods The participants were junior high school students aged 11-13. Five surveys were conducted in the town of Onagawa at about six months (n = 195), one year (n = 160), two years (n = 175), three years (n = 148), and four years (n = 156) after the natural disaster. Survey items included health-related quality of life (HRQL, the 23-item Pediatric Quality of Life Inventory Version 4.0 Generic Core Scales, Varni et al., *Ambul Pediatr.* 2003; 3(6): 329-41), and whether or not students engaged in sports club activities after class. A two-way ANOVA (F1: time, F2: sex) was used to examine secular changes of HRQL. A Cohen's d was used to calculate the size of the effect of sports club activity at each time point. Results The results of a two-way ANOVA showed there was no significant interaction (p = .987) between time\*sex. A significant difference was found only for the sex factor (F(1, 824) = 47.47, p = .000), and the total score of HRQL for boys was higher than for girls (pooled mean: 83.7+/-12.5, 77.4+/-13.4, respectively). The pooled mean for girls was especially low compared to a previous study (83.7+/-13, reported by Varni et al., 2003). There was not a significant secular change (p = .692) in HRQL. The effect size between the sports club group and non-sports club group

in the first year ( $d = 3.54$ ) was clearly higher than the other time points. Conversely, the fourth year ( $d = 0.52$ ) was smallest in all time points. Conclusions These findings might suggest the following: 1) the mental health level of adolescents living in natural disaster areas has not changed since the disaster, 2) the mental health level of adolescent girls is lower than boys, 3) the effect of sports club activity was the highest in the first year, and the effect reduces over time. This study was supported by the Japan Society for the Promotion of Science (Grant-in-Aid for Young Scientists A: 24680065).

## ASSOCIATION BETWEEN HAND GRIP STRENGTH AND PHYSICAL FITNESS TEST PERFORMANCE FROM A LARGE SAMPLE <10-18 YEARS> OF HUNGARIAN SCHOOL CHILDREN

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**Introduction** The hand grip strength test (HGST) is an widely used method to estimate the general functioning of the human musculoskeletal system, the measurement is simple and can be done at any age (Roberts et al., 2011). The achieved values can be linked to actual health status and effects of lifestyle which is why it is often used in epidemiological studies (Saint-Maurice et al., 2015). Professional literature describes several physical test batteries to determine specific muscle profiles of different populations (athletes, school children, workers and the elderly) but the association between the HGST and those test performances is still not clear. The aim of the present study is to provide further information about the link between HGST and other test performances. **Methods** Data was collected according the NETFIT system (Csányi et al., 2015) in Hungary during the physical fitness assessment period of the 2014/15 school year (192 702 girls, 190 256 boys). Groups were defined by gender and age. Correlation coefficients (CC) were calculated between the test results of the HGST and the curl up (CU), push up (PU), standing long jump (SLJ), trunk lift (TL), backsaver sit and reach (BSR) and predicted VO<sub>2</sub>max of PACER (PVO<sub>2</sub>). Results There is a wide variability across gender and age groups in the values of the CC between HGST and the involved parameters but with all groups the TL with acceptable  $r$  values typically ranges between 0.106 -0.173 ( $p < .001$ ) and the SLJ typically ranges between 0.157 -0.302 ( $p < .001$ ). **Discussion** While many daily functions and sporting events require high activity levels of the flexor musculature of the forearms and hands and, except sitting and reclining, any kind of physical activity requires muscle involvement from the locomotor muscles and from the trunk muscles which are responsible for maintaining the equilibrium of the upper body, the link between HGST and TL, SLJ can be explained with a higher level of activation of the muscles which are also activated in the linked tests. According to these findings, the HGST can itself be a good indicator of sedentary versus physically active life style for 10-18 age groups. References Roberts HC, Denison HJ, Martin HJ, Patel HP, Syddall H, Cooper C, Sayer AA. (2011). Age Ageing. 40(4):423-9. Saint-Maurice PF, Laurson KR, Karsai I, Kaj M, Csányi T. (2015). Res Q Exerc Sport. 26;86 Suppl 1:S29-36. Csányi T, Finn KJ, Welk GJ, Zhu W, Karsai I, Hász F, Vass Z, Molnár L. (2015). Res Q Exerc Sport. 26;86 Suppl 1:S3-S12. Contact istvan.karsai@aok.pte.hu

## PROFILE IN PHYSICAL FITNESS IN CHILDREN AGED 3-6 YEARS

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**PROFILE IN PHYSICAL FITNESS IN CHILDREN AGED 3-6 YEARS** **Introduction** The importance of physical activity for health is well known and research has noted both physical and psychological benefits when children participate in physical activity (Ahn and Fedewa, 2011; Janssen and LeBlanc, 2010). Are a few studies have focused on analysing the physical abilities and fitness level of children aged 3-6 years (Latorre et al., 2015; Ortega et al., 2015). The aim of this study is determined physical condition, equilibrium and coordination in children 3-6 aged years. **Methods** 296 children of  $4.10 \pm 1.75$  years are selected. An anthropometrics (weight, height, BMI, waist circumference), balance (Flamingo Balance Test and Walking Heels Raised), coordination (Crawling and Bouncing ball), and finally the physical fitness (strength, endurance and speed) were evaluated. The IBM SPSS v.20.0 (SPSS, Chicago, USA) software was used to perform the statistical analysis. Data were expressed as mean and standard deviations of the mean (SD). Results The results show the next values in anthropometrics: weight ( $18.93 \pm 4.08$  kg); height ( $108.54 \pm 8.35$  cm); BMI ( $15.92 \pm 1.91$  kg/m<sup>2</sup>), WC ( $55.11 \pm 8.36$  cm). Coordination: crawling ( $13.95 \pm 6.43$  s); and bouncing ball ( $8.07 \pm 5.37$ ). Physical fitness: handgrip right hand ( $4.12 \pm 2.49$  kg), handgrip left hand ( $3.97 \pm 2.49$  kg), horizontal jump ( $80.24 \pm 27.50$  cm), resistance ( $261.31 \pm 65.99$  m), speed 5-m ( $1.61 \pm 0.32$  s), speed 25-m ( $7.77 \pm 1.87$  s). **Discussion** Are few studies than study physical fitness, but then have similar values of this study (Sugihara et al., 2006; Latorre et al., 2015). This study has novel data on balance and coordination in children. This information would be of great practical importance for teachers, offering them a test handy and inexpensive solution. Taking into account the above information, is necessary more investigation in preschool children. References Ahn, S., Fedewa, A.L. (2011). A meta-analysis of the relationship between children's physical activity and mental health. Journal Pediatrics Psychology, 107, 1-13. Janssen, I., LeBlanc, A.G. (2010). Review Systematic review of the health benefits of physical activity and fitness in school-aged children and youth. International Journal Behaviour Nutrition Physical Activit, 7(40), 1-16. Ortega FB1, Cadenas-Sánchez C, Sánchez-Delgado G, Mora-González J, Martínez-Téllez B, Artero EG, Castro-Piñero J, Labayen I, Chillón P, Löf M, Ruiz JR. (2015) Systematic review and proposal of a field-based physical fitness-test battery in preschool children: the PREFIT battery. Sport Medicine, 45(4), 533-555. Latorre Román, PA., Mora López, D., Fernández Sánchez, M., Salas Sánchez, J., Moriana Coronas, F., García-Pinillos, F. (2015). Test-retest reliability of a field-based physical fitness assessment for children aged 3-6 years. Nutrición Hospitalaria, 32(4), 1683-1688.

## A MULTILEVEL ANALYSIS OF CHILDREN AEROBIC FITNESS

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**A MULTILEVEL ANALYSIS OF CHILDREN AEROBIC FITNESS** Maia, J.I, Gomes, T.I, Pereira, S.I, Reyes, A.I, Bacciotti, S.I 1: FADEUP (Porto, Portugal) **Introduction** Children aerobic fitness (AF) is expected to change with age. Since children spend most of their daily awake time at school, it is expected that it may favour AF development. This study aims (1) to describe children AF increases with age, (2) together with the joint effects of gender (GE), physical activity (PA) body mass index (BMI), (3) as well as school size (SZ). **Methods** Sample comprises 1057 Portuguese children (547 girls) aged  $8.53 \pm 1.36$  yrs from 23 primary schools. AF was assessed with the time to run/walk 1-mile (1M), PA with the Godin-Shephard questionnaire, and BMI from height and weight. School size was marked by number of students. Reliability (R) was estimated. Since children are nested within schools, a multilevel model was used: Model 1 included child predictors (age, GE, PA, BMI); Model 2 added SZ. Parameters maximum likelihood estimates (b) were computed in SuperMix software. Results Data was reliable in all variables ( $R > 0.70$ ). Schools explain 9% of the total variance in AF. Older children are more aerobically fit – less time to cover the 1M

( $b = -0.50 \pm 0.04$ ,  $p < 0.05$ ); girls, on average, run the 1M in 12.13 min; boys run in less time ( $b = -1.11 \pm 0.11$ ,  $p < 0.05$ ), as well as those with greater PA ( $b = -0.005 \pm 0.002$ ,  $p < 0.05$ ), but those with greater BMI take more time to cover the distance ( $b = 0.14 \pm 0.02$ ,  $p < 0.05$ ); SZ had no significant ( $p > 0.05$ ) effect on children AF. Discussion Few studies investigated the school role in children AF. Similar to Zhu (1997), AF is also explained by the school-level characteristics. Older children have higher AF given that they run fast the 1M (Zhu, 1997). Consistent with our findings, sex-differences exist in AF favouring boys during middle and late childhood (Malina et al, 2004); further, more physically active children are more likely to increase their AF (Lamme et al, 2012; Zhu et al, 2010). On the contrary, heavier children tend to have lower AF because the test requires propelling the body on a horizontal axis (Malina et al, 2004). Although SZ was not an AF significant predictor, the between schools variance suggests that other school context characteristics may be related to it. References Lamme L, Worth A, Bos K (2012). Socio-demographic correlates of physical activity and physical fitness in German children and adolescents. *Eur J Public Health*, 22(6), 880-884. Malina RM, Bouchar C, Bar-Or O (2004). Growth, Maturation and Physical Activity. Champaign: Human Kinetics. Zhu, W (1997). A multilevel analysis of school factors associated with health-related fitness. *Res Q Exerc Spor*, Jun;68(2),125-135. Zhu W, Boiarskaia EA, Welk GJ, Meredith MD (2010). Physical education and school contextual factors relating to students' achievement and cross-grade differences in aerobic fitness and obesity. *Res Q Exerc Spor*, 81(Sup3), S53-S64. Contact [jmaia@fade.up.pt]

## PHYSIQUE AND PHYSICAL STRENGTH IN BOYS WITH DIFFERENT LEVELS OF FAT ACCUMULATION AND BMI-ANALYSIS ON SOUTH KOREAN JUNIOR HIGH SCHOOL STUDENTS -

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**INTRODUCTION** According to an analysis of previous studies demonstrated that body fat has an effect, although slight, on physical strength during puberty. However, there are no reported investigations of physical strength characteristics depending on differences in level of fat accumulation by body fatness type among individuals. In the present study, in addition to categorizing body types by BMI, we also determined level of fat accumulation, and investigated physical strength in 9 different body types in South Korean boys. **METHODS** The subjects were 201 first-year junior high school boys, in whom height, weight, BMI, fat mass, body fat percentage, and soft lean mass were measured. Items of physical strength measured were sit and reach, 20 m shuttle run, push-ups, and sit-ups. A mean value evaluation method was applied to determine standards for judging body fatness by BMI. To determine the level of fat accumulation, a standard regression evaluation chart was constructed for body fat percentage with respect to BMI. Evaluation zones with five levels were established in the standard regression evaluation chart. Using the determinations of BMI and fat accumulation, the subjects were classified into the 9 groups. **RESULTS** The results showed a clear trend for height to increase as BMI became greater. However, the height of boys with excessive accumulation of fat tended to be short and not to differ greatly regardless of BMI type. In muscle endurance, it was found that physical strength evaluations were similar in people with little fat accumulation in the BMI obese group and people with much fat accumulation in the BMI normal or slim groups. In general endurance ability, it was found that physical strength evaluations were similar in people with little fat accumulation in the BMI obese group and people with much fat accumulation in the BMI slim group. **DISCUSSION** In the present study, excluding the groups with the characteristic of excessive fat, the 9 groups showed a tendency for higher body fat percentage when height was taller. Furthermore, the present finding of short height in students with excessive fat regardless of whether BMI was high or low has not been reported previously. In physical strength items, the results suggest that even if BMI is low, muscular endurance of the upper limbs or trunk and endurance ability will be low if there is a high level of fat accumulation. The subjects with low BMI in the present study were late matures; in other words, it is thought that level of maturation affects elements of muscular endurance of the upper limbs or trunk and endurance ability in the growth period. **REFERENCE** Tanaka, N, Fujii, K, et al (2009) Auxological approach to relational construction among body compositions and physical fitness in Korean junior high school students. *Japan Journal of Human Growth and Development Research*, 41:44-57. Contact : tanaka-n@tokaigakuen-u.ac.jp

## ACTIVE VERSUS PASSIVE TRANSPORTATION TO SCHOOL: HEALTH MOMENT IN THE SCHOOL.

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**Introduction** Health status is related to the physical activity we do and in particular how to move in the middle. So, this study examines the physical activity levels of children and adolescents based on compliance with international health recommendations, and establishes the relationship between it and the transport used to access school. **Methods** The sample of this study consists of a total of 455 subjects (247 girls and 208 boys) 9 years old, who participated in the European Youth Heart Study (EYHS) in Spain. It was selected by a process subjects stratified cluster in public, charter and private schools of the urban semi-urban and rural areas, Community of Madrid. AF data were collected by the accelerometer GTIM of Actigraph. As inclusion criteria the existence of records for at least four days was established with a minimum of 10 hours per day recorded as directed by Riddoch et al. (2004) **Results** The results show as the population tested does comply with international recommendations for healthy physical activity (girls 62.28; 85.81 children, minutes / day) with differences between boys and girls; also it shows how the active transport to school can contribute to comply levels of physical activity (3.10; 3.56 minutes / day). **Discussion** The World Health Organization (WHO, 2010) established the current international PA recommendations for health. They established that children and adolescents should engage in at least 60 min of PA from moderate-to-vigorous intensity (MVPA) daily. El viaje activo es una forma excelente de incorporar más ejercicio en la rutina diaria, y así lo demuestran estudios como Mota et al. (2007) o el informe EURYDICE (2013). Our study shows that active transport may be very important to comply with international health recommendations, so it is an excellent opportunity for children to be active as they can reach the center by bicycle or foot. so it contributes to the accumulation of minutes to implement these recommendations and the recommended steps. **References** EURYDICE (2013). Physical Education and Sport at School in Europe [on line].doi:10.2797/49648 Available from <http://eacea.ec.europa.eu/education/eurydice> (accessed: 12/11/2015). Mota, L., Gomes, H., Almeida, M., Ribeiro, J.C., Carvalho, J. and Santos, M.P. (2007). Active versus passive transportation to school – differences in screen time, socio-economic position and perceived environmental characteristics in adolescent girls. *Annual of Human Biology*, 34 (3), 273-282. Riddoch, C., Andersen, L., Wedderkopp, N., Harro, M., Klasson-Heggebö, L., Sardinha, L., Cooper, A. and Ekelund U. (2004). Physical activity levels and patterns of 9 and 15 year old European children. *Medicine & Science in Sports & Exercise*. 36(1), 86-92.

## ARE MODERATE AND VIGOROUS INTENSITY ASSOCIATED WITH CHILDREN'S SELF-PACED PHYSICAL ACTIVITY RELATED TO HEALTH AND FITNESS OUTCOME?

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**INTRODUCTION:** Children's self-paced physical activity (SPA) is associated with ranges of energy expenditures (EE) and percentages of moderate-vigorous intensity (%MVPA) in a simulated environment. The purposes of this study were to determine: a) if a program approach using children's SPA exhibits a range of EE and %MVPA; and b) if children's physical activity levels (PAL) are related to changes in body composition (i.e., weight; body mass index (BMI); waist circumference (WC); sum of 6 skinfolds (SSF6)) and cardiorespiratory fitness (CRF) variables (i.e., systolic and diastolic blood pressure (SBP, DBP); resting heart rate (HRr); and aerobic power (estimated VO2max)). **METHODS:** Thirty-three children (age  $9.8 \pm 1.3$  years; weight  $43.1 \pm 13.4$  kg; BMI  $20.8 \pm 3.2$  kg/m<sup>2</sup>), registered in a community recreation centre, were recruited to participate in a SPA (guided active play) program for 8 weeks (4x/week; 1hr/d). Daily PA was assessed (using ActiGraph GT3X+ accelerometer) with EE and %MVPA estimated using regression equations from calibrated ACC (using CosMed2 oxygen collections system). All other variables weight, BMI, WC, SSF6, SBP, DBP, HRr and aerobic were measured following standard procedures (all within  $\pm 3.5\%$  coefficient of variation). Statistical procedures were performed using ANOVA and/or Pearson Correlation 'r' (SPSS 22.0). **METHODS:** Children's SPA averaged  $280 \pm 47$  kcal/session, 5.6 kcal/min and  $4.1 \pm 0.6$  MET across the 8wks. The average time spent in sedentary and MVPA were  $23 \pm 11\%$  and  $39 \pm 14\%$ , respectively. The changes (pre-post) for WC (+1.1cm), SSF6 (+4.2mm), DBP (-5.4mmHg), SBP (-4.5mmHg), and VO2max (+2.3mL O<sub>2</sub>/kg-1/min-1) were significant. Following the program a 5% increase in aerobic power and a 4.5% and 9.0% decrease in resting systolic and diastolic blood pressures, respectively, were observed ( $p < 0.05$ ). When these changes are compared to the time spent at %MVPA, no relationship was evident ( $p > 0.05$ ); however SBP, DBP and VO2max had an improving trend with greater %time spent in both %MVPA and %VPA (effect sizes of -0.45, -0.71 and 0.43, respectively). **CONCLUSION:** children's SPA programs promote EE and %MVPA sufficient to modify important health and fitness variables, which may result in improved health benefits for children.

## THE EFFECTS OF A NINE MONTH INTRADIALYTIC EXERCISE PROGRAM ON FUNCTIONAL CAPACITY AND FATIGUE SYMPTOMS IN HEMODIALYSIS PATIENTS

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**Introduction** Hemodialysis (HD) patients suffer from generalized weakness, exercise intolerance and muscle atrophy and disturbed sleep, all leading to a generalized fatigue and a lack of energy (Sakkas and Karatzaferi, 2013; Giannaki et al., 2014). It is noteworthy that one third of HD patients report that they feel worse in the immediate hours after the end of HD session while one out of four patients reports severe or very severe intensity of fatigue after the end of the HD session (Gordon et al., 2011). In addition, post- HD fatigue has been reported to be associated with physical inactivity (Gordon et al., 2011). According to our knowledge, no data exist regarding the effects of chronic exercise training on post-HD fatigue. The aim of the current study was to assess the effectiveness of a nine month intradialytic exercise program on fatigue symptoms occurring during and after the HD session as well as on functional capacity in patients receiving HD therapy. **Methods** Twenty stable HD patients participated in the study ( $59 \pm 13.7$  years; 16 males). All participants completed a 9-month supervised exercise training program during the HD session (3 times weekly). Fatigue, sleep quality, depression levels and daily sleepiness status were assessed via validated questionnaires, while functional capacity assessed by a battery of tests, before and after the intervention period. **Results** After the nine month aerobic exercise training intervention, exercise capacity increased by 65% and functional capacity by an average of 40%. Regarding the post dialysis fatigue questions, patients reported feeling better post HD after 9 months of exercise training program. Finally, overall fatigue symptoms were found to be significantly improved. **Discussion** Our study showed that a 9-month aerobic exercise training program improved both functional capacity and exercise capacity, followed by an improvement of the general perception of fatigue and by a reduction in the severity and the duration of post-HD fatigue symptoms. Exercise training could be considered as a safe and effective non pharmacological approach to ameliorate fatigue symptoms in HD patients. **References** Giannaki CD, Hadjigeorgiou GM, Karatzaferi C, Pantzaris M, Stefanidis I, Sakkas GK. (2014). Kidney Int, 85(6):1275-82 Gordon PL, Doyle J, Johansen KL. (2011). Clin Nephrol, 75(5): 426-33. Sakkas GK, Karatzaferi C. (2012). Front Physiol, 3: 306.

## THE EFFECT OF INTERMITTENT HYPOXIC TRAINING ON BLOOD ANTIOXIDANT STATUS IN SWIMMERS

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Do not insert authors here **Introduction** Training in hypoxic conditions has become an important element of preparing elite athletes for major competitions. However, both physical exercise and hypoxia can lead to increased cellular and tissue oxidative stress and defense antioxidant system. The main objective of this study was to examine the effect of simulated intermittent normobaric hypoxia during the land training of swimmers on the induction in oxidative stress and the antioxidant defense system. **Methods** The study included 23 male swimmers divided into hypoxic (HG, n=14) and normoxic groups (NG, n=9). The HG performing part of their land training ( $3 \times 1.5$  h = 4,5 h per week for 3 weeks), under simulated intermittent normobaric hypoxia (O<sub>2</sub> = 15.5%; corresponding to an altitude of 2,500 m a.s.l., LOS-HYP-1/3NU, LOWOXYGEN @ SYSTEMS, Ger), but NG in normoxia condition. The swim training program was similar for both groups and included 9 training units per week in normoxia. Blood was drawn before and after the initial and final training units. In blood was determined: the oxidative stress marker (MDA), enzymatic (CAT, SOD, GPx, GR) TAS level and non-enzymatic (GSH, UA) antioxidants also activities of CK and LDH. **Results** Hypoxia condition of swimmers land training insignificantly differentiated of oxidative stress marker MDA, level of TAS, enzymatic and non-enzymatic antioxidant defense system. However variable "training" had significant effect on MDA level and GR, CK and LDH activity. Similarly had significant effect on UA and TAS level. **Discussion** Antioxidant defense system in blood to countered effects of oxidative stress is complex in nature and consist with multiple factors such antioxidants (Rodríguez et al., 2007). We observed a relatively minor alteration of blood antioxidants in the swimmers during training in hypoxia condition. Correspond to a mild induction of oxidative stress in these athletes (Truijens et al. 2002). Other authors, like Bailey et al. (2001), Pialoux et al. (2010), Rodríguez et al. (2007) were observed, that, training with IHT programme had significant effect for generating oxidative stress and stimulated antioxidant status in athletes. In conclusion, short training program of swimmers at normobaric hypoxia condition (2,500 m a.s.l., 4,5 h a week for 3 weeks) combined with sea-level training had insignificant effect for oxidative stress and antioxidant status in blood of competitors. **References** Bailey DM, Davies B, Young IS. (2001). Clin Sci (London), 101, 465-475. Pialoux V, Brugniaux JV, Rock E, et al. (2010). Eur J Nutr,



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### PO-CPP-12 Neuromuscular Physiology 2

#### LONGITUDINAL CHANGES IN MUSCLE SIZE AND FUNCTION DURING A 5 YEAR FOLLOW UP STUDY IN OLDER MEN AND WOMEN

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**Introduction** In order to help older people to live independently and actively for longer we need to understand the physiological processes of muscle wasting leading to clinical syndromes of sarcopenia and weakness. The typical approach to this very important issue simply compares physiological measurements between young and old, but secular and lifestyle differences between young and old may confound these comparisons. Longitudinal studies are needed in order to directly measure the physiological changes in the same people over a period of several years. **Methods** We followed up 35 older individuals aged  $71 \pm 4$  yrs at baseline, repeating the original protocol five years later. Knee extensor muscle size was measured from Magnetic Resonance Imaging (MRI), with torque and neural activation assessed from voluntary contractions and the interpolated twitch technique. **Results** After 5 yrs, torque was 9% lower ( $151 \pm 41$  N.m vs  $138 \pm 43$  N.m;  $p < 0.01$ ), muscle cross-sectional area fell by 6% ( $53.4 \pm 12.7$  cm<sup>2</sup> vs  $50 \pm 10.4$  cm<sup>2</sup>;  $p < 0.01$ ), Neural activation decreased by 5% ( $90.5 \pm 5.1\%$  vs  $85.1 \pm 7.6.8\%$ ;  $p < 0.01$ ). **Discussion** These results indicate that muscle weakness in septuagenarians occurs principally due to reduced strength per unit muscle mass, this was also accompanied in part by a reduction in neural control. Future work will complete more detailed assessments looking into changes in muscle specific tension and mobility. Contact J.Cameron@mmu.ac.uk

#### AGE-RELATED INCREASE IN MUSCLE DEFORMABILITY OF THE RECTUS FEMORIS: RELEVANCE TO SARCOPENIA

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**Introduction** Age-related muscle loss (sarcopenia) has been widely recognized. Thigh muscles, the quadriceps in particular, are known to demonstrate outstanding sarcopenia [1]. There is also some evidence of an increase in noncontractile tissues within a muscle by aging [2], which can change elastic properties of a muscle [3]. We tested the hypothesis that such age-related changes in muscle might be associated with deformability of a muscle upon mechanical loading, in a cross-sectional study design. **Methods** Fifty-six healthy males and females (17 males and 39 females with age ranging from 41 to 81 yr; no significant gender difference in age) participated. Cross-sectional images of the rectus femoris (RF) were taken with B-mode ultrasonography while a participant stood at rest. At the midhigh level, an ultrasonic probe was applied onto the skin in the transverse direction to RF in 2 conditions, 1) without any compressive force (N) and 2) with pushing force in the direction from the mediolateral center of RF to that of the femur, up to when no more RF deformation occurred (P). The RF muscle thickness (anteroposterior distance between fascial borders) and width (mediolateral distance between fascial borders) were measured in the recorded images, and RF cross-sectional area was evaluated. In addition, the ratio of thickness (P/N) was calculated as an index of deformation. Pearson product-moment correlations and unpaired t-tests (between genders) were performed with the level of statistical significance at  $p < 0.05$ . **Results and discussion** The RF cross-sectional area was negatively correlated with age ( $r = -0.30$ ), showing the sign of sarcopenia. The deformation index (P/N) was also correlated negatively with age ( $r = -0.42$ ) and with RF cross-sectional area ( $r = 0.33$ ). These results suggest that RF deformability upon mechanical loading increases (RF becomes more compliant) with aging. The deformability is related to its size (smaller RF more compliant) but the higher correlation of P/N with age suggests factors other than size, e.g. infiltration of adipose tissues into muscle [3]. Further analysis is currently under way on the same subjects to evaluate intramuscular fat content. **Acknowledgments** This work was partially supported by Council for Science, Technology and Innovation (CSTI), Cross-ministerial Strategic Innovation Promotion Program (SIP), "Technology for creating next-generation agriculture, forestry and fisheries" (funding agency: Bio-oriented Technology Research Advancement Institution, NARO). **References** 1) Porter, M.M. et al. (1995) Scand J Med Sci Sports 5: 129-142. 2) Kent-Braun, J.A. et al. (2000) J Appl Physiol 88: 662-668. 3) Chan, S.-T. et al. (2012) Spine J 23: 487-494. Contact fumiko@aoni.waseda.jp

#### CIRCULATING MIRNAS AS EARLY BIOMARKERS OF SKELETAL MUSCLE DENERVATION IN RATS

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Skeletal muscle loss is a common feature in a variety of diseases and a result of prolonged inactivity or aging. Recently, circulating muscle-enriched miRNAs have been shown to be biomarkers of muscle damage, but whether they could be markers of early muscle loss is unknown. Our aim was to evaluate the use of single and combinational measurements of circulating miRNAs in the early diagnostic of muscle loss in a denervation model in rats. Skeletal muscle denervation was induced by the section of the soleus muscle nerve (DNV,  $n = 32$ ). Blood samples were drawn 6 h, 12 h, 24 h and 48 h post-denervation in DNV or sham operated rats (SHAM,  $n = 32$ ) as well as in a control group (CON,  $n = 12$ ) to measure miR-1-3p, -133a-3p, -133b-3p, -206-3p, -208b-3p, -499-3p, -378a-3p and -434-3p by RT-qPCR. The diagnostic accuracy of each individual miRNA was assessed by a receiver-operating characteristic (ROC) curve analysis and the resulting area under the curve (AUC). DNV rats were considered positive, SHAM and CON were considered negative for muscle remodeling. Then, we sought to optimize the diagnostic accuracy by using a logistic regression analysis with a backward selection to identify the best miRNAs combination. We found no significant alterations of the circulating levels of miR-1-3p, -206-3p, -499-5p and -378a-3p in DNV and SHAM rats, while miR-208-3p remained undetectable in most samples. Both miR-133a-3p and -133b-3p significantly increased at 12 h in DNV group compared to SHAM (1.9 and 3.3 -fold, respectively) with a peak value at 24 h (3.5 and 5.2 -fold, respectively), and returned to baselines at 48 h. MiR-434-3p transiently increased 6 h after the sham-operation but not in DNV. The ROC curve analysis

revealed that miR-1-3p and -206-3p had the lower diagnostic accuracy (AUC = 0.528) while miR-133a-3p (AUC = 0.723) and miR-133b-3p (AUC = 0.856) had the higher. By using a logistic regression, we identified a model combining miR-133b-3p + miR-206-3p. This model was able to discriminate almost perfectly denervated rats from non-denervated rats as shown by the AUC = 0.947. In conclusion, we describe that individual circulating miRNAs could be useful biomarkers of early muscle remodeling in response to denervation. Furthermore, the combination of multiple biomarkers is an efficient strategy to greatly improve the diagnostic accuracy.

## THE NEED FOR EMG NORMALIZATION METHODS FROM A CLINICAL PERSPECTIVE

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**Introduction** Normalization of electromyographic (EMG) data is an essential process to limit the influence of external factors such as electrode replacement within longitudinal studies (Soderberg & Knutson, 2000). However, none of these methods seem suitable for clinical applications, due to patients' limited ability of motion. Previous studies investigated the analysis of normalization methods as well as the analysis of absolute data and suggest that normalization may not always necessarily be required. Both approaches seem to be capable to provide at least fair reliability. However, a direct comparison is still lacking. Thus, this study targets at the quantification of electrode replacement effects and reliability, and the benefit of normalization methods compared to the analysis of absolute data. **Methods** 13 recreational cyclists (5m/8f, 22-28years) performed 1 min cycling trials (150-170W; 90 rpm, Cyclus 2) on 3 consecutive days. Electrode placement was orientated to recommendations by Hermens et al. (2000) but extended by the application of a parallel pair of electrodes. While one pair was regularly replaced between the measurements, the other was kept permanent. EMG data (Myon 320, prophys AG) were determined for m. vastus medialis (VM) and m. tibialis anterior (TA). RMS was calculated for every test cycle. The effect of electrode replacement was then quantified comparing signals from permanent and regular setups. Intra-session (Split-Half) and inter-session reliability (intra-class-correlation) were calculated to assess reproducibility of myo-electrical signals. For normalization, a functional 10 s T-V test and a static 5 s MVC were applied. Results Internal consistency was found to be excellent ( $r = 0.98$ ). The permanent electrode set-up resulted in higher ICC values (VM: 0.86, TA: 0.88) compared to regular electrodes application (VM: 0, TA: 0.82). Normalization of VM signals led to higher ICCs (MVC: 0.66, T-V: 0.91), while TA signals remained at the same level of reliability (MVC: 0.86, T-V: 0.76). **Discussion** Permanent set-ups are recommended for electrode placement. They led to higher reproducibility due to avoidance of electrode replacement. In clinical settings, it will save time and simplifies the physiological demands to the patients. If permanent set ups are not feasible, normalization is still a key aspect of EMG measurements. Nonetheless, it was not possible to clearly examine a preference for either T-V or MVC normalization, based on this study's results. It is suggested that the optimal normalization method depends on the patient's motion abilities and the respective muscle task. **References** Hermens HJ, Freriks B, Disselhorst-Klug C, Rau, G (2000). *J Electromyogr Kinesiol*, 10(5), 361-374. Soderberg GL, Knutson LM (2000) *Phys Ther*, 80(5), 485-498. Contact stefan.kratzenstein@email.uni-kiel.de

## PROTECTIVE EFFECTS OF QUERCETIN SUPPLEMENTATION ON MUSCLE DAMAGE AND NEUROMUSCULAR IMPAIRMENT INDUCED BY ECCENTRIC CONTRACTIONS

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**INTRODUCTION** It is well known that eccentric muscle contractions, cause structural damage of muscle cells, which increases the production of free radicals, oxidative stress, inflammation (Myburgh, 2014; Dartnall et al, 2011). This disruption leads to a decline of muscle strength and it is associated to modifications of the electromyographic (EMG) activity of the affected muscles in the days after the exercise (Turner et al., 2008). This study examined the potential protective effect of quercetin (Q), a potent antioxidant and anti-inflammatory, on altered muscle contractile properties induced by eccentric exercise. **METHODS** 16 healthy young subjects were randomly assigned, in a double-blind crossover design, to start with either 1000 mg of Q or with a placebo (PLA) for 14 days before and for 7 days after performing voluntary eccentric muscle actions of the elbow flexors. Elbow flexors' strength and surface electromyography (sEMG) were recorded in both isometric and isokinetic (30, 60, 120, 240 °/s) contractions. Mean fibre conduction velocity (MFCV) was estimated from the sEMG from the biceps brachii. Indices of muscle damage, soreness, elbow angles, swelling and measures of plasma concentration of creatine kinase (CK) and lactate dehydrogenase (LDH) were taken at baseline, PRE and POST exercise, and 24, 48, 72, 96 h and 7 days after exercise. **RESULTS** Eccentric exercise induced an acute muscle damage as evidenced by significant increases observed for all indices. Differences between treatments were detected in strength loss, MFCV, muscle pain and in elbow angle after exercise. The PLA treatment induced greater decreases in maximal voluntary isometric contraction (MVIC) and in MFCV (33% and 9.9% on average, respectively) than the Q (22.5% and 2.7% on average, respectively) after exercise. Torque-angular velocity curve was lower in PLA (33% on average) than Q treatment (28% on average) at all time after exercise. Similarly, the decrease of MFCV value at all angular velocities ( $P < 0.05$ ) was more pronounced in the PLA (6.5% on average) than Q (1% on average) conditions. At 72 and 96h the PLA treatment had greater increases in CK and LDH than Q. **DISCUSSION** These data show a protective effect of Q supplementation on markers of muscle damage and inflammation after eccentric exercise. Q seems to be able to attenuate the loss of contractile function and to potentially contribute to ameliorate the recovery of maximal force capacity. (Dartnall et al, 2011). Dartnall TJ, Nordstrom MA, Semmler JG. (2011). *Journal of Neurophysiology*, 105(3), 1225-1235. Myburgh KH. (2014). *Sports Med*. 44 Suppl 1, S57-70. Turner TS, Tucker KJ, Rogasch NC, Semmler JG. (2008). *J. Appl. Physiol* 105, 502-9 Contact E-mail address: federica.patrizio@uniroma4.it

## NEUROMUSCULAR FUNCTION OF THE QUADRICEPS MUSCLE IN GONARTHROSIS PATIENTS

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**Introduction** Knee osteoarthritis (KOA) is commonly associated with a dysfunction of the quadriceps muscle which contributes to alterations in motor performance [1]. However, the underlying neuromuscular mechanisms of muscle dysfunction are not fully understood. The main objective was to analyse how KOA affects neuromuscular function of the quadriceps muscle during isometric maximal, submaximal and fatiguing voluntary contractions. **Methods** Twenty patients and 20 healthy controls participated in this cross-sectional study. The following parameters were assessed: (i) isometric maximal voluntary torque (IMVT) and neuromuscular activation (average EMG) (ii) position control, i.e. joint position sense (mean absolute error) at 30° and 50° of knee flexion, (iii) torque control, i.e. accuracy (mean

absolute error), absolute fluctuation (standard deviation), relative fluctuation (coefficient of variation) and periodicity (mean frequency) of the torque signal at 20%, 40% and 60% of IMVT, (iv) EMG-torque relationship at 20%, 40% and 60% of IMVT and (v) fatigue resistance (time to task failure) at 40% of IMVT. Results Patients produced significantly lower IMVT (-60.0%;  $p = 0.001$ ) accompanied by reduced average EMG of the rectus femoris (-33.5%;  $p = 0.046$ ). The knee joint repositioning error was significantly higher at 30° (143.6%;  $p = 0.001$ ) and 50° (147.9%;  $p < 0.001$ ) of knee flexion in patients. The mean absolute error of the torque signal was significantly higher in the patient group at 20% and 40% of IMVT by 96.6% ( $p = 0.034$ ) and 101.5% ( $p = 0.044$ ), respectively. The SD and MNF of the torque signal were significantly reduced at all three torque levels in patients. Furthermore, patients had 27.0% greater CV ( $p = 0.079$ ) at 20% of IMVT whereas no differences could be found at 40% and 60% of IMVT. EMG-torque relationship was decreased for the vastus lateralis at 20% and 40% of IMVT by 64.1% ( $p = 0.006$ ) and 33.1% ( $p = 0.016$ ), respectively. Between-group differences in the EMG-torque relationship could only be documented for the vastus lateralis at 20% and 40% of IMVT with higher average EMG values (64.1%;  $p = 0.006$  and 33.1%;  $p = 0.016$ , respectively) in the patient group. Patients produced significantly shorter time to task failure (-51.1%;  $p = 0.049$ ) during sustained submaximal fatiguing contraction. Discussion This study has shown that KOA is not only associated with a deterioration of torque and neuromuscular activation during isometric maximal voluntary contractions, but also with an impaired position and torque control at submaximal torque levels, an altered EMG-torque relationship and a higher fatigability of the quadriceps muscle. 1. Bennell KL, et al. (2013). *Rheum Dis Clin North Am*, 39, 145-76. Contact [anett.mau-moeller@uni-rostock.de](mailto:anett.mau-moeller@uni-rostock.de)

## DEVELOPMENT AND VALIDATION OF AN EXERCISE DEVICE FOR USE IN AN LBNP BOX

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INTRODUCTION: The LBNP box is widely used to study cardiovascular physiology, orthostatic intolerance and responses to exercise. An exercise multiplatform (ENTIRETY) was constructed for use in an LBNP box. The study evaluated physiological responses and perceived exertion (RPE) during 5 min of exercise using ENTIRETY in supine and standing positions. METHODS: Six subjects (28.8±10.9yr, 64.8±11.2kg, 163.2±6.9cm) had heart rate (HR), oxygen consumption (VO<sub>2</sub>), carbon dioxide production (VCO<sub>2</sub>), respiratory exchange ratio (RER), electromyography of the VL and VM muscles (sEMG), and Borg scale RPE measured at rest and during exercise in both body positions. RESULTS: Increased HR during the 5 min exercise was not affected by body position. However, a decrease in VO<sub>2</sub> and VCO<sub>2</sub> (29.34±22.79ml/kg/min; 26.30±6.66ml/kg/min) mean measurements for the supine position in comparison to the orthostatic position (14.2±4.45ml/kg/min; 18.40±4.55ml/kg/min) ( $P < 0.05$ ) was observed. The mean RER showed no significant difference between the supine (1.16±0.37) and standing (1.28±0.11) positions. The mean RPE was higher in the supine position (6.67±2.83 points) than in the standing (4.83±2.85 points) ( $P < 0.05$ ). Comparison of the sEMG showed higher average activation of the VM and VL muscles in the supine position (18.88±5.15mV; 14.88±6.09mV) than in the standing (12.62±4.25mV; 8.42±3.45mV) ( $P < 0.05$ ). DISCUSSION: Performance of exercise while standing requires a greater metabolic response due to the effect of gravity on the individual at the Gz axis, which is decreased in the supine position. These results are in accordance with findings from the scientific literature and therefore validates the use of the ENTIRETY exercise device in LBNP studies. Thus, ENTIRETY could present greater potential of use for muscle and cardiovascular conditioning, when individuals exercise in supine and standing positions, respectively.

## EFFECT OF PELVIC TILT ON ABDOMINAL MUSCLE ACTIVITY DURING ABDOMINAL HOLLOWING -AN ULTRASONIC SHEAR WAVE ELASTOGRAPHY STUDY-

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Introduction The abdominal hollowing technique is commonly used to preferentially recruit the transversus abdominis (TrA) for individuals with low back pain in clinical practice (Hodges et al., 2003). However, selective contraction of TrA is difficult even with visual feedback using ultrasound B-mode (Urquhart et al., 2005). The purpose of this study was to clarify the effect of pelvic posterior tilt on abdominal muscle activity during abdominal hollowing. Methods Nineteen healthy men participated in this study. Participants were instructed to perform pelvic posterior tilt or maintaining pelvic position neutral with/without abdominal hollowing. To measure the muscle tension, the shear elastic modulus of the four anterior trunk muscles: rectus abdominis(RA), external oblique(EO), internal oblique(IO) and TrA was calculated using ultrasonic shear wave elastography. To determine differences in shear elastic modulus of each abdominal muscles, two way repeated measures analysis of variance (pelvic tilt×hollowing) and post hoc Bonferroni test were performed. To determine differences in contribution ratio of TrA (shear elastic modulus of TrA/(RA+EO+IO+TrA)), one way repeated measures analysis of variance and post hoc Bonferroni test was performed. Results Two way analysis of variance showed a significant main effect only for pelvic tilt in RA and EO, and main effect for both pelvic tilt and hollowing in IO and TrA. Post hoc test indicated that shear elastic modulus of RA and EO was significantly greater in posterior pelvic tilt than in pelvic neutral position, while there were no significant differences with/without hollowing. Shear elastic modulus of IO and TrA was significantly greater in pelvic posterior tilt with hollowing than in the others. Contribution ratio of TrA in pelvic neutral position with hollowing was significantly greater than in the others. Discussions Our results suggest that abdominal hollowing in the pelvic neutral position is suitable for preferential contraction of TrA, while muscle tension of all of the anterior abdominal muscles increased in abdominal hollowing in the pelvic posterior tilt position. Reference Hodges PW, Holm AK, Holm S, Ekstrom L, Cresswell A, Hasson T, Throstensson A. (2003). *Spine*, 28, 2594-2601. Urquhart DM, Hodges PW, Allen TJ, Story IH. (2005). *Manual Therapy*, 10, 144-153. Contact: [shimizu.itsuroh.87s@st.kyoto-u.ac.jp](mailto:shimizu.itsuroh.87s@st.kyoto-u.ac.jp)

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## PO-CPP-16 Physiology 4

## CYTOKINES LEVELS IN HIPPOCAMPAL FORMATION OF RATS SUBMITTED TO DIFFERENT EXERCISE MODELS

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**Introduction:** Cytokines are cell-signalling proteins secreted in order to mediate the response of the body's defence system to injury and to regulate diverse inflammatory processes. Investigation with rats has shown that aerobic exercise can alter brain levels of inflammatory cytokines (Gomes da Silva et al., 2013). However, little is known whether other types of exercise (e.g., resistance exercise) can provide similar effects. In this way, we evaluated the hippocampal levels of cytokines in rats submitted to resistance, voluntary or forced exercise. **Methods:** Forty Wistar rats were divided into the following groups: control, resistance exercise, voluntary exercise and forced exercise (n=10 rats for each group). Rats of exercise groups were submitted to exercise programs over 25 consecutive days. Twenty-four hours after last exercise session, rats were decapitated, hippocampi dissected and interleukin 10 (IL10), interleukin 6 (IL6) and tumour necrosis factor alpha (TNF $\alpha$ ) quantified by multiplex microbead immunoassay. One-way ANOVA, followed by Tukey post hoc tests were utilized to compare the results. **Results:** Voluntary and forced exercise did not induce alterations in hippocampal cytokines (IL-6, IL-10 and TNF $\alpha$ ) levels ( $p > 0.05$ ). Compared to control rats, resistance exercise increased IL6 ( $p = 0.009$ ) and IL6/IL10 ( $p = 0.001$ ) ratio, and decrease the TNF $\alpha$  ( $p = 0.013$ ) levels. **Discussion:** Inflammatory cytokines can exert negative or positive effects on brain function. These effects are dependent on numerous factors including the type of cytokine produced, the functional state and type of stimulated cells, and also concentration and duration of exposure to the cytokines. We demonstrated that aerobic exercise at low intensities does not alter brain inflammatory cytokines. Considering that IL-6 can have a dual effect (Spooren et al., 2011) and it can also inhibit TNF $\alpha$  release (Benveniste et al., 1995; Shrikant et al., 1995), it is possible that elevated levels of IL-6 induced by resistance exercise may have reduced hippocampal TNF $\alpha$  levels. In sum, our findings indicate for the first time a possible favourable effect of resistance exercise on hippocampal reduction of pro-inflammatory cytokine TNF $\alpha$ . **References** Benveniste EN, Tang LP, Law RM. *Int J Dev Neurosci.* (1995). 13(3-4):341-9. Gomes da Silva S, Simões PS, Mortara RA, Scorza FA, Cavalheiro EA, da Graça Naffah-Mazzacoratti M, Arida RM. *J Neuroinflammation* (2013). 10:61. Shrikant P, Weber E, Jilling T, Benveniste EN. (1995). *J Immunol.*, 1;155(3):1489-501. Spooren A, Kolmus K, Laureys G, Clinckers R, De Keyser J, Haegeman G, Gerlo S. (2011). *Brain Res Rev*, 67(1-2), 157-83. Do not insert authors here

## FUNCTIONAL AND CORTISOL RESPONSES AFTER EXERCISE INDUCED MUSCLE DAMAGE IN HUMANS

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**Introduction** The Skeletal muscle is being forcibly lengthened while generating active tension during eccentric exercise, which can cause muscle damage (Philippou et al. 2009). Various functional and systemic responses have been described as a result of eccentric exercise-induced muscle damage. The purpose of this study was to investigate cortisol response and functional outcomes after an eccentric exercise protocol (Nosaka et al. 2002) particularly modified for the lower extremities. **Methods** Six male volunteers (age:24 $\pm$ 3 years, height: 179 $\pm$ 3cm, mass: 82.42 $\pm$ 10.8kg) performed 8 sets of 6 maximal eccentric actions of the knee extensors muscles of one leg. Baseline measurements including maximum strength, perceived muscle soreness evaluation (palpation and flexion-extension), and jumping performance [counter-movement jump (CMJ) and drop jump (DJ)] were performed in each leg 2 days prior to eccentric exercise, immediately after (0h), as well as 48h and 96h post exercise. Blood samples were collected at baseline and 48h after the eccentric exercise, while all measurements and blood sampling took place between 9.00 and 10.30 a.m. Student's T-test for cortisol, and one-way ANOVA with repeated measures and Tukey's post hoc test were used for statistics. **Results** Eccentric exercise protocol resulted in a loss of muscle force by 47%, 42% and 31% at 0h, 48h and 96h post-exercise, respectively. Performance in DJ and CMJ was also impaired; maximum height in DJ was reduced by 33%, 28%, 26% at 0h, 48h and 96h, respectively, ( $p<0.05-0.01$ ), while in CMJ the maximum height decreased by 15%, 18%, 11% at 0h, 48h and 96h post-exercise, respectively ( $p<0.05-0.01$ ). The participants reported significant muscle soreness, i.e. 17.8mm, 25.8mm and 13mm in a 100mm visual analogue scale at 0h, 48h and 96h post exercise, respectively ( $p<0.05-0.001$ ). Serum levels of cortisol increased by 37% 48h after the eccentric exercise protocol. **Discussion** The findings of this study indicate that the eccentric exercise protocol used resulted in muscle damage, as reflected by the prolonged muscle force loss and the delayed onset muscle soreness post-exercise (Nosaka et al. 2002). Interestingly, the muscle damaging protocol also led to a prolonged impairment of the jumping performance, potentially attributable to neuromuscular dysfunction of the damaged muscles. Moreover, the perturbation in circulating levels of cortisol may be indicative of an inflammatory activity and subsequent muscle degradation following eccentric exercise-induced muscle damage (Miles et al. 1994). **References** Philippou et al. *In vivo*2009; 23:859-865 Nosaka et al. *Scand J Med Sci Spor* 2002;12:337-346 Miles et al. *Clin Sci* 1994; 87:87-88 Contact arg.papadopetraki@gmail.com

## EFFECTS OF HYPEROXIA ON MUSCULAR ENDURANCE

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**Introduction** A number of studies have shown that hyperoxic environment can enhance the aerobic endurance, whereas its effect on the muscular endurance has not been well understood. This study investigated the endurance performance, activation level and tissue oxygenation in the working muscle during repeated weight-lifting tasks in the hyperoxic environment. **Methods** Ten healthy young men performed repetition of one-hand preacher curl at an intensity of 30%1RM until exhaustion in two separate sessions: one was under normoxic condition (20.9%O<sub>2</sub>) and the other under hyperoxic condition (30.0%O<sub>2</sub>). Each session was conducted on a different day in randomized order. During the exercise, electromyographic activity (EMG) and oxygenation level of the biceps brachii muscle were measured with surface electrodes and near-infrared spectroscopy (NIRS), respectively. Root mean square (RMS) of EMG was normalized to that at the maximal voluntary contraction. In NIRS, changes in oxygenated, deoxygenated, and total hemoglobin levels from those at rest, and tissue oxygenation index were analyzed. All of these values were averaged for five repetitions. Since the maximal number of repetition varied with subjects and oxygen conditions, the mean values for the first, middle and last five repetitions were compared between hy-



peroxic and normoxic conditions. Results The maximal number of repetition under the hyperoxic condition was significantly larger than that under the normoxic condition. For all parameters relating to muscle activation and oxygenation, two-way analysis of variance tests showed no significant effects of oxygen concentration (normoxia vs. hyperoxia), but significant time effects (the first, middle, and last five repetitions). Significant interaction effects were found in RMS of EMG, oxygenated hemoglobin level, deoxygenated hemoglobin level, and tissue oxygenation index. Multiple comparison tests showed that only RMS of EMG during the last five repetitions was significantly larger under normoxia than under hyperoxia. Discussion These results indicate that hyperoxia can improve muscular endurance by delaying the fatigue-induced elevation of muscle activation. However, the muscle oxygenation level may not be related to this effect. Intramuscular  $H^+$  during exercise is lower under hyperoxic condition than normoxic condition (Eiken and Tesch, 1984; Adams and Welch, 1980), which could cause the positive effects of hyperoxia on muscular endurance. References Adams RP, Welch HG. (1980). J Appl Physiol Respir Environ Exerc Physiol, 49(5), 863-8. Eiken O, Tesch PA. (1984). Acta Physiol Scand, 122(4), 629-33. Contact Email: d157616@h.k.u-tokyo.ac.jp

## THE EFFECTS OF RUNNING AN ULTRA TRAIL RUN OF 130 KILOMETERS – A CASE REPORT

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Introduction Data on the impact of ultra-marathons on the concentration of novel cardiovascular biomarkers are scarce. A study of 16 experienced runners, who completed a 60 km ultra-marathon, could show significant changes in copeptin and midregion proadrenomedullin concentrations (1). We sought to report echocardiographic, electrocardiographic and laboratory changes of established and novel biomarkers in a young female participant of an endurance trail run. Results Immediately after the run a significantly prolonged QT (410ms) and QTcB (457ms) interval was found. NT-proBNP concentrations increased from 61 ng/L at baseline to 834 ng/L and 138 ng/L at the time point 1 and at the time point 2, respectively, whereas troponin I levels remained below the upper limit of normal. With respect to novel cardiovascular biomarkers, we observed a clinically significant elevation of copeptin levels to 11.47 pmol/L. Discussion The main finding in this case was that despite an uninterrupted run of 130 km, the elevation of the above mentioned markers were clinically significant but modest in extent. Particularly, troponin I elevation did not occur at any point in time, whereas markers of cardiac stress, such as NT-pro-BNP and copeptin did increase above the ULN. Repolarization changes in electrocardiography and apical hypokineses in the right ventricle reserved after a recovery period of 34 hours. References (1) Lippi G, Schena F, Salvagno GL, Sanchis-Gomar F, Guidi GC. Serum copeptin and midregion proadrenomedullin (MR-proADM) after an ultramarathon. Journal of clinical laboratory analysis. 2015;29(1):15-20.

## MUSCLE OXYGENATION CHANGES DURING THE EXERCISE AND THE RECOVERY PHASES OF REPEATED SPRINTS OF DIFFERENT DURATIONS

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Introduction Muscle metabolism is dependent upon sprint duration and is greatly challenged during the execution of multiple sprints. Based on sprint duration, muscle oxygen availability, oxygen extraction and oxygenation levels during repeated sprints may affect muscle metabolism and fatigue. Thus, the purpose of this study was to examine the changes in muscle oxygenation levels during exercise and recovery phases of repeated sprints of short (5 s), moderate (10 s) and long duration (20 s). Methods Twelve males (age:  $21.3 \pm 2.1$  yrs) performed three protocols of repeated sprints on a cycle ergometer. The first protocol included the performance of 12 sprints of 5 s duration with 50 s recovery, the second 6 sprints of 10 s duration with 100 s recovery and the third 3 sprints of 20 s duration with 200 s recovery. Using near infrared spectroscopy, the range of changes of oxyhemoglobin (O2Hb), deoxyhemoglobin (HHb) and Hb difference (Hbdiff) of VL were measured during each sprint as well as during the first 30 sec of recovery. Results Mechanical power decreased by  $11.2 \pm 8.2$ ,  $19 \pm 6.4$  and  $16 \pm 4.9\%$  during the 12x5, 6x10 and 3x20 s sprints, respectively. During the exercise phases of the 12x5 s protocol, the range of increase of HHb progressively narrowed ( $p < 0.05$ ) while there were no changes ( $p > 0.05$ ) in the range of decrease of O2Hb and Hbdiff. During the exercise phases of the 6x10 s and the 3x20 s protocols, the range of decrease of O2Hb and Hbdiff was augmented ( $p < 0.05$ ) while there was no change ( $p > 0.05$ ) at the range of increase of HHb. During the first 30 s of recovery phases at the 12x5 s and the 6x10 s protocols the increase of O2Hb and Hbdiff, and the reduction of HHb progressively declined ( $p < 0.05$ ). At the recovery phases of the 3x20 s protocol, the increase of O2Hb declined ( $p < 0.05$ ) while the increase of Hbdiff and the decrease of HHb remained stable. Discussion Muscle oxygen availability and oxygenation levels remain stable during short duration repeated sprints while oxygen extraction decreases. Though, during moderate and long duration repeated sprints, oxygen availability and oxygenation levels decrease whereas oxygen extraction remains stable. Furthermore, duration during the recovery phases among sprints of either short or moderate, muscle oxygen availability and oxygenation levels decrease while oxygen extraction increases. Among long duration sprints, oxygen availability decreases although oxygen extraction and oxygenation levels do not change. It appears that sprint duration differentiates the mechanisms used to respond to the metabolic demands of a repeated sprint exercise session regardless of the fact that total exercise duration (60 s) and exercise to rest ratio (1:10) are similar. Contact ismilios@phyed.duth.gr

## EFFECTS OF NITRATE ON O2 COST OF EXERCISE IN HEALTHY ELDERLY MEN

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Introduction Many studies report the beneficial effects of nitrate supplementation ( $NO_3^-$ ) in improving exercise tolerance and in reducing the energy cost of exercise in young adults. However, age, muscle fiber type and fitness level may affect the effect of  $NO_3^-$  on the cost of muscular exercise. Aging, f.i., may deteriorate vascular integrity and responsiveness, lead to muscle weakness and exercise intolerance and may therefore weaken the beneficial ergogenic effect of  $NO_3^-$ . The aim of this study was to investigate whether  $NO_3^-$  may be effective in decreasing the energy cost of exercise in healthy elderly men. Methods The study was a double blind, randomized, controlled, crossover design, with 8 days beetroot juice (BJ) supplementation ( $NO_3^-$  - 8-mmol  $NO_3^-$ /day) or nitrate-depleted BJ as placebo (PL - 0.8-mmol  $NO_3^-$ /day). At this time, 5 males ( $68.8 \pm 5$ yr;  $77.3 \pm 10$ kg;  $172.2 \pm 6.3$ cm;  $\dot{V}O_{2max}$   $39.2 \pm 4.2$  mL/kg/min) have completed the study. Breath-by-breath  $O_2$  uptake kinetics (Quark PFT, Cosmed, IT) was evaluated before (B) and after (A) intervention during two square wave transitions on cycle ergometer (Excalibur Sport, Lode, NL) at a mechanical power corresponding to 80% of GET (Low Intensity - LI) and to 50%Δ (50% of the difference between GET and  $\dot{V}O_{2max}$  - High Intensity - HI). Transitions lasted 6 min each, were followed by 6 min rest

and were repeated in three different days. After four weeks of washout, the treatments were crossed and the tests repeated. The data of three transitions were averaged and time aligned. At LI, the average values of the last 30s were taken at rest and in the last min of transition. At HI, average values (30s) were taken at rest, in the 3rd and 6th min of exercise. Results During HI exercise, the  $\dot{V}O_2$  slow component amplitude decreased by 11% in NO3- ( $2.17 \pm 0.30$  l/min (B) and  $2.14 \pm 0.22$  l/min (A) ( $P < 0.05$ ); it remained the same with PL ( $2.16 \pm 0.19$  l/min (B) and  $2.16 \pm 0.21$  l/min (A). Steady state  $\dot{V}O_2$  uptake during LI decreased by 6% with NO3- ( $1.18 \pm 0.34$  l/min (B) and  $1.09 \pm 0.25$  l/min (A). With PL, it amounted to  $1.16 \pm 0.26$  l/min (B) and  $1.13 \pm 0.30$  l/min (A) (NS). Discussion In spite of the paucity of the subjects (the study is still ongoing), preliminary results suggested that NO3- significantly reduced the  $\dot{V}O_2$  slow component amplitude during severe-intensity exercise, but had smaller effects on  $\dot{V}O_2$  cost of moderate-intensity exercise. A better  $\dot{V}O_2$  delivery to  $\dot{V}O_2$  utilization ratio in the exercising muscles may be the potential responsible of the observed effects. References Grassi B, Rossiter HB, Zoladz JA, Exerc. Sport Sci. Rev., Vol. 43, No. 2, pp. 75Y83, 2015 Breese BC, McNarry MA, Marwood S, Blackwell JR, Bailey SJ, Jones AM, Am J Physiol Regul Integr Comp Physiol, 2013. 305 (12): p. R1441-50. Contacts luca.dalsacco@univr.it

## EFFECT OF PALM PRE-COOLING WITHOUT NEGATIVE PRESSURE ON ENDURANCE PERFORMANCE IN HOT ENVIRONMENT

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**Introduction** The palm pre-cooling techniques with the negative pressure have shown the preventive effect on increase core temperature during exercise, consequently, the positive effect on the endurance. Unfortunately, from practical point of view, the device which provides the negative pressure is not affordable especially for the team sports. Furthermore, the effect of the palm pre-cooling without negative pressure which is much easier to apply has not been proven yet. The purpose of this study was to examine the effect of the palm pre-cooling without negative pressure on endurance performance in hot environment. **Methods** Subjects were seven male well trained collegiate rugby players. Subjects randomly completed two trials before exercise; the 15min pre-cooling (PC) by touching icing pad (10°C) palms without negative pressure and the no pre-cooling (CON) with crossover design. After either PC or CON, subjects started the 40min cycle exercise at 60%  $\dot{V}O_{2max}$  (EX1) in hot environment (30°C, 60%RH), then continued cycling at 80%  $\dot{V}O_{2max}$  to exhaustion. Before, during and after exercise, tympanic temperature (Tty), heart rate (HR), blood pressure (BP), time-to-exhaustion (TTE), and Rating of Perceived Exertion (RPE), Visual Analog Scale (VAS) were measured periodically as the physiological and subjective fatigue parameters, respectively. **Result** Although BP was kept comparatively in low at the initial 20min of EX1, and TTE was comparatively longer in PC, there were no statistically significant differences in TTE, Tty, HR, BP, RPE and VAS between PC and CON. **Discussion** Contrary to the many evidences on the positive effect of the palm pre-cooling with the negative pressure, the results of this study did not show the same effect. The application of the 15min pre-cooling time and the without negative pressure were thought to be the main reasons for the result. As previous studies indicated, longer cooling time than 30min would be necessary for the effective palm pre-cooling. Palm pre-cooling without negative pressure may lead to the vasoconstriction in palm so that the forearm blood circulation was restricted. In conclusion, the negative pressure is essential for palm pre-cooling. **References** Wegmann M, Faude O, Poppendieck W, Hecksteden A, Fröhlich M, Meyer T (2012). Sports Med. Jul 1;42(7):545-64. Kuennen MR, Gillum TL, Amorim FT, Kwon YS, Schneider SM (2010). Eur J Appl Physiol. Apr;108(6):1217-23. Dennis A. Grah, Vinh H. Cao, Christopher M. Nguyen, Mengyuan T. iu, and H. Craig Heller (2012). J Strength Cond Res. Sep;26(9):2558-69. 2012 Contact Yuta Masuda e-mail: y.masu2016@outlook.jp

## Conventional Print Poster

### PO-CPP-20 Physiology 5

## EFFECTS OF ENDURANCE EXERCISE AND PDTC ON SKELETAL MUSCLE ENERGY METABOLISM GENE EXPRESSION IN RATS FED A HIGH-FAT DIET

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**Objective:** Nuclear factor-kappa B (NF- $\kappa$ B) signaling pathway is the master regulator of chronic inflammation, which is a risk factor of insulin resistance. However, it is still unclear that whether NF- $\kappa$ B signaling pathway involves in the exercise-induced improvement of energy metabolism. The aim of this study is to investigate the effects of endurance exercise combined with the PDTC (inhibitor of NF- $\kappa$ B) on skeletal muscle protein gene expression involved in energy metabolism in rats fed high-fat diet (HFD). **Materials and methods:** Twenty-four male SPF rats fed with HFD for 6 weeks were randomized into 4 groups ( $n=6$  in each group): HFD group (H group), HFD+exercise group (HE group), HFD+PDTC (HP group), HFD+exercise+PDTC (HEP group). The rats in HE group and HEP group were performed the exercise training for 4 weeks from the 8th week on and those in HP group and HEP group received the intraperitoneal injection of the PDTC with the dose of 80mg/kg/day for 2 weeks from the 10th week on. After this, the glucose tolerance test and insulin tolerance tests were performed, and the activity of skeletal muscle mitochondria oxidative enzyme and protein gene expression involved in energy metabolism were measured. **Results:** Both exercise and PDTC reduced content of body fat and the ratio of body fat weight/body weight in HFD rats. PDTC impaired exercise-induced increase of extensor digitorum longus (EDL) weight/body weight in HFD rats. In addition, PDTC increased fasting plasma triglyceride in HFD rats; Exercise improved glucose tolerance, and both exercise and PDTC improved insulin tolerance in HFD rats, but PDTC had no significant effects on glucose tolerance; Exercise significantly improved the activities of succinate dehydrogenase (SDH) and cytochrome C oxidase (COX) in EDL of HFD rats, but PDTC attenuated the exercise-induced increase of COX activity in EDL of HFD rats; PDTC significantly increased mRNA expression levels of uncoupling protein 2 (UCP2) and peroxisome proliferator-activated receptor coactivator-1 $\alpha$  (PGC-1 $\alpha$ ), but PDTC blocked exercise-induced increase of COX4 mRNA in EDL of HFD rats. **Discussion:** Previous studies showed that exercise can improve mitochondrial function in skeletal muscle and reduce inflammation. We found that inhibiting NF- $\kappa$ B signaling can be beneficial to HFD rats. However, our study showed that PDTC attenuated mitochondrial adaptation to endurance exercise in male HFD rats, which is similar to the changes in female chow rats (Feng et al, 2013). Our results indicated

that NF- $\kappa$ B signaling pathway is also necessary to exercise-induced mitochondrial adaptation in HFD rats. Reference Feng H. Kang C, Dickman J, et al. *Exp Physiol*, 2013, 98:784-95 Contact whoomin@hotmail.com

### CARBOHYDRATE SUPPLEMENTATION ALLEVIATES NEUROMUSCULAR FATIGUE DURING PROLONGED CYCLING

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**Introduction** The neuromuscular fatigue induced by prolonged cycling has both peripheral and central origins (Thomas et al., 2015). This could be manipulated by carbohydrate (CHO) availability. We assessed the effect of CHO supplementation on exercise tolerance, rate of perceived exertion (RPE), and neuromuscular functions during heavy-intensity exercise. **Methods** Nine trained cyclists (age:  $29 \pm 9$ , weight:  $78 \pm 5$  kg, peak  $\dot{V}O_2$ :  $3.9 \pm 0.6$  l.min<sup>-1</sup>) exercised to exhaustion at  $69 \pm 4\%$  of peak  $\dot{V}O_2$  (SRM ergometer, Germany) twice (single-blinded): Ingestion of 1) a non caloric sweet placebo solution (PLA), 2) a 12% CHO solution (90g CHO.h<sup>-1</sup> in 150 ml per 15 min; 2:1 glucose:fructose ratio). Before, at minutes 60 and 90, at exhaustion for PLA (EXH:  $130 \pm 31$  min) but matched EXH time for CHO (ISO), responses to transcranial magnetic stimulation and supramaximal electrical femoral nerve stimulation were obtained to assess corticospinal and neuromuscular function, respectively. Capillary blood glucose and lactate concentrations, and RPE were also recorded. Results No trial-difference was found pre-exercise. Blood glucose was systematically greater ( $+1.5$  mmol.l<sup>-1</sup>) with a lesser decrease throughout CHO (end values:  $4.0 \pm 0.3$  vs  $3.0 \pm 0.3$  mmol.l<sup>-1</sup>). RER was also greater during CHO ( $.89 \pm .04$  vs  $.88 \pm .03$ ). With no trial-difference, blood lactate concentration decreased significantly from minute 60 (around 2.3 mmol.l<sup>-1</sup>) to 90 (around 1.9 mmol.l<sup>-1</sup>) and did not change thereafter (around 1.5 mmol.l<sup>-1</sup> at end-exercise). With similar RPE values at minute 60 (around 13), RPE increased more slowly during CHO (end values:  $16 \pm 1$ ; EXH-PLA:  $18 \pm 2$ ). For the right knee extensors, exercise induced reductions in maximum voluntary contraction (MVCs; CHO: -7%; PLA: -13%), potentiated twitch force (CHO: -18%; PLA: -17%) and peripheral voluntary activation (CHO: -5%; PLA: -7%) with greater MVCs for CHO ( $P < 0.05$ ). There was no discernible pattern for voluntary activation from stimulation of the motor cortex. **Discussion** Exogenous CHO supplementation increases CHO availability and utilisation during exercise, and reduces the perception of effort for a given sub-maximal work rate. With no difference in peripheral fatigue, the greater force-generating capacity of the knee extensors post-exercise supports CHO supplementation enhancement of exercise tolerance. However, alleviation of fatigue mechanisms upstream from the neuromuscular junction could not be confirmed using transcranial magnetic stimulation. Reference Thomas K, Goodall S, Stone M, Howatson G, St Clair Gibson A, Ansley L. (2015). *Med Sci Sports Exerc*, 47(3): 537-46. Contact j.dekerle@brighton.ac.uk

### THE USE OF GOL SCALE TO MEASURE PERCEIVED EXERTION IN SOCCER

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**Introduction** The peripheral signals integration from the muscles and joints and also the central signals from ventilation have their integration in the somatosensory cortex, enabling general or local perception of effort. Despite the Rate of Perceived Exertion usually used to estimate the internal training load and monitoring the exercise, few instruments have been developed and validated for specific sports. This study aimed to analyze the preliminary evidences of validation of a scale for soccer players named Gol Scale. **Methods** The new scale has been developed in two phases. In the first phase the cartoons of the scale were drawn based on the theoretical construct of perceived exertion. The final version of the scale is composed by six cartoons that show different grades of effort (1: low effort to 6: exhaustion). To ensure the representativeness of the cartoons they were validated by judges (nine PhD professors: physiologists, sports trainers and sports psychologists). In the second phase 13 soccer players ( $18.8 \pm 0.77$  years old, stature  $177 \pm 8.0$  cm, body mass  $70.8 \pm 7.53$  kg, % body fat  $13.42 \pm 3.19$ , lean mass  $60.49 \pm 4.75$  kg and fat mass  $9.60 \pm 3.19$  kg) were evaluated by a 3 minutes progressive protocol up to exhaustion with 1-minute recovery between stages. The Borg Scale 6-20, The Cavasini Scale, The cartoon Gol Scale, Heart Rate (HR), Percentage of Heart Rate (%HR) and Blood Lactate Concentration (lLaI) were immediately determined after each stage. Pearson's correlations coefficients were used. The level of significance was .05. **Results** We found significant correlation between the Gol Scale and Borg Scale 6-20 ( $r = 0.92$ ,  $p < 0.05$ ), Cavasini Scale ( $r = 0.92$ ,  $p < 0.05$ ), %HR ( $r = 0.88$ ,  $p < 0.05$ ), HR ( $r = 0.82$ ,  $p < 0.05$ ), and lLaI ( $r = 0.66$ ,  $p < 0.05$ ). **Discussion** A recent theoretical model explain that perceived exertion is associated to the increase of corollaries stimuli to motor impulses. The intensification of motor impulses generated by the central nervous system for the movement executions would be the main factor responsible for the increased of the RPE. These results showed that the Gol Scale is a promissory instrument for measuring perceived exertion. References Costa E.C., Vieira C.M.A., Moreira A., Ugrinowitsch C., Castagna C., Aoki M.S. (2013). *J Sports Sci Med*, 12, 559 – 564. Marcora S. (2009). *J Appl Physiol*, 106, 2060-2062. Contact futebollf@uol.com.br

### BIOCHEMICAL AND FUNCTIONAL ANALYSIS OF MUSCLE RESPONSE TO A HIGH INTENSITY CONCENTRIC EXERCISE

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**Introduction** It is generally assumed that concentric muscle actions cannot lead to severe exercise induced muscle damage (EIMD). A higher mechanical strain produced in eccentric actions is one of the main causes of sarcomeric disruptions (Fridén et al., 2001). However, other indirect mechanisms of EIMD are the accumulation of metabolic products and the increased production rate of Reactive Species, produced by a hypermetabolic state (Fisher-Wellman et al., 2009). The aim of this study was to assess the extent of EIMD when concentric muscle actions are performed at very high intensity. **Methods** 9 physically active men (age  $24.2 \pm 2.9$  years) performed 3 sets of the Wingate anaerobic test on a Lode Excalibur Sport cycle ergometer. 4 minutes of active rest were given between sets. Each set consisted of 30 seconds of all-out cycling against a resistance designed to elicit the maximum mechanical power (0.75N/kg body weight). Serum biomarkers of EIMD, including CK, CK-MB, AST, ALT, cardiac troponin I (cTnI), slow myosin (SM) and fast myosin (FM) isoforms were assessed before exercise, and 1 minute, 1, 24, 48 and 144 hours after exercise. Other indirect markers of EIMD as Delayed Onset Muscle Soreness (DOMS), Maximum Voluntary isometric Contraction force (MVC) of knee extensors, Counter Movement Jump height (CMJh), and 8 seconds cycling peak power were also assessed following the same time sequence. **Results** Effort caused a great decrease in muscle function ( $-16.1 \pm 13.4\%$  MVC,  $p = .007$ ;  $-26.5 \pm 19.7\%$  CMJh,  $p = .001$ ) and high levels of muscle pain ( $7.7 \pm 1.9$  in a 0-10 scale) after exercise. MVC and CMJh were re-established 1 hour after exercise and pain diminished near basal values, showing no posterior increments. A significant increase was shown in CK ( $+161.3 \pm 48.3\%$ ,  $p = .020$ ) values 24 hours after exercise, which decreased progressively thereafter. There were no significant changes in concentrations of fast and slow myosin, nor differential behaviour between the two markers. AST, ALT and

cTnI showed no changes during all the follow up. Discussion High intensity concentric muscle actions cause acute muscle fatigue and the release of cytoplasmic enzymes into the bloodstream. Fast recovery of muscle function, disappearance of muscle pain, and absence of changes in sarcomeric markers, suggest an increase in membrane permeability (Brancaccio et al., 2010), with muscle structure not being significantly affected. References Brancaccio P, Lippi G, Maffulli N. (2010). CCLM, 48(6), 757–767 Fisher-Wellman K, Bloomer R. (2009). Dynamic Medicine, 8(1), 1 Fridén J, Lieber, RL. (2001). Acta Physiologica Scandinavica, 171(3), 321–326 Funded by INEFC; 2014SGR/1629; MICINN; DEP2013-46574-P; MECD (FPU14/03006)

### PERCEIVED EXERTION IS LOWER IN RUNNING THAN WALKING AT THE SAME HEART RATE AND LACTATE LEVEL

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The purpose of this study was to examine physiological characteristics of perceived effort to relative intensity in human walking and running. Fifteen male subjects participated in this study. Two progressive protocols were randomized, starting at a treadmill speed of 3 Mts to measure ratings of perceived exertion (RPE), heart rate (HR) and blood lactate. From these data, RPE was estimated at an intensity corresponding to fixed HR (FHR; 120, 130, 140, 150 bpm) and fixed blood lactate concentrations (FBLC; 2 and 3 mM) from the individual regression line. RPE in running was significantly lower than in walking at FHR of 120, 130, 140 and 150 bpm, respectively ( $p < 0.01$  for all). For blood lactate, RPE in running were significantly lower than in walking at FBLC of 2 and 3 mM, ( $p < 0.05$ ,  $12.6 \pm 1.7$  vs  $14.0 \pm 1.7$  and  $15.1 \pm 1.4$  vs  $16.9 \pm 2.4$  respectively). Running may be performed more easily than walking at the same physiological demand. Factors other than blood lactate may affect perception of exertion during walking.

### BASKETBALL MATCH-INDUCED DEHYDRATION IS RELATED TO A REDUCED JUMP HEIGHT AFTER A MATCH IN YOUNG BASKETBALL PLAYERS

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Muscle damage and dehydration have separately been shown after basketball matches. However, their influence in jumping performance is unknown. The aim of this study is to relate the jump height to indirect muscle damage markers, loss of fluids, and changes in plasma electrolyte levels in young basketballers after a match. 14 basketballers ( $17.1 \pm 3.4$  years) participated in this study. Sodium (Na<sup>+</sup>), potassium (K<sup>+</sup>) and creatine kinase isoenzymes (CK) concentration, urine specific gravity (USG), body mass and countermovement jump height (CMJ) were measured before and after a match. Na<sup>+</sup> ( $p < 0.002$ ), CK ( $p < 0.0001$ ) were increased (1.4% and 38.1% respectively) after match, whilst body mass (fluid loss) ( $p < 0.0001$ ) and CMJ ( $p < 0.0002$ ) decreased (1.3% and 10.8%, respectively). Reduced CMJ performance was associated with increased Na<sup>+</sup> ( $r = 0.67$ ,  $p = 0.01$ ), but not with reduced K<sup>+</sup> ( $r = 0.36$ ,  $p = 0.21$ ) levels. Reduced CMJ performance was also correlated to fluid loss ( $r = 0.067$ ,  $p = 0.01$ ), but not with CK increased ( $r = 0.10$ ,  $p = 0.73$ ). Fluid loss was related to pre-match body mass and USG ( $r = 0.68$ ,  $p = 0.01$ ;  $r = -0.58$ ,  $p = 0.02$ , respectively). In conclusion a basketball match induces muscular damage and dehydration. However, only dehydration and increases in plasma Na<sup>+</sup> after match were associated with changes in jump height.

### EFFECT OF 12 WEEKS EXERCISE PROGRAM ON CIRCULATING LEVELS OF WNT INHIBITORS IN BREAST CANCER SURVIVORS

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Introduction Dickkopf-1 (DKK1) and secreted frizzled-related protein-1 (SFRP1) are inhibitors of Wnt/ $\beta$ -catenin signaling. Accumulating evidence suggests that higher serum level of DKK1 is positively correlated with pathologic conditions such as cancer and atherosclerosis. Furthermore, DKK1 disrupts osteoblast differentiation and precipitates osteoporosis. Several recent studies showed that exercise reduces DKK1 level in healthy volunteers or experimental animals. We investigated the changes of serum levels of DKK1 and SFRP1, as Wnt/ $\beta$ -catenin inhibitors, by long-term exercise in breast cancer patients. Methods Twenty four breast cancer patients ( $50.4 \pm 11.8$  years of age) after chemo- or radiotherapy were participated. Intervention groups were randomized to 12 wks of breast cancer exercise program ( $n = 11$ ) or control group ( $n = 13$ ). Blood samples were collected to examine the serum level of DKK1 and SFRP1. Results The serum levels of DKK1 ( $p < .01$ ), SFRP1 ( $p < .01$ ) and leptin ( $p < .05$ ) were significantly reduced during 12 wks exercise program. However, those in control group were not changed during 12 wks. Also adiponectin/leptin ratio was significantly reduced during exercise program compared to control group ( $p < .05$ ). The serum level of insulin was significantly decreased during 12wks exercise intervention ( $p < .05$ ), but serum level of Hs-crp was not significant changed. Exercised group showed remarkable increases in health related fitness such as hand-grip strength, muscle endurance, flexibility ( $p < .05$ ). Also, body fat percentage ( $p < .01$ ), waist circumference and visceral fat area were significantly decreased in exercised group compared to control group ( $p < .05$ ). Conclusion Our results suggest that long-term exercise decreases serum levels of DKK1 and SFRP1, which may contribute to the beneficial effects of exercise on physical fitness and metabolism in cancer patients. DKK1 and SFRP1 could be a therapeutic target for prevention of disease complications and improvement of metabolism. Contact Byung Il Yeh, MD, PhD: mia1@yonsei.ac.kr

### GENDER DIFFERENCES IN SALIVARY HORMONES AND PERCEPTION OF EXERTION OF ELITE VOLLEYBALL PLAYERS DURING TOURNAMENT

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Do not insert authors hereIntroduction Sports tournaments induce both physiological and psychosocial stress, which seems to be different between men and women (1). It induces anticipatory rises in testosterone and cortisol hormones, which may affect performance and perceived exertion. The aim of this study was to compare the changes in salivary cortisol and testosterone concentrations between men and women during an official volleyball tournament and to correlate the changes in these hormones with the perceived exertion after match Methods Three matches of each team were assessed in the group stage of the Men and Women South American Volleyball Championship. Measures of salivary cortisol and testosterone were taken in fasting state, before and after each match (2). The rate of perceived exertion (RPE) was assessed after each match. Changes in these variables were compared between men and women and



between matches with a multifactorial ANOVA. Results Fasting cortisol concentrations were higher in women than men and fasting testosterone was higher in men than women. Women did not increase their cortisol concentrations after any match. However, cortisol concentration increased after the second match. The average rate of perceived exertion was correlated with the average change in testosterone level after the matches in both women and men, which was not observed for cortisol concentration. Discussion These results suggest that women have more pronounced anticipatory responses and increase their hormonal levels less throughout tournaments than men. It seems that hormone changes in men are modulated by the experience in this type of competition and the opponent's level. References 1) Kivlighan et al. 2005. Psychoneuroendocrinology 30, 58-71. 2) Bateup et al. 2002. Evolution and Human Behavior 23, 181-192. Contact lpenaillo@uft.cl

### THE RELATIONSHIP BETWEEN BALANCE, ENDURANCE OF CORE MUSCLES AND ANAEROBIC PERFORMANCE IN PROFESSIONAL BASKETBALL PLAYERS

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**Introduction** The purpose of this study was to identify relationships between endurance of core muscle, balance and anaerobic performance in basketball players. The muscles of the core help control movements, transfer energy, shift body weight and distribute the stresses of weight-bearing. Balance is the ability to maintain the Center of Gravity (COG) of a body within the base of support with minimal postural sway. Functional movements are highly dependent on the core endurance, and lack of core muscles strength can result in decreased performance and balance. **Methods** 20 professional male basketball players (age  $17 \pm 0.64$ , height  $186.1 \pm 6.7$ , weight  $78.9 \pm 9.38$ ) were included to this study. Balance was measured using Biodex Biosway™. Endurance of core muscle was evaluated using McGill Core Endurance Tests. Anaerobic performance was assessed with running based anaerobic sprint test (RAST). Statistical analysis was performed using the statistical software SPSS. **Results** Spearman correlation analysis results showed that there was positive significant correlation between performance and endurance of core muscles ( $p < 0.05$ ). A positive significant relationship was demonstrated between anaerobic performance and balance ( $p < 0.05$ ) and between balance and endurance of core muscles ( $p < 0.05$ ). **Discussion** In this study, it was shown that there were statistically significant relationship between core endurance, balance and anaerobic power which effects the athletes performance directly during the match. Therefore, it can be suggested core muscle endurance exercises should be integrated to normal sports specific training programmes in basketball players. **References** Guskiewicz K. Regaining postural stability and balance. In: Rehabilitation Techniques for sports medicine and athletic training. Prentice WE (2011). Fifth ed. McGraw Hill NY, Pp:145-170. Hrysmallis C. (2007). Relationship between balance ability, training and sports injury risk. Sports Medicine, 37(6): 547-556. Contact pelinaksen@hotmail.com

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### PO-CPP-24 Sports Medicine & Orthopaedics 2

#### THERAPEUTIC PERCUTANEOUS ELECTROLYSIS COMBINED WITH ISOINERTIAL ECCENTRIC EXERCISE FOR THE MANAGEMENT OF CHRONIC PATELLAR TENDINOPATHY: A 3 MONTH FOLLOW-UP STUDY

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**Introduction** Galvanoxsis reactions modulated by percutaneous electrolysis seems to be a promising new therapeutic approach for chronic tendinopathy. There is evidence that eccentric exercise programs elicits therapeutic benefits for this pain condition. The purpose of the present study is therefore to ascertain the effectiveness of using EPTE® combined with isoinertial eccentric exercise (IEE), as compared to using EPTE® solely as treatment for chronic patellar tendinopathy. **Methods** 17 patients (6 women and 11 men; age  $33.41 \pm 11.82$ ) diagnosed clinically and confirmed by ultrasonography with unilateral insertional chronic patellar tendinopathy of at least 3 months length were randomized in two groups; 8 assigned to receive EPTE® intratendinous guided by ultrasonography with a needle of 0.32 mm to  $350 \mu\text{A}/\text{cm}^2$  for 1 minute and 20 seconds at the to the lower pole of the patella, for 5 sessions once a week. The other 9 patients were assigned to receive the same EPTE® treatment plus an evidenced IEE protocol (Romero-Rodríguez, 2011). Pain, function and ability to undertake physical activity was measured with VAS (0-10) scale and VISA-P questionnaire, respectively, same as ultrasonographic measurement of the tendon thickness, greyscale imaging and Doppler flow was performed on first and last treatment session, and at 3 month follow-up. **Results & Discussion** Initially, there were no significant differences between the groups at any outcome. In both groups there were a significant improvement in the total score of the VISA-P questionnaire (Both groups at baseline:  $56.71 \pm 13.23$ ) being greater at IEE group after the last treatment session ( $76.25 \pm 13.29$  EPTE® only vs.  $87.11 \pm 5.97$  IEE;  $P = 0.043$ ) and at 3 month follow-up ( $83.63 \pm 11.44$  vs.  $92.11 \pm 4.88$ ;  $P < 0.01$ ). IEE group showed more capabilities to retake, pain free, physical activity, likely due to the well known tendon structural changes associated with eccentric loads as literature reports. Pain was improved in both groups (Both groups baseline:  $7.12 \pm 1.58$ , last treatment session:  $3.12 \pm 1.58$ ;  $P < 0.001$ , 3 month follow-up:  $1.71 \pm 1.05$ ;  $P < 0.001$ ), without significant differences between groups at any time ( $P > 0.05$ ). The ultrasonographic thickness significantly decreased in both groups at 3 months (Both groups baseline:  $0.74 \pm 0.10$  cm, 3 month follow-up  $0.71 \pm 0.11$  cm;  $P < 0.05$ ), same as disappearance of the hypochoic areas in 10 of the 17 tendons, without significant differences between groups ( $P > 0.05$ ). Neovascularity trail was present at 7 of 17 tendons, disappearing after treatment completion in both groups ( $P < 0.001$ ), possibly as result of tendon regenerative process going on (Malliaras, 2010). Our findings suggest that treatment with EPTE® combined with an isoinertial eccentric training shows good and safe clinical results in patients with chronic patellar tendinopathy, specially those patients who are willing to retake physical activity soon. **References** Malliaras P, Purdam C (2010). Br J Sports Med, 44, 944-947. Romero-Rodríguez D, Gual G (2011). Phys Ther Sport, 12(1), 43-8. Contact alvaro.fernandez@alumno.ujc.edu

## LEG DOMINANCE AND BONE CROSS-SECTIONAL GEOMETRY OF THE PROXIMAL FEMUR IN ELITE CRICKET FAST BOWLERS

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**Introduction:** The skeleton of an elite cricket fast bowler is exposed to substantial ground reaction forces that are delivered through the front foot during the contact phase. There is also significant loading to the lumbo-pelvic region, through peak transverse plane rotation moments and increased anterior posterior shear forces. Non-contact bone injuries are common amongst elite cricket fast bowlers, but few studies have investigated unilateral bone strength in this sports population. The aim of this study was to investigate bone cross-sectional geometry of the proximal femur in elite fast bowlers to determine if any asymmetries or insufficiencies exist. **Methods:** Dual energy X-ray absorptiometry (GE Lunar iDXA) of the left and right proximal femur was performed in 16 elite male fast bowlers (age:  $21.4 \pm 4.4$  years; BMI:  $24.7 (2.2)$  kg.m<sup>-2</sup>; %body fat:  $18.0 (3.8)$ ; lean tissue mass (LTM):  $66.7 (5.3)$  kg) and 12 normally-active controls (age:  $21.4 (1.6)$  years; BMI:  $23.7 (2.6)$  kg.m<sup>-2</sup>; %body fat:  $20.5 (5.0)$ ; LTM:  $56.5 (3.8)$  kg). The hip structural analysis programme (enCORE v 15.0) determined areal bone mineral density (BMD), cross-sectional area (CSA), section modulus (Z), and cross-sectional moment of inertia (CSMI) and bone strength index (BSI) of the femoral neck. **Results:** Femoral neck, wards area, trochanter and total hip aBMD were significantly greater in fast bowlers than controls, and differences remained after adjustment for LTM ( $1.202$  to  $1.417$  g.cm<sup>-2</sup> v  $0.982$  to  $1.163$  g.cm<sup>-2</sup>,  $p < 0.005$ ). All bone geometrical properties of the left and right femur were superior in fast bowlers compared to controls ( $p = 0.024$  to  $p < 0.001$ ), and after adjustment for LTM, differences in CSA and BSI remained ( $p < 0.01$ ). There were no associations with age. There were no asymmetries in bone density or geometrical properties when considering leg dominance (front foot) of the fast bowlers ( $p = 0.103$  to  $0.784$ ). **Conclusions:** This study indicates that elite male fast bowlers have superior bone strength of the proximal femur with results inferring an enhanced resistance to axial (CSA), bending (Z) and compressive loads (BSI). This is likely to reflect a positive adaptation of bone to loading through fast bowling and greater LTM. No asymmetries in femur bone properties were identified.

## MUSCLE STRENGTH CHARACTERISTICS OF ANKLE AND TOE IN RUNNERS WITH HISTORY OF MEDIAL TIBIAL STRESS SYNDROME

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**Introduction** Medial tibial stress syndrome (MTSS) is one of the most common overuse injuries in runners. Because of pain location and alignment during running, MTSS is considered to associate with elongational stress to inverter muscles. However, studies on muscles strength in athletes with MTSS revealed conflicting results. Because flexor digitorum longus (FDL) and flexor hallucis longus (FHL) works as the inverter of the ankle, strengths of hallux and lesser toe could relate to MTSS. However, muscle strength of the hallux and lesser toes has conventionally not been evaluated because of the lack of method to evaluate this strength quantitatively. In this study, using a newly developed device, we examined the muscle strength characteristics including the 1st metatarsopharangeal joint (MTPJ) and 2nd to 5th MTPJ in runners with MTSS history. **Methods** Eighteen collegiate male runners (10 subjects with bilateral MTSS history, 1 with unilateral MTSS, and 7 without MTSS history) participated in this study. Their limb were classified into either MTSS group (history limbs, 21 limbs) or no history group (no history limbs, 15 limbs). MTSS history was defined as those who meet the following criteria; 1) having an experience of exercise induced pain which is located on the posteromedial border of the tibia, 2) palpation of the posteromedial border of the tibia produced discomfort, 3) the site had to be spread over a minimum of 5 cm, 4) no diagnose of stress fracture by surgeon, 5) no pain in lower limb now. We measured maximal voluntary isometric contraction (MVIC) torque of plantarflexion, dorsiflexion, inversion and eversion of ankle using an electrical dynamometer. Additionally, MVIC torque of the 1st MTPJ and 2nd to 5th MTPJ were measured using a custom made torque measuring device (Saeki et al., 2015). Unpaired t-test was used to test the difference of each MVIC torques between the two groups. **Results** MTSS history group produced significant higher MVIC torque of 1st MTPJ than no history group. There was no difference between two groups in other indices. **Discussion** Elongational stress to the tibialis posterior (TP), FDL or soleus is considered to be one of the causes of MTSS (Moen et al., 2009). MTSS history limbs produced higher MVIC torque of 1st MTPJ than no history limbs in this study. This result suggested that activity of the FHL, which originate not from the tibia but has the same function of inversion may increase to reduce the load on TP or FDL during running in MTSS history limb. **Reference** Saeki J, Tojima M, Torii S (2015). J Phys Ther Sci, 27(6), 1795-1797. Moen MH, Tol JL, Weir A, Steunebrink M, De Winter TC (2009). Sports Med, 39(7), 523-546. Contact saeki.junya.55z@st.kyoto-u.ac.jp

## IMPACT OF THREE-POINT WALKING IN WOMEN WITH TOE DEFORMITY

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**Introduction** Toe deformity as hallux valgus (HV) and floating toes, is the common foot pathologies problem in modern society. Previous study was reported that patients with HV were larger in women compared to men, because the majority women wear high heels and thin shoes. Normally, healthy foot has three arches. There are anterior transverse arch, lateral longitudinal arch, and medial longitudinal arch. However, if there is a toe deformity, these three arches of the foot collapses. Additionally, these collapses cause lumbar pain, stiff shoulder, autonomic imbalance and so on. Three-point walking could replace to the healthy foot. Therefore, the purpose of this study was to evaluate whether three-point walking improved toe deformity in women. **Methods** Seven healthy women were enrolled in this study. All subjects underwent a three-point walking. And wear the sock, as a roll of taping with three arches. They walked to continue 3 months, twice a week, 30 minutes per each time. We measured muscle hardness in lower back, toe muscle power, plantar pressure, bearing area of the plantar, and position of the center of gravity. Additionally, we evaluated toe condition score, as a quantitative parameter. **Results** Mean subjects age was  $42 \pm 6$  years. Muscle hardness in lower back was not significantly changed in 3 months walking. However, toe muscle power after walking was significantly increased compared to before walking (right,  $16.7 \pm 2.7$  vs.  $19.6 \pm 3.0$  kg,  $P = 0.04$ ; left,  $16.2 \pm 2.7$  vs.  $19.1 \pm 3.7$  kg,  $P = 0.03$ ). Appearance ratio with HV in 3 months after walking was significantly decreased compared to before walking ( $42.9$  vs.  $7.1$  %,  $P = 0.05$ ). Floating toe score and bearing area of the plantar were significantly improved with walking (floating score,  $5.9 \pm 3.1$  vs.  $13.1 \pm 4.1$ ,  $P = 0.01$ ; bearing are,  $40.1 \pm 15.6$  vs.  $56.3 \pm 12.1$  %,  $P = 0.01$ ). In addition, position of gravity was shown a trend toward improvement in 3 months after walking ( $3.4 \pm 1.9$  vs.  $4.6 \pm 0.7$ ,  $P = 0.08$ ). **Discussion** Three-point walking increased toe muscle power. Moreover, appearance ratios with HV, floating toe score, and bearing area of the plantar were significantly

improved with walking. Consequently, three-point walking in 3 months improved toe deformity in women. References Morales-Orcajo E, Bayod J, Becerro-de-Bengoa-Vallejo R, et al. (2015). *Med Biol Eng Comput*, 53(7), 645-653.

### NON-ELITE ATHLETES WITH VENTRICULAR PREMATURE BEATS: WHAT IS THE ARRHYTHMIC BURDEN CONTINUING INTENSE TRAINING?

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**INTRODUCTION** Isolated ventricular premature beats (VPBs) are commonly found during pre-participation screening in athletes. Several studies on elite athletes suggest that VPBs may be expression of 'athletes' heart', other authors advise that VPBs may increase the cardiovascular risk and rise suspicion of Cardiomyopathy. Currently the debate about the role of detraining in reducing the number of VPBs is still open (Biffi et Al, 2002; Mc Claskey et Al, 2013). The aim of the study was to evaluate the arrhythmic burden and follow-up in a population of young competitive non elite athletes showing VPBs during pre-participation screening and that continued practicing competitive sports. **METHODS** In a four-year period, 2784 subjects underwent to pre-participation screening. Athletes who showed VPBs were selected (n.66) and underwent to a complete second level evaluation (Echocardiogram, 24h Holter Electrocardiogram (ECG) recording and Maximal Exercise test). Athletes were re-evaluated after 6 to 48 months, while they continued practicing competitive sports. **RESULTS** 2,3% of total screened population showed ventricular arrhythmias. Among this athletes 80% showed isolated VPBs. 83% showed monomorphic VPBs, 17% showed polymorphic VPBs. There was not relation between morphology of VPBs and gender, number of VPBs/24h or complexity of VPBs. At echocardiogram no pathology determining exclusion from competitive activity was found. No athlete showed exercise-induced VPBs. At Holter ECG recording mean number of daily VPBs was  $1777 \pm 4045$  (range 0-23.094). Exercise test follow-up (17±12 months) did not show any worsening in the pattern of presentation of VPBs and the complexity of arrhythmias was unchanged. At Holter ECG follow-up (21±13 months) the median number of VPBs decreased from 309 (IQR 20-3065) to 149 (IQR 2-1299); the complexity of VPBs was reduced. **DISCUSSION** Continuing competitive sport in athletes with ventricular arrhythmias even frequent, with a low grade of complexity and without structural cardiomyopathy at echocardiogram, did not increase the arrhythmic burden. **REFERENCES** Biffi A, Pelliccia A, Verdile L et Al. Long-term clinical significance of frequent and complex ventricular tachyarrhythmias in trained athletes. *J Am Coll Cardiol*. 2002 McClaskey D, Lee D, Buch E. Outcomes among athletes with arrhythmias and electrocardiographic abnormalities: implications for ECG interpretation. *Sports Med*. 2013 **CONTACT:** e.tranchita@uniroma4.it

### IMMEDIATE CHANGES IN MEDIAL ELBOW LAXITY DURING REPETITIVE THROWING IN HIGH SCHOOL BASEBALL PLAYERS

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**Introduction** Although a previous study has demonstrated changes in medial elbow laxity over time in baseball pitchers (Ciccotti MG, 2014), the immediate effects of baseball pitching on elbow laxity has not been reported. Therefore, the purpose of our study was to investigate the immediate changes in medial elbow laxity following repetitive throwing. **Methods** 19 high school baseball players participated in this study. Each subject pitched 100 times. Ultrasound imaging of the medial aspect of the elbow was obtained under two conditions: 1. gravitational stress applied at 90 degree elbow flexion and 2. 30 N of valgus stress on the ulnar styloid process at 30 degree elbow flexion. In each situation the subject was supine with the shoulder in 90 degrees abduction. Measurement of laxity was carried out before pitching and after every 20 pitches. 2-way repeated measures ANOVA was used to compare ulnohumeral joint space width between repeated trials, and between gravity stress and 30N of valgus stress. This study was approved by the Ethics Committee at the Saitama Medical University, Saitama, Japan (M-66). **Results** Ulnohumeral joint space width (mean±SD: under gravity stress and 30N of valgus stress) was as follows: prior to pitching ( $4.98 \pm 0.96$ mm,  $5.59 \pm 0.89$ mm), after 20 pitches ( $5.23 \pm 0.97$ mm,  $6.04 \pm 0.77$ mm), after 40 pitches ( $5.55 \pm 0.88$ mm,  $6.30 \pm 0.80$ mm), after 60 pitches ( $5.88 \pm 0.96$ mm,  $6.55 \pm 0.79$ mm), after 80 pitches ( $6.01 \pm 1.12$ mm,  $6.88 \pm 1.01$ mm) and after 100 pitches ( $6.24 \pm 1.08$ mm,  $7.24 \pm 0.99$ mm). 2-way repeated measure of ANOVA showed significant differences between ulnohumeral joint space width before pitching and following every 20 pitching, and between gravity stress and 30N of valgus stress. Post hoc testing showed that after more than 60 pitches, ulnohumeral joint space width was significantly greater than prior to pitching ( $p < 0.05$ ). In addition, there were also significant changes in ulnohumeral joint space width with gravity stress and with 30N of valgus stress. **Discussion** In our study, it was likely that repetitive loading of elbow valgus stress during repetitive throwing contributed to the increase in medial elbow laxity. Although previous studies have assessed medial elbow laxity using gravity stress or Telos stress (Harada, M, 2014), our study is the first to assess gravity stress and 30N of valgus stress, and the results were consistent with previous studies. **References** Ciccotti MG, et al. (2014). *Am J Sports Med*, 42(3), 544-551. Harada, M, et al. (2014). *J Shoulder Elbow Surg*, 23, 561-566. **Contact** hiroshi.hattori1024@gmail.com

### DYNAMIC KNEE VALGUS INFLUENCES ANGULAR IMPULSES IN THE LOWER EXTREMITY DURING THE DECELERATION PHASE OF A SINGLE-LEG LANDING

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1: Saitama Medical University Graduate School of Medicine, 2: Sekishindo Hospital, 3: Saitama Medical University, 4: Zenshukai Hospital, 5: Yokohama Asahi Center General Hospital, 6: Kanetsu Hospital **Introduction:** Dynamic knee valgus during landings has been associated with an increased risk of non-contact ACL injuries. Additionally, the shock imposed on the body during landings must be attenuated by "soft" landings in the lower extremity. It has been suggested that decreasing the capacity to attenuate the shock is one of the factors to cause a knee injuries including ACL. The purpose of this study was to investigate the characteristic of the shock attenuation mechanism on dynamic knee valgus by measuring the vertical ground reaction impulse (vGRI) and angular impulses in the lower extremity during the deceleration phase of a single-leg landing. **Methods:** Thirty-four college females participated in this experiment. They performed the single-leg drop vertical jump. Lower extremity kinetics and kinematics data were obtained from the 3D motion analysis system and two force plates. All participants were divided into the valgus group (N=19) and the varus group (N=15) according to knee angular displacement in the frontal plane during the deceleration phase, defined as the time period from initial contact to peak vertical ground reaction force (vGRF). The vGRI and angular impulses of hip, knee and ankle were calculated by integrating the vGRF - time and the respective joint

moment - time curves. Unpaired t test was used to analysis the difference between two groups. This study was approved by the Ethics Committee at the Saitama Medical University, Saitama, Japan (M-54). Results: The vGRI was no difference between two groups ( $p>.05$ ). Knee angular impulse in the valgus group was significantly greater than those in the varus group ( $0.91\pm0.31$  vs.  $0.44\pm0.40$  Nms/kgm,  $p<.01$ ). On the other hand, hip angular impulse in the valgus group was significantly smaller than those in the varus group ( $0.18\pm0.33$  vs.  $0.65\pm0.29$  Nms/kgm,  $p<.01$ ). There was no difference in ankle angular impulse between two groups ( $p>.05$ ). Conclusion: The vGRI and angular impulses show the net force and joint moments applied to the lower extremity over time periods during the deceleration phase of landings. From this study, our results indicated that dynamic knee valgus cause a increasing of the shock applied to knee joint. In addition, dynamic knee valgus might attenuate the shock in hip joint during the deceleration phase of landings. These findings suggest the importance of evaluations and exercises related to the shock attenuation mechanism on dynamic knee valgus. Contact: a.tamura.dp@gmail.com

## VIDEO ANALYSIS OF HEAD INJURIES CAUSED BY TACKLING IN COLLEGE RUGBY UNION PLAYERS

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**Introduction** In recent years, we focus on head injuries included concussion to have possibilities to trigger catastrophe in rugby union. Head injuries and concussion alike were commonly sustained in the tackling (Kemp et al., 2008). Thus, it suggests that we need to analyze injury situations during tackling in particular. Additionally, to make a comparison between injury situations and general tackle situations, we clear up the questionable points to head injuries caused by tackling. Therefore, the aim of this study was to identify mechanisms of head injuries caused in rugby union from video records. **Methods** Elite collegiate rugby players sustained head injuries in match were extracted during six playing seasons in Japan collegiate rugby union. Tackle which caused a head injury and general tackle in the same match which tackles were performed by the injured tacklers before the head injury happened were coded risk factors for head injuries from video records of the matches (Fuller et al., 2010; Quarrie et al., 2008). Risk factors for head injuries were determined using a logistic regression model. Results 56 players sustained head injuries during the six seasons. 42 head injuries of all head injuries during the six seasons were coded risk factors from video records and 22 head injuries were caused by tackling. The following performance were extracted for head injuries : tacklers approached and contacted ball carriers, with moving same direction of the ball carrier (OR, 21.6; 95%CI, 6.3-73.8;  $p=0.00$ ), head or neck of tacklers contacted ball carriers (OR, 7.8; 95%CI, 1.3-47.0;  $p=0.03$ ), tacklers hit from front side of ball carriers (OR, 32.8; 95%CI, 1.9-559.12;  $p=0.02$ ) **Discussion** Head injury were more frequency caused by tackling. We found that moving same direction of the opposition player before the tackle situation, contacting by head and static condition in the tackle situation were associated with head injuries. Concussion occurred when linear and/or rotational force are transmitted to the brain (Harmon et al., 2013). Thus, enough damage to the brain may result from contacting the opposition player by the head of the tackler. **References** Fuller CW, Ashton T, Brooks JH, Cancea RJ, Hall J, Kemp SP. (2010). Br J Sports Med. 44, 159-167. Harmon KG, Drezner J, Gammons M, Guskiewicz K, Halstead M, Herring S, Kutcher J, Pana A, Putukian M, Roberts W. (2013). Clin J Sport Med. 23, 15-26, 2013. Kemp SP, Hudson Z, Brooks JH, Fuller CW. (2008). Clin J Sport Med, 18, 227-234. Quarrie KL, Hopkins WG. (2008). Am J Sports Med. 36, 1705-1716. Contact Keita Suzuki (k.s.19920312@gmail.com)

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### PO-CPP-28 Training & Testing 6

#### THE RELATIONSHIP BETWEEN THROWING VELOCITY AND SHOULDER INTERNAL AND EXTERNAL STRENGTHS IN JAPANESE WATER POLO PLAYERS AGED 9 – 18 YEARS

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**Introduction** Throwing is one of the most important skills in water polo. Throwing factors are difficult to determine for various reasons such as differences in physical fitness and techniques. The relationship between throwing velocity and shoulder internal and external muscle strengths in baseball players has been studied extensively (Cater, et al., 2007). Compared with that in baseball, the throwing movement in water polo differs according to the size of the ball. Therefore, this study aimed to examine the relationship between throwing velocity and shoulder internal and external muscle strengths in different age water polo players. **Methods** A total of 48 Japanese water polo players participated in this study. The participants were divided into the following 3 groups according to age range: elementary school group ( $n = 16$ ; ages, 9 - 12 years), junior high school group ( $n = 13$ ; ages, 13 - 15 years), and high school group ( $n = 19$ ; ages, 16 - 18 years). During a penalty throw, each player threw the ball 3 times to shoot at the goal. The throwing initial velocity was measured by a speed gun using Doppler ultrasonography. The following physical fitness indicators of the shoulder joint were used: internal and external isometric muscle strengths were measured using a handheld dynamometer (µTas F-1, Anima). Results The throwing initial velocity was  $43.2 \pm 8.7$  km/h,  $55.9 \pm 4.9$  km/h, and  $60.0 \pm 5.7$  km/h, in the elementary school, junior high school, and high school groups, respectively. The internal and external isometric muscle strengths were increase with advancing age. Moreover, the internal and external isometric muscle strengths on the throwing side were higher than those on the non-throwing side. The throwing initial velocity had a moderate correlation with internal and external isometric muscle strength on the throwing side. **Conclusions** These findings showed a correlation between throwing velocity and internal and external muscle strengths regardless of age. Therefore, increased shoulder internal and external muscle strengths are required. In conclusion, the results of this study suggested that the shoulder internal and external isometric muscle strengths were important indicators of throwing velocity in water polo players. **Reference** Cater, et al. (2007). Effects of high volume upper extremity plyometric training on throwing velocity and functional strength ratios of the shoulder rotators in collegiate baseball players. J Strength Cond Res, 21, 208-215. Contact komori@oiu.jp



## TRAINING LOAD AND SUBSEQUENT WELLNESS UNDERTAKEN BY AN ELITE SOCCER GOALKEEPER: A CASE STUDY REPORT

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**Introduction** The role of a goalkeeper is a unique but often overlooked position in soccer. Whilst the training load practices of outfield players has been examined in detail (Malone et al. 2015), such information in goalkeepers is relatively unknown. Therefore, the purpose of the present study was to quantify the training load undertaken by an elite professional goalkeeper. **Methods** One male international elite goalkeeper participated in this study. Training load data was collected over an 8 week period during the in-season phase (two mesocycles) using a global positioning system (GPS) device, heart rate and session rating of perceived exertion (S-RPE). The following parameters were exported and analysed from the software: duration, total distance covered, average speed (total distance/total duration), high speed distance (> 5.5 m/s), high acceleration and deceleration efforts (> 3 m/s<sup>2</sup>), PlayerLoad<sup>TM</sup> and average heart rate. Data was assessed in relation to the number of days prior to a match (MD-). In addition, the subsequent total wellness was assessed using an adapted questionnaire from Hooper et al. (1995). **Results** Duration, total distance, PlayerLoad<sup>TM</sup> and session-RPE were highest on MD-2, but remained similar across the remaining training days. Total wellness scores were highest on MD-3 (mean 21 au), but remained similar across the training microcycles (mean 17-18 au). There was no significant relationship between training load measures and the subsequent wellness response across all MD- days ( $P > 0.05$ ). **Discussion** This exploratory case-study provides novel data about the training load undertaken by a goalkeeper towards matches. The data suggest there is a limited relationship between training load measures and subsequent wellness in goalkeepers. Previous work has found large correlations between such measures (Buchheit et al. 2013) using parameters applicable to the athlete's role (e.g. high speed distance covered in Australian Rules Football). The lack of relationship in the present study may be due to the lack of position-specific training load parameters we can currently measure in the applied context. Future work should look to utilise current wearable technology to generate goalkeeper-specific parameters in order to fully understand the loading profile at the elite level. **References** Buchheit et al. (2013) J Sci Med Sport, 16, 550-555. Hooper et al. (1995) Med Sci Sports Exerc, 27, 106-112. Malone et al. (2015) Int J Sports Phys Perf, 10, 489-497. Contact Dr. James Malone – james@catapultsports.com

## THE EFFECTS OF ISOKINETIC HIP FLEXION AND EXTENSION TRAINING FOR MEN'S UNIVERSITY FOOTBALL PLAYERS

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**Introduction** The studies about hip muscular strength have been reported that the muscles iliopsoas was active during the entire kicking motion and the mean ball velocity related significantly with hip flexion strength of the kicking leg and hip extension strength of the supporting leg. So this study was designed to clarify the effect of isokinetic hip flexion and extension training over eight weeks training and to examine the change in mean ball velocity by kick, jump height, and sprint speed before and after training for men's football players. **Methods** The Subject were sixteen university football players. The team had trained 12 to 15 practice hours per week and played at least one soccer game per week. There were divided into 2 groups (training group, control group), and measured isokinetic hip Flex/Ext strength at 3 angular velocities (60, 180, 300deg/sec), mean ball velocity by kick, jump height (Squat jump: SJ, Counter movement jump: CMJ), and 30m sprint speed before and after training. Training group did isokinetic hip flexion and extension training. BIODEX SYSTEM 3 was used for training and measurement of muscular strength. Training intensity was 180deg/sec of angular velocity. Training was conducted 3 days per week, 3 sets per day, and 10 repetitions per set for 8 weeks. **Results** As a result, the changes of isokinetic hip Flex/Ext strength were indicated as follows. Isokinetic hip extension strength at 180, 300 deg/sec was significantly improved with training. And isokinetic hip Flex/Ext strength at all angular velocities tended to improve. Mean ball velocity by kick and jump height was significantly improved. Although sprint speed shows no improvement, it tended to improve within after 15m. **Discussion** It suggested that improvement of hip extension strength affected improvement of mean ball velocity and jump height. These results suggested that hip extension strength is important for mean ball velocity and jump height. **References** 1. Dorge,H.C. et al. (1999). Scand. J. Med. Sci. Sports, 9, 195-200. 2. Masuda,K. et al. (2005). J SPORTS MED PHYS FITNESS, 45, 44-52.

## COMPARISON OF DIFFERENT EVALUATION METHODS OF PROFESSIONAL SOCCER PLAYERS' PHYSICAL AND PHYSIOLOGICAL CHARACTERISTICS

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**Introduction** The aim of this study is determination of the most suitable and fastest method to measure the physical and physiological capacities of soccer players by comparing laboratory and field tests with software supported non-invasive method (SSNM) relatively new approach. **Method** First of all all players were joined the antropometric measurements (height, weight, fat), SSNM measurements and VO2max measurements. Secondly, lactic acid tests were applied. Thirdly, Aerobic capacity (Yo-yo IR1) test was completed. And finally, anaerobic capacity (Sprint, Sprint Fatigue-Power Maintenance) test were completed. Repeated measures of ANOVA was used to analysis of variable within the triple groups to learn the statistical differences. Paired-Samples t test was used to investigate the differences between binary groups measurements, and correlation was used to investigation of relationships. **Results** As a result of the measurements, 2mmol HR values and Aerobic threshold maintenance values obtained from the SSNM measurements, 4mmol HR values and Yo-yo IR1 HR values, VO2max HR values and Yo-yo IR1 HR values, VO2max HR values and 4mmol HR values, 4mmol threshold running speed values and Yo-yo IR1 running speed values, SSNM VO2max values and VO2max values, SSNM VO2max values and Yo-yo IR1 VO2max values were similar. But there were differences between SSNM anaerobic threshold HR values and 4mmol HR values, VO2max HR values and Yo-yo IR1 HR values, SSNM anaerobic threshold running speed values and 4mmol threshold running speed values, SSNM anaerobic threshold running speed values and Yo-yo IR1 running speed values. **Discussion** Subjects' running speeds were determined as 15.42±0.99 km/h for 4 mmol level, and 13.65±0.93 km/h for SSNM. There are similar resulted studies in literature, 4 mmol running speed is 15.9±0.9 km/s (Kunduracioglu et al, 2007), 15.9±2.6 km h<sup>-1</sup> (Berthoin et al., 1994). Subjects' Direct VO2 max value was determined as 53.53±2.69 ml/min/kg and SSNM VO2 max value was determined as 53.74±3.90 ml/min/kg. Luhtanen et al., (2007) explained the VO2 max of soccer players is 53.5 ml/min/kg to investigate the heart rate variability at a tournaments. Rampinini et al (2005) was determined VO2 max of players as 53.3±4.2 ml/min/kg at training to determine the physiological load from HR. There is similarity between this study's VO2 max values and studies of Luhtanen et al., (2007) and Rampinini et al (2005). **References:** Kunderacioglu, B. et al. (2007).

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### LACTATE TURN POINTS IN INCREMENTAL LEG CYCLE ERGOMETER AND BICEPS CURL EXERCISE

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**Introduction** The lactate shuttle theory (LST) describes a 3-phase response of the balance between muscle lactate (La) production and local or systemic La oxidation (l). 2 turn points (TPs) separate these phases in incremental ergometer exercise (lET) (l), also described for leg resistance exercise (3l). Aim of the study was to determine lactate TPs and to analyse metabolic and cardiorespiratory responses to incremental biceps curl (B) and cycle ergometer exercise (C). **Methods** 12 trained male (10) and female (2) subjects (24.5±3.2 yrs, 75.2±7.4 kg) performed a cycle lET (20-40W; 15-20W; 1min) to determine the first (LTP1) and the second (LTP2) lactate TP and an lET biceps curl test (B) after a 1RM test. In B, workload was increased by 30% of 1RM/15 kg per min (30 curls/min) up to max. LTP1 and LTP2 were determined by lin. regression break point analysis. Heart rate (HR) and gas exchange variables were measured continuously and La was determined after each load step. Results Pmax in C was 289.6±38.8 W (HRmax: 183.2±10.9 b.min<sup>-1</sup>, Lamax: 11.5±2.3 mmol.l<sup>-1</sup>, VO2max: 3.9±0.5 l.min<sup>-1</sup>). LTP1 was detected at 91.2±21 W (HR: 118.9±12.7 b.min<sup>-1</sup>, La: 1.2±0.4 mmol.l<sup>-1</sup>) and LTP2 at 193.9±27.1 W (HR: 158.8±10.2 b.min<sup>-1</sup>, La: 3.6±0.8 mmol.l<sup>-1</sup>). Peak load in B was 5.1±0.7 kg and HRmax (132.4±14.1 b.min<sup>-1</sup>), Lamax (2.2±0.4 mmol.l<sup>-1</sup>) and VO2max (1.2±0.3 l.min<sup>-1</sup>) were sign. lower. LTP1 was detected at 1.8±0.6 kg (HR: 90.9±13.5 b.min<sup>-1</sup>, La: 0.9±0.4 mmol.l<sup>-1</sup>) and LTP2 at 3.7±0.6 kg (HR: 104.4±10.3 b.min<sup>-1</sup>, La: 1.4±0.4 mmol.l<sup>-1</sup>). %Pmax at LTP1 and LTP2 were significantly different between C (LTP1: La 10.6%; HR 64.9%; LTP2: La 31.5%; HR 86.7%) and B (LTP1: La 41.1%; HR 68.7%; LTP2: La 63.5%; HR 78.9%) but not sign. for power output related to max in B and C (C: LTP1: P 31.5%; LTP2: P 67.0%; B: LTP1: P 34.8%; LTP2: P 71.8%). **Discussion** LTP1 and LTP2 could be determined in B, and PLTP1 and PLTP2 as well as % of Pmax were comparable between B and C. Values for La and HR at max and LTP1 / LTP2 were sign. different in absolute terms and as % of max between B and C. HR in local small muscle lET such as B shows a different HR pattern due to a different haemodynamic regulation but the 3-phase response as well as the distribution of metabolic phases is comparable to C. These results indicate that the LST may be applied to small muscle group strength endurance exercise. **References** (1) Hofmann, P. & Tschakert, G. (2011). Cardiology research and practice, 2011: 209302. (2) Brooks, G. A. (2007). Sports Med. 2007;37(4-5): 341-3. (3) Maté-Muñoz, J. L., Domínguez, R., Barba, M., et al.: (2015). Journal of sports science & medicine, 14(3): 648-656. Contact: [alexander.mueller@uni-graz.at; peter.hofmann@uni-graz.at]

### ASSOCIATIONS BETWEEN DYNAMIC KNEE VALGUS, AND ABDOMINAL AND HIP ABDUCTOR MUSCLES ACTIVATION DURING SINGLE-LEG SQUATS

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**Introduction** Many researchers conduct the screening test for dynamic knee valgus to prevent non-contact anterior cruciate ligament injury. The factors of dynamic knee valgus are detailed malalignment of lower extremity caused by dysfunction of abdominal or hip abductor muscles. The activities of thigh muscles during single-leg squats were indicated, but there were few reports about abdominal and hip abductor muscles. The aim of this study was to determine association between dynamic knee valgus and, abdominal and hip abductor muscles activation. **Methods** Eight healthy basketball players (12 legs) participated in this study (age: 20.7 ± 1.2 years, height: 166.0 ± 9.1 cm, weight: 57.3 ± 7.2 kg). The subjects performed single-leg squats of both the right and left legs. This procedure was recorded using a 3D motion capture (VICON) and surface electromyography (EMG). Knee abduction and flexion angles were measured using the VICON. Surface EMG data was recorded for each external oblique (EO), transversus abdominis-internal oblique (TrA-IO), rectus abdominis (RA), erector spinae (ES), gluteus medius (GM) and tensor fasciae latae (TFL) muscles. Each EMG activities were calculated the root mean square for 1 second until maximal knee flexion, and normalized by maximal voluntary contractions. Pearson's correlation coefficient was used to examine correlations between each EMG activities and the 3D kinematic variables. The significance of differences in muscle activation between weight bearing and non-weight bearing sides during single-leg squats was analyzed using Mann-Whitney U test. Statistical significance was established at a level of  $p < 0.05$ . **Results** There was no statically significant relationship between knee abduction angle and muscle activation. RA and ES activations in non-weight bearing side were greater than in weight bearing side (RA:  $p < 0.02$ , ES:  $p < 0.01$ ). GM activation in weight bearing leg was greater than in non-weight bearing leg ( $p < 0.01$ ). **Discussion** It was interesting that the EMG activities in non-weight bearing side were great not so much for local muscles but for global muscles such as RA and ES. Kagaya et al. (2015) reported that a dynamic Trendelenburg test (DTT) positive which observed contralateral pelvic drop was about 30% of the legs in single-leg squats, and the dynamic knee valgus was twice as high in the DTT-positive group than in the DTT-negative group. In the future, increasing a number of subjects and considering not only sex but also influence of DTT are needed to find out associations between dynamic knee valgus, and abdominal and hip abductor muscles activation during single-leg squats.

### USING TIME TO EXHAUSTION IN THE UNIVERSITÉ DE MONTRÉAL TRACK TEST TO EVALUATE MAXIMUM OXYGEN UPTAKE IN THE TRACK FIELD FOR FEMALE MASTER RECREATIONAL RUNNERS

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**INTRODUCTION** Over the years, coaches have used many different field tests to assess indirectly maximum oxygen uptake (VO2max) since it has an important relationship with running performance. Due to its simplicity and feasibility, one of the most well-known progressive incremental field tests for runners is the Université de Montréal Track Test (UMTT) (1). The purpose of our study was to validate the use of time to exhaustion (TE) to determine VO2max in the track field for female master recreational runners. We obtained, after performing UMTT in a treadmill in the laboratory, a formula that correlates both variables. **METHODS** Forty-two women (mean age 40±7 years), trained for recreational running, performed a UMTT in a treadmill until exhaustion. Ventilatory parameters and heart rate were continuously monitored and tVO2max (treadmill VO2max) and tTE (treadmill TE) were obtained. The same UMTT was performed in a track field recording fTE (field TE). After checking the significant correlation between tTE and fTE, the association between tVO2max and fTE was tested with a Pearson correlation test, thus obtaining a first order equation that allowed estimating fVO2max from fTE. The mean differ-

ence between  $\dot{V}O_{2\max}$  and  $\dot{V}O_{2\max}$  values was also calculated. RESULTS The correlation between  $\dot{V}E$  and  $\dot{V}E$  was statistically significant ( $r=0.92$ ,  $P<0.001$ ) as well as the relationship between  $\dot{V}E$  and  $\dot{V}O_{2\max}$  ( $r=0.66$ ,  $P<0.01$ ). The first order equation obtained in the treadmill for calculating  $\dot{V}O_2$  (mL/kg/min) from  $\dot{V}E$  (seconds) was:  $\dot{V}O_2=0.027\cdot\dot{V}E+26.953$ . The mean difference between  $\dot{V}O_{2\max}$  and  $\dot{V}O_{2\max}$  was  $0.2\pm 4.3$  mL/kg/min. DISCUSSION The UMTT is a well-known progressive incremental field track test for runners. Many studies used this test to calculate  $\dot{V}O_{2\max}$  from several parameters obtained in a treadmill. Most of these studies were done on populations of young (mainly male) trained athletes (1, 2, 3). Here we present a first order simple equation to estimate  $\dot{V}O_{2\max}$  from a single parameter ( $\dot{V}E$ ) that applies to a very specific population group: Caucasian middle-aged pre-menopause women trained at the recreational level. Since in recent years there has been a growing inclusion of women of all ages in running, this equation will provide an easy tool to obtain the maximal aerobic power in this population group. REFERENCES (1) Léger L, Boucher R (1980) Can J Appl Sports Sci 5:77-84. (2) Berthoin S et al (1999) J Sports Med Phys Fitness 39:107-112. (3) McLaughlin et al (2010) Med Sci Sports Exerc 42:991-997.

## ARE CURRENT EXHAUSTION CRITERIA FOR PHYSICAL EXERCISE TESTING HIGH ENOUGH TO SUFFICIENTLY DETERMINE $\dot{V}O_{2\max}$ ?

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Introduction: In physical exercise testing exhaustion is necessary to determine the maximum volume of oxygen uptake ( $\dot{V}O_{2\max}$ ), but different criteria to define exhaustion are found in different guidelines. We compared values from three different guidelines (Steinacker et al., 2002; Tschopp et al., 2001; Rassouli and Thurnheer, 2015) for maximum heart rate ( $HR_{\max}$ ), maximum respiratory exchange ratio ( $RER_{\max}$ ), maximum rating of perceived exertion ( $RPE_{\max}$ ) and maximum blood lactate concentration ( $Lac_{\max}$ ) with values found in young male athletes. The criteria in the guidelines ranged from  $> 90\%$  to  $\geq 100\%$  of the predicted  $HR_{\max}$ ,  $> 1.05$  to  $\geq 1.15$  for  $RER_{\max}$ ,  $> 12$  to  $\geq 18$  for  $RPE_{\max}$  and  $> 4$  to  $\geq 8$  mmol/l for  $Lac_{\max}$ . Methods: Eighty-four males performed a cardiorespiratory fitness test on a bicycle ergometer, starting at 50 W with a linearly increasing workload of 25 W/min until exhaustion to determine  $\dot{V}O_{2\max}$ . Breath-by-breath gas analyses and HR were measured permanently, RPE was recorded every three minutes and blood lactate concentration was determined at exhaustion and three minutes after exhaustion. Further,  $\dot{V}O_2$  was assessed for the time points when  $RER$  reached 1.05, 1.10 and 1.15 and when HR reached 90% and 100% of the predicted  $HR_{\max}$ . Results: Participants' median (interquartile range, IQR) age was 23 years (22; 29), maximum workload was 400 W (368; 429) and  $\dot{V}O_{2\max}$  was 61 mL/kg/min (56; 66). Regarding the exhaustion criteria, the median  $HR_{\max}$  was 191 bpm (187; 197),  $RER_{\max}$  was 1.18 (1.15; 1.22),  $RPE_{\max}$  was 20 (20; 20) and  $Lac_{\max}$  was 14.1 mmol/l (12.6; 15.9). The median  $\dot{V}O_2$  (IQR) at  $RER=1.05$  was 54 mL/kg/min (50; 60), at  $RER=1.10$  it was 57 mL/kg/min (53; 63) and at  $RER=1.15$  it was 59 mL/kg/min (55; 54). At 90% and 100% of the predicted  $HR_{\max}$  the median  $\dot{V}O_2$  (IQR) was 47 mL/kg/min (41; 53) and 58 mL/kg/min (50; 63), respectively. A total of 16/84 subjects did not reach  $RER=1.15$ , 13 did not reach 100% of the predicted  $HR_{\max}$  and one did not reach  $Lac_{\max} \geq 10$  mmol/l. Discussion: In intervention studies as well as in evaluating training effects it is crucial to determine  $\dot{V}O_{2\max}$  precisely. In male athletes we recommend to raise exhaustion criteria to accept exhaustion only when all of the following four criteria are fulfilled:  $HR_{\max} \geq 95\%$  of the predicted  $HR_{\max}$ ,  $RER_{\max} \geq 1.10$ ,  $RPE_{\max} \geq 19$  and  $Lac_{\max} \geq 10$  mmol/l. References: Rassouli F, Thurnheer R. (2015). Swiss Med. Forum, 15(14), 315-321. Steinacker JM, Liu Y, Reissnecker S. (2002). Dtsch. Z. Für Sportmed., 53(7), 228-229. Tschopp M, Held T, Villiger B, Marti B. (2001). Schweiz. Z. Für Sportmed. Sporttraumatologie, 49(2), 57-66

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## PO-CPP-32 Physical Education & Pedagogics 2

### HEALTH-RELATED QOL AND SOC OF JUDO EXPERTS AND SENIOR PLAYERS

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Introduction Judo is one of the martial arts belonging to the traditional Japanese cultural practice called Budo. The ultimate goal of Judo is not the acquisition of brute strength, but rather the perfection of oneself across a lifetime through an understanding of philosophy and characteristic Kata2). Therefore, for the present study, we decided to examine the usefulness of Judo practice for health maintenance over long periods by researching the psychological characteristics and related factors of Judo experts (high rank dan holders) and long-time practitioners. The concepts that I focused on were health-related QOL (quality of life)3) and SOC (sense of coherence)4). Health-related QOL is a globally recognized, credible, and valid measure of physical, mental, and social well-being. In contrast, SOC is a relatively recently recognized concept that refers to "strength of mind" or stress tolerance ability; it is a psychological characteristic that tends to differ according to each person's way of life. The degree of SOC is believed to be strongly connected to lifelong enjoyment of mental health. For the present study, I investigated the usefulness of long-term Judo practice by researching the relation between these two concepts and martial arts practice. Methods For this study, we conducted a questionnaire survey. The survey subjects were 3rd dan through 7th dan rank holders who had participated in a Judo high rank dan holders' competition held in Tokyo. The questionnaires comprised the SF-12v25), a health-related QOL scale developed by Fukuhara; the shortened version of the SOC scale developed by Yamazaki4). The survey was conducted on November 1, 2015. Results The results showed that for the SOC scale, the average scores for all three factors were higher in the 60+ age group ( $n = 31$ ) than in the <60 age group ( $n = 18$ ). For health-related QOL, we divided the sample into five 10-year age groups, ranging from the 30s to the 70s ( $n = 9$  for ages 31-40,  $n = 2$  for ages 41-50,  $n = 7$  for ages 51-60,  $n = 23$  for ages 61-70,  $n = 8$  for ages 71-80), and compared the average scores of each of the 8 factors with the national average3) among the age groups. The comparison results showed that, while the 30s age group exceeded the national average in only one factor (generally sound outlook), the number of factors that surpassed the national average increased with participants' age. The 70s age group exceeded the national average for all eight factors. References 1)Inoue S. Born of the Budo [in Japanese]. Yoshikawa Kobunkan. 2004 2)Murata N. Learning from master Kano Jigoro [in Japanese]. Nippon Budokan. 2001. 3)Fukuhara S, Suzukamo Y. Manual of SF-36v2 Japanese version: iHope International Inc. 2004, 2015. 4)Antonovsky A. Unraveling the Mystery of Health: How People Manage Stress and Stay Well [Kenko-no-nazo-wo-toku] Trans Yamazaki Y, Yoshii K. Tokyo: Yushindo Kobunsha; 1987. 5)Ware J Jr, Kosinski M, Keller SD. A 12-Item Short-Form Health Survey: construction of scales and preliminary tests of reliability and validity. Medical Care 1996; 34(3): 220-33.

## RELATIONSHIP BETWEEN THE OBJECTIVE AND SUBJECTIVE EVALUATION OF CHILDREN'S PHYSICAL ACTIVITY LEVEL BY THEIR PARENTS AND NURSERY SCHOOL TEACHERS

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**Introduction** Physical activity (PA) is an integral part in children's development education. Researches have clarified the importance and benefits of conducting physical activity in early year's education. PA has been associated with health and movement ability in preschool children (Harriet G. et al.2008; Fisher et al.,2005 ;Kagaya et al., 2003). This study examines the relationship between objective and subjective evaluation of children's PA level from the parents' and teachers' perspectives. **Methods** 214 nursery children (mean age,  $5.7 \pm 0.6$  years) participated in this study together with their parents and nursery school teachers. An objective PA assessing the level of children's activity was conducted using a triaxial accelerometer (Active Style Pro, Omron) for seven consecutive days. A subjective assessment using a questionnaire on parents' and teachers' perceptions of the children's level of activeness comprising four categories was conducted. The relationship between the objective PA and the subjective evaluation was investigated using correlation analysis. **Results** The results indicate that parents had a higher ratio when evaluating the child as "active", while the teachers were more likely to evaluate the child as "scarcely active," or "inactive." The teachers' evaluation results correlate with the step counts and the MVPA on weekdays, but only the MVPA in the weekend. The parents' evaluation results have a weak correlation with the MVPA on weekdays, and no correlation in the weekend. **Discussion** These findings suggest that both parents and teachers could detect the children's actual PA level to a certain degree (Tanaka et al. 2013). In addition, their evaluation was primarily focused on the children's MVPA. However, the parents tend to consider their child "more active" as compared to the teachers. Further research can identify the underlying factors of the varying evaluations between parents and teachers toward a child. **References** Harriet G. et al. (2008) Obesity, 16 (6), 1421-1426 Fisher et al. (2005) Med. Sci. Sports, 37(4), 684-688 Kagaya et al. (2003) J. Exerc.Sci.13, 1-8 Tanaka et al. (2013) Jpn. J. Hum. Growth. Dev. Res., 58 : 18-24 Contact j-ishizawa@soai.ac.jp

## COMPARISON OF PHYSICAL FITNESS OF CHILDREN BETWEEN TWO DIFFERENT AREAS OF SNOW COLD REGIONS IN JAPAN

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**Introduction** A decline in physical fitness of children has become an important issue as a social problem in Japan. The issue is serious especially in snowy cold regions such as Hokkaido in Japan, as snowy cold environment may limit physical activity. In fact, physical fitness of children in Hokkaido has been consistently the lowest over Japan. In contrast, physical fitness of children in Akita which is also located in such snowy cold regions has been one of the highest five. Therefore, the aim of this study was to compare factors that may cause the difference in physical fitness of children between Akita and Hokkaido both of which are located in snowy cold regions in Japan. **Methods** We collected data comprising number of coaches, junior sports clubs, ratio of coaches to junior sports clubs, and physical fitness of children in Hokkaido and Akita. Moreover, we investigated contents of sports promotion each local government did by interviewing. **Results** Physical fitness of children in Hokkaido was the lowest, whereas that in Akita was one of the highest five over Japan in 2015. There were 2,104 junior sports clubs with 8,984 registered-coaches in Hokkaido. On the other hand, there were 832 junior sports clubs with 7,849 registered-coaches in Akita, indicating that ratio of sports coaches to children can be greater in Akita than that in Hokkaido. Moreover, it was found that they secure time to do exercise indoor besides physical education classes during a snow cover period in Akita. **Discussion** There was an apparent difference in physical fitness of children between Akita and Hokkaido. Physical fitness of children in Hokkaido may be affected by snowy cold environment that may limit physical activity. However, it appears that such limitation has been overcome in Akita. They secure certain time and place to do exercise besides physical education classes using free classrooms effectively at school. For example, they regularly do exercise using a free classroom before the first class. Moreover, they appear to have more opportunities to learn and play sports under coaches instead of school teachers after school in Akita compared with that of Hokkaido. Therefore, it is suggested that they need to overcome environmental factors to help enhance children's ability, as physical fitness would be affected by environment. **References** Ministry of Education (2015) National Physical Fitness and Exercise Capacity, Exercise Habits Survey. Akita Prefecture (2014) Akita prefecture's sports promotion plan 'Sports stand prefecture Akita promotion plan' 2014-2017. Hokkaido School Physical Education Federation (2014) Physical Education Research, p.1-9. Contact nagatani@hokusho-u.ac.jp

## EFFECTS ON VERTICAL JUMP ABILITIES OF ELEMENTARY STUDENTS DURING PROGRAMING PLAY IN THE MORNING

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**Introduction** The decrease of physical fitness and ability in children are pointed out in Hokkaido, Japan. We conducted practical research about the physical fitness improvement in elementary students in Ebetsu city where our university is located. The purpose of this study is to clarify the effect on vertical jump abilities of elementary students during programing play in the morning. **Methods** The subjects were students 28 students (19 boys, 9 girls) in 2013 and 22 students (10 boys, 12 girls) in 2014, all in the first grade of elementary school. Each "morning exercise" program was designed for the subjects and the morning exercise program was carried out 27 times in 2013 and 18 times in 2014, from May to December respectively. These programs were taught by the university students who were aiming to become teachers. These morning exercise programs were made for the purpose of physical fitness improvement and enjoyment for the students. Two vertical jump performance tests, a countermovement jump(CMJ), and repeated 5 times rebound jump(5RJ) on a mat switch system had been carried out before (in May) and after (in December) the program. CMJ and 5RJ abilities were evaluated by jump height and RJ-index (= jump height 【RJ-H】 /ground contact time 【RJ-CT】 ),respectively. Statistical differences between the values of before the program (in May) and after the program (in December) were determined by the T test (both sides). Differences with  $p < 0.05$  were considered significant. **Results** In 2013, the boys had significant increased in CMJ and RJ abilities but the girls had not in comparison between before and after. In 2014, boys and girls had both increased in CMJ and RJ abilities. **Discussion** In 2013, the boy's CMJ and RJ ability improved, but it did not improve for the girl's ability during the 27th exercise programs had no play jumping frequency. In 2014, despite the fewer number of subjects than in 2013, more subjects increased in their jumping ability, jumping exercise play programs held more often. This is thought to be because it contained a lot of short contact time in the jumping exercises. **References** Takeda, T et al. (2014). Bulletin of Hokusho University School of Lifelong Sport, 5,1-14. Takeda, T et al. (2015). Bulletin of Hokusho University School of Lifelong Sport, 6,13-27.



## EFFECTS OF DIFFERENTIAL AND TRADITIONAL TEACHING METHODS IN CHINESE HEALTH QIGONG ON CONCENTRATION, MINDFULNESS AND EMOTIONAL STATE

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**Introduction** Current research lists a high number of pupils who have behavioural problems and are unable to concentrate properly (DuPaul et al., 2011; Hetherington et al., 2006). The objective of the study was to explore whether different teaching approaches (traditional repetition-based, differential learning) in the dynamic Chinese Health Qigong technique Wu Qin Xi (Five Animals Play) have different effects on the pupils' concentration, mindfulness, and the emotional state. **Methods** N = 108 female pupils (mean age = 11) were examined. Four classes performed the dynamic Qigong technique Wu Qin Xi, applying two different teaching methods: the differential learning method and the traditional repetition-based method. The development possibly caused by Qigong was examined using three different tests: concentration (test of attention and concentration d2-R), mindfulness (mindfulness questionnaire of the city Freiburg) and emotional state (Multidimensional questionnaire about the emotional state). The attitude of the pupils towards Qigong was explored by a self-constructed questionnaire, which was evaluated by Mayring's qualitative content analysis (2010). The pupils' state was analysed before and after five Qigong lessons using MANOVAs. **Results** The study revealed benefits for the concentration in all participating classes (differential learning:  $p < ,008$ ;  $p < ,007$ ; traditional repetition-based method:  $p < ,000$ ;  $p < ,000$ ). However, there were no statistically significant effects on mindfulness and the emotional state. No effect was found concerning the teaching method. Qigong was equally liked and disliked by the pupils with 36% of the pupils opting to continue their practice of Qigong. **Discussion** As a result, Qigong may be considered an option to improve the pupils' concentration in both teaching techniques. However, it remains to be explored further, whether regular exercise of the dynamic Qigong technique Wu Qin Xi offers an improvement to mindfulness and the emotional state of pupils as well. To exclude effects of maturation on attentional performance, an additional control group should be tested. **References** DuPaul GF, Helwig JR, Slay PM (2011). Classroom Interventions for Attention and Hyperactivity. In MA Bray, TJ Kehle, The Oxford Handbook of School Psychology, 428-441. Oxford University Press, New York. Hetherington EM, Parke RD, Gauvain M, Locke VO (2006). Child Psychology. A Contemporary Viewpoint (6th ed.), 660-666. McGraw-Hill, New York. Mayring P (2010). Qualitative Inhaltsanalyse. Grundlagen und Techniken (11. Aufl.). Beltz Verlag, Weinheim. Contact ahellmic@students.uni-mainz.de

## CONDITIONAL SKILL DEVELOPMENT IN PHYSICAL EDUCATION

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**Introduction:** The general goal of physical education (PE), besides giving experience of different kinds of sports and developing an overall personal movement culture, showing the way to a healthy lifestyle, prevention, and giving individuals a daily opportunity to develop their motor skills and performance. According to the basic biological principals used in movement practice, there should be some kind of measurable progression of performance. Nowadays the applied physical education curriculum in Hungary needs some improvement to offer an appropriate possibility for the achievement of the expected goals. Therefore, the aim of this study is to examine the effect of some modifications in the physical education curriculum, using only individually differentiated bodyweight exercises, allowing progression in maximal strength, strength-endurance, postural corrections and prevention, coordination, and also sport specific skills. **Methods:** The first section (8-10 min) of every PE lesson is started with: joint mobility as general warm up (2-3 min); warm up, training set of bodyweight exercises (5-8 min); and a transition set of bodyweight exercises related to the actual sport that is going to be taught (2-3 min). The bodyweight exercises are push up, pull up, one legged squat, and bridge. Exercises are differentiated by their difficulty, that allows progression steps, and individual differentiation also. The subjects are adolescents from 7th to 12th grade. At the school, before, during, and after the study period we measure the postural situation with FMS (Functional Movement System) screening method, the intensity of the lessons with Polar Team System, and strength-endurance with bodyweight exercises. At the laboratory, we measure with the aid of a dynamometer (Multicont II isokinetic device), the level of maximal strength development in case of musculus biceps brachii, latissimus dorsi, quadriceps femoris, and biceps femoris, and with EMG during the actual bodyweight exercise performance. **Preliminary Results:** The pilot study was done in 2015, including 30 lessons in 11 weeks. We measured 19 subjects. Preliminary results suggested that maximal strength significantly increased in upper and lower extremity, and the performance of the exercises highly improved. Improvement in the most difficult push up and squat variations by number of students able to perform the exercise, and percentage of performance quality improvement: Assisted one arm push up: before: 5, after: 12, performance improvement: 75,9% One arm push up: before: 1, after: 6, performance improvement: 85,3% Half one legged squat : before: 5, after: 10, performance improvement: 69% Full one legged squat: before: 2, after: 10, performance improvement: 75,6% **Discussion:** According to our preliminary results we expect that long term progression strength training in physical education curriculum is effective in developing maximal strength and strength-endurance, coordination, and postural correction.

## Conventional Print Poster

### PO-CPP-36 Sport Statistics & Analysis

## LOW BACK PAIN IN PROFESSIONAL VOLLEYBALL AND HANDBALL PLAYERS

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**LOW BACK PAIN IN PROFESSIONAL VOLLEYBALL AND HANDBALL PLAYERS** **Introduction** Low back pain frequently affects professional athletes and it can seriously hinder their performance. One has to be familiar with trigger factors, physical characteristics of the athlete, his/her age and the type and characteristics of the sport as all of these contribute to low back pain. The aim of our prospective study was to establish the frequency of low back pain in professional volleyball and handball players. **Methods** The study included professional athletes competing in volleyball or handball. We devised a survey questionnaire to obtain demographic data, present and average low back pain and the information on frequency of low back pain. The intensity of the pain was assessed using the Visual analogue scale. The questionnaire was filled in by the specialist of physical and rehabilitation medicine. **Results** The study included 38 professional volley-

ball or handball players with average 9,4 years of professional sport career. They were in average 23 years old. 31 athletes (82%) reported having LBP in the past. In the opinion of 27 athletes (87%), their first experience of low back pain was related to their sport activities. 28 athletes (90%) thought that LBP has a negative effect on their performance in sport activities. 23 athletes (74%) used physical and rehabilitation medicine methods for treatment of low back pain. Discussion With the help of the survey questionnaire we established that the low back pain is common in professional volleyball and handball players in Slovenia and hinders the athletes performance. When treating an athlete with low back pain, who is motivated to make a speedy recovery in order to re-enter training and competitions, we have to take into account the biomechanical factors and include them in the rehabilitation program (Trainor, 2002). The program should concentrate on specific goals to reduce low back pain and allow a safe return to sport activities. References Trainor TWS. (2002). Clinics in sports medicine, 21 (1): 93-103.

### CHAMPIONS' TATICS: DO THEY DIFFER FROM THOSE OF OTHER COMPETITORS?

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Introduction Taekwondo is a full contact sport where most points are scored through kicks (Kazemi et al., 2006). Taekwondo athletes use various types of kicks in matches and these different kicking techniques have different scoring efficiencies (Tan & Krasilshchikov, 2015). A series of matches has to be won in order to warrant a gold medal in a Taekwondo competition. Do Taekwondo champions use different kicking tactics from other competitors? The purpose of the study was to examine the kicking tactics between the champions and other competitors in Taekwondo competitions. Methods Video files of the 2015 Taekwondo Grand Prix Final from the Internet were used in the study. Matches of 8 athletes per weight category were analyzed using the Simi Scout behavioral and tactical analysis system. Four individual kick tactics, Roundhouse kick (R), front-leg roundhouse kick (F), pushing kick (P), back kick (B), and others (O), as well as the combination tactics of any 2 of the individual kicks were registered by 2 black belt Taekwondo experts for both athletes of each match. The number of occurrences of each type of kick tactics for gold medalists (champions) and other competitors was analyzed. Results There were no differences in the amount of tactics used between the single and combination tactics for either the gold medalists or other competitors. F had the highest amount of occurrences for both groups in the single tactics, while the gold medalists also showed a highest frequency of F+F among all the combination tactics. The P kick was the 2nd/3rd highest single tactic for the gold medalists/other competitors, and the R kick was the 3rd/2nd highest single tactic for the gold medalists/other competitors. In addition to the F+F combination, other high frequency combinations that were used in both groups were P+R, P+F, and F+R. Discussion The front-leg roundhouse kick has been considered as a difficult technique to perform but it can be very useful in scoring points (Lee, Chin & Liu, 2005). In high-level Taekwondo competitions such as Grand Prix Final, F appeared to be the most used of the single tactics. Furthermore, the gold medalists most frequently used the F+F tactic, which was not observed as frequently in other competitors. From the four most frequently used combination tactics, we also observed that the front-leg roundhouse kick was the only one used in both the initiation and the follow-up segments. The findings of the study suggest that the Taekwondo champions exploit the front-leg roundhouse kick tactic to a fuller extent and the tactic may be one of the important factors that lead to their success. References Kazemi M, Waalen J, Morgan C, White AR. (2006). J. Sports Sci & Med, CSSI, 114-121. Lee CL, Chin YF, Liu Y. (2008). ISBS-Conf Proceed Arch. Vol. 1. No. 1. Tan YL, Krasilshchikov O. (2015). International J. Perform Anal in Sport, 15, 913-923.

### STATISTICAL ANALYSIS OF DECATHLON: A NEW APPROACH.

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Introduction Decathlon is one of the most challenging disciplines in track and field. Previous studies have assessed the relationships between the performance in the 10 decathlon events by means of correlations or cluster analyses (Woolf et al, 2007, Cox et al, 2002, Van Damme et al, 2000). The aim of this study was to assess the correlations between the 10 decathlon events and the final competitive outcome, with particular focus on possible strategies used to achieve the final score by athletes of the most represented nations in the top 100 all-time world ranking. Methods The 100 world top (all-time) decathlon performances (taken from IAAF scores) were analysed. Scores achieved before the change of the javelin throw rule in 1986, have been compared to the results obtained after 1986, after standardization of the different throwing results according to Borgström (2000). The ranking has been analyzed to investigate how the different events are clustered and affect the final score. Furthermore, the data of the 3 states with the highest number of athletes in the all-time list (Russia, Germany and USA) were compared to study how their training strategies may affect the final performance. Results In agreement with previous studies (Cox et al, 2002, Woolf et al, 2007), the analysis showed two main clusters observed in the dendrograms. The 100m, 110m hurdles and long jump belonged to the same cluster and their scores were well correlated with the final results (r between 0.536 and 0.564). The shot put and discus throw were linked to another cluster, and were not correlated with the final score. The javelin throw, the pole vault and the high jump showed a weaker relationship with the final score, probably due to the high level of technical skill required. There were no significant differences between the three examined nations, with the exception of the average 100m and 1500m results between Russia and USA (851 pts vs. 892pts, and 745 pts vs. 702 pts, respectively). Discussion The results show that the sprint events influence the decathlon performance more than other events. This outcome may be taken into account to select talents and develop a more effective training programs. Among the 3 examined nations, USA showed higher score than the Russia especially in the sprint events and consequently in the final score. Russia showed better scores in the throwing events and 1500m race. Finally, athletes from Germany were generally ranked between those of the other 2 nations in all the decathlon events. References Borgström A (2000). New Studies in Athletics, 15, 3/4, 25-28. Cox TF, Dunn RT (2002). The Statistician, 51, part 2, 179-187. Van Damme R, Wilson RS, Vahhooydonck B, Aerts P (2002). Nature, 415, 755-756. Woolf A, Ansley L, Bidgood P (2007). J. of Quantitative Analysis in Sports. 3,4,5.

### COLLECTIVE PERFORMANCE IN RUGBY UNION: XV DE FRANCE VS NEW-ZEALAND.

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Introduction: Rugby performance depends on the individual capacities of the players and also is strongly influenced by physical and tactical cohesion of the team. It is hypothesized that rugby men who have played with each other throughout their career will be more effective during a game than those who haven't. Our aim is to evaluate team performance throughout a quantitative analysis of team cohesion of the XV de France and the All Blacks. The study focuses from 2000 to 2015, to set against four collective constructions of the

last four rugby world cups. Methods: Names, positions, age and numbers of selections, dates, opponents, scores and match venues were collected for all XV de France and All Blacks games from 1987 up to 2015. We computed the number of cumulated shared selections for each match as a key collective performance indicator. For each game, we quantified the number of selections that each player has shared with the others. Results: 235 French players were involved in 183 matches during the studied period against 184 New-Zealanders in 202 matches. The values of cumulated shared selections fluctuate strongly between the competitions, ranging from 100 to 1600 for the French team and 100 to 3200 for the team of New Zealand, with greater values of shared selections during the world cups and a minimum during the tests matches, suggesting a team pattern for the world cups. The performance indicator increases between two world cups, except for the XV de France during the last edition (1042 for the French against 3156 for the New-Zealanders) where the XV de France didn't pass the quarter final. This evolution illustrates the building of a group becoming more and more experimented for the prestigious competition. Conclusion: Collective performance in rugby union is based on a balance between young players at the peak of their physical performance and older and more experienced players indispensable to the tactical group cohesion and its optimal operation.

## COMPARING THE SPATIAL INFORMATION IN OFFENSIVE STRATEGY AND SCORING STYLE BETWEEN WINNING AND LOSING TEAMS OF BASKETBALL GAMES

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**Introduction** In basketball games, coaches deploy offensive tactics on different locations on the court (Atkins, 2004). Scoring in the lane is very important but shooting from the perimeter also contributes to a successful game (Tseng, 2011). Could the outcomes of the games attribute to the patterns of shooting/scoring locations on the court? The purpose of the study was to use the principal component analysis (PCA) to identify and compare the offensive tactics in basketball games based on the shooting and scoring zones between winning and losing teams. **Methods** All games (n= 32) from 2012-2014 Taiwanese University Basketball Association (UBA) men's division 1 were recorded and a total of 5296 shootings were analyzed. The court was divided into five zones (Z1: the lane, Z2: 2-point high zone, Z3: 2-point low zone, Z4: 3-point high zone, Z5: 3-point low zone). Two independent observers recorded all the shots and the Cohen's Kappa for intra and inter-rater reliability was 0.9 and 0.78, respectively. PCA was performed on the shooting zones and scoring zones for the winning teams and losing teams. **Results** For the shooting zones, both winners (85.38%) and losers (86.89%) had 3 PCs that had eigen values larger than 1. For the winners, PC1 (36.46%) consisted of Z1 and Z5, PC2 (27%) consisted of Z3 and Z4, PC3 (21.93%) consisted of Z2. For the losers, PC1 (38.97%) consisted of Z1, Z5, Z4, PC2 (26.51%) consisted of Z3, PC3 (21.41%) consisted of Z2. For the scoring zones, winners had 3 PCs (86.72%) and losers had 2 PCs (69.78%) that had eigen values larger than 1. For the winners, PC1 (31.69%) consisted of Z1 and Z4, PC2 (31.59%) consisted of Z5 and Z2, and PC3 (23.45%) consisted of Z3. For loser, PC1 (43.04%) consisted of Z1, Z4, and PC2 (26.74%) consisted of Z3 and Z5. **Discussion** Based on the shooting zones results, in addition to the lane and the 3-point offensive strategy that both the winning teams and losing teams had, the winners showed another offensive pattern, which included the low post zone and the high 3-point zone. The results from the scoring zones also showed similar patterns for the winners and losers where both the lane and the 3-point high zone had the highest contributions. However, the opposite signs of the coefficient of the 2 zones for the losing teams indicated that the scoring contributions of the 2 zones were negatively correlated whereas the scoring contributions for the 2 zones from the winning teams were positively correlated. Generally speaking, both winning teams and losing teams had similar offensive strategies in terms of the shooting and scoring deployment. It is the results of the offensive strategies that determined the outcomes of the games. **Reference** Atkins, K. (2004). *Basketball: Offences and Plays*. Champaign, IL: Human Kinetics. Tseng, K-T. (2011). *The road to success for bench coach: dynamic analysis of offence tactic and strategy in basketball*. Unpublished master thesis, NTNU, Taipei, Taiwan. Contact yclan@ym.edu.tw

## HAND POSITIONING EFFECTIVENESS IN BLOCKING IN HIGH-LEVEL FEMALE VOLLEYBALL

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**INTRODUCTION** The teams use the block as a first defensive action that could also bring to a direct-point realization (Mesquita and César, 2007). The purpose of this study was to analyse a selection of technical/tactical aspects of volleyball blocking with particular focus on the single hand involved in the block. This analysis would allow to elucidate some key characteristics of blocking and to study the strategies used by attackers against the block. **METHODS** The study sample consisted of 2128 blocks from 65 matches during the Women's Volleyball World Championship - Italy 2014. Only attacks from zone 2 and zone 4 were examined. The considered variables were: The contact between the ball and the two blockers, for which a code was specifically created to distinguish every single hand (1-4 for the external hand of the outside or middle-blocker respectively, 3-6 for the internal hand), and both hands of one player hit simultaneously (2-5). Block outcome (Peña et al 2013): winning (direct point), positive (ball played again by the home team), poor (ball played again by the opponents), and error block (opponents' point). To test the relation between the variables, chi-square tests were used. **RESULTS** When the attack was performed from zone 2, the external blocker was hit more frequently than the internal one ( $p < 0.01$ ); specifically, in most cases, his hands were hit individually rather than simultaneously ( $p < 0.01$ ). Conversely, there wasn't a large difference between the number of times the ball touched each blockers when the attack was from zone 4. In the first case, when the external hand of the outside blocker was hit, a blocking error often occurred (58%), whereas in fewer cases there was a direct point (11%). Conversely, when the internal hand was hit, the more frequent block outcome was winning (33%) ( $p < 0.01$ ). With reference to attacks from zone 4, the less searched direction was clearly the one leading to hit both hands of the middle blocker ( $p < 0.01$ ). When the external hand of the outside blocker was hit, the block outcome was in most cases a blocking error (57%), while poor blocks (11%), positive blocks (16%) and winning blocks (16%) occurred in fewer cases ( $p < 0.01$ ). Moreover, when the attackers hit both hands of the outside blocker, they were less likely to make a point. **DISCUSSION** The effectiveness of the block changes depends on which hand is hit by the attacking player. The hand hit more often by attackers, regardless of their position, is always the external one of the outside blocker since it's closer to the side-line of the court. In this case, more than 50% of times the attacker scores. In practice, these observations can be employed to improve the block technical/tactical and the attack strategies, knowing the best attack direction. **REFERENCES** Mesquita I, César B (2007). *Int J Perf Anal Sport*, 7(2), 13-27. Peña J, Rodriguez-Guerra J, Busca B, Serra N (2013). *J Strength Cond Res*, 27(9), 2487-2493. **CONTACT** luca.gubellini3@unibo.it

**AEROBIC PHYSICAL ACTIVITY ASSESSED WITH FOUR DIFFERENT METHODS IN FINNISH POPULATION SAMPLE**

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Introduction Studies use a variety of self-assessment methods and objective devices to measure physical activity (PA), but agreement between these methods is poorly understood. In recent decades, technical development has offered objective tools, such as accelerometers to assess PA. Yet there is a need to better understanding, what we are actually measuring. The aim of this study was to determine the agreement between accelerometry, diary, questionnaire and interview in assessing weekly time spent in moderate to vigorous physical activity (MVPA) minutes. Methods Participants of the PA and fitness subsample of the Health 2011 Study were given an accelerometer (Hookie AM 20, Traxmeet Ltd, Espoo, Finland) and a diary for seven day measurement. They also filled in questionnaire and were interviewed about their regular weekly PA. Participants were asked to report the average frequency and duration of moderate and vigorous aerobic activity. These intensities were combined as MVPA minutes. All the methods included PA lasting at least 10 minutes at a time. Paired samples t-test was used for statistical comparison. Results Adult participants (18-75 years old) who had sufficient accelerometer data (at least 10 h/day for 4 days) were included in to the study (n=1489). The mean age of the participants was 51 years (SD 14), 57.4% being women. The highest amount of MVPA minutes was obtained from interview and questionnaire (153min/wk), while the lowest amount was obtained from diary (106min/wk). There was statistically significant difference between accelerometry and PA diary (13min/wk,  $p<0.001$ ), accelerometry and questionnaire (-43min/wk,  $p<0.001$ ), accelerometry and interview (-42min/wk,  $p<0.001$ ), diary and questionnaire (-54min/wk,  $p<0.001$ ) and between diary and interview (-55min/wk,  $p<0.001$ ) in total weekly MVPA minutes. There was no difference in total MVPA minutes between PA questionnaire and interview (2min/wk,  $p=0.693$ ), but there was huge individual variance between the methods. Discussion Different PA assessment methods yielded highly varying results of weekly amount of aerobic MVPA. Especially at the individual level, inter-method differences were huge. Obviously the PA measurements reflect different issues; measured activity vs recalled behavior over different timeframes. In conclusion, results obtained from different PA assessment methods are not interchangeable and their interpretation must be done with caution. Contact Henna.Hukkanen@uta.fi



## e-posters not debated

### PP-UD01

#### e-posters not debated

#### Adapted Physical Activity

##### COMPARISON OF PHYSICAL ACTIVITY ATTRIBUTABLE TO NEIGHBOURHOOD ENVIRONMENT BETWEEN CHILDREN IN AN EARTHQUAKE- AND TSUNAMI-AFFECTED AREA AND THOSE IN UNAFFECTED AREA

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**Introduction** We compared objectively measured daily steps attributable to neighbourhood environment taken by children living in an area affected by the 2011 Great East Japan Earthquake and tsunami with those living in an unaffected area, and postulated that the physical activity (PA) of children living in affected areas had decreased. **Methods** Totally, 234 children aged 9–12 years from an affected coastal area (N=143, group AA) and a non-affected area (N=91, group OA) participated in this study conducted 4 years after the earthquake. Children reported their personal and demographic characteristics; the number of steps was measured objectively using accelerometry. Their parents reported on environmental factors pertaining to walking and bicycling in the neighbourhood using the PA Questionnaire Environmental Module (Inoue et al., 2009). **Results** The number of daily steps taken by boys in group AA was 9491, 10518 and 6840 compared with 8174, 12411 and 3856 taken by those in group OA on a weekly average, weekdays alone and weekends, respectively. The number of daily steps taken by girls in group AA was 7854, 8323 and 5330 compared with 6857, 10632 and 3545 taken by those in group OA, respectively. General linear model analysis indicated a significant association with interaction between study area and social environment for weekly steps ( $F(2, 69)=3.27$ ,  $\eta^2=0.09$ ) and access to destinations for steps on weekdays ( $F(2, 80)=3.62$ ,  $\eta^2=0.08$ ) taken by boys. **Discussion** For both genders in group AA, the number of daily steps on weekends was higher than that for both genders in group OA, whereas there was no association between subject area and environmental variables. This suggests that PA of children was more affected by other factors than the neighbourhood environment on weekends. Socioeconomic indicators and parental support were previously reported to be important in predicting children's participation in PA (Vella et al., 2014). Moreover, access to destinations should be considered for improving PA on weekdays for children living in affected areas. This study was JSPS KAKENHI Grant Numbers (24680065 and 26750323) and Special Grants from University President for Research on the Great East Japan Earthquake. **References** Inoue et al. (2009) Association of physical activity and neighborhood environment among Japanese Adults. *Prev Med*, 48, 321–325. Vella et al. (2014) Socio-ecological predictors of participation and dropout in organised sports during childhood. *Int J Behav Nutr Phys Act*, 11: 62. Contact Kanzo Okazaki [kanzook1015@hotmail.com]

##### EPIDEMIOLOGICAL ASPECTS OF THE BRAZILIAN PARALYMPIC ATHLETES OF THE MODALITIES OF SWIMMING AND ATHLETICS

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**Introduction** In the last decades note to growth in the number of athletes in the Paralympic Games. In parallel to this fact, Brazil has become a world power in the sport paralímpico. Thus, the objective of this study was to map geographically the athletes of the modalities of swimming and athletics, and the type of deficiency of these athletes. **Methods** The epidemiological aspects of paralympic athletes were collected during the three stages of the Circuit Boxes Lottery, competition organized by the Brazilian Paralympic Committee (CPB) in the city of São Paulo, in the months of July, September and November 2015. In the initial database had a total of 2.354 athletes, distributed in three phases competitive. However, were excluded from the analysis the athletes (646 athletes) who were with duplicate names. **Results** The sample of 1.708 athletes (men:  $n = 1.076$ ; 63% and women:  $n = 632$ ; 37%), 913 (53.5%; men:  $n = 539$ ; 59% and women:  $n = 374$ ; 41%) are the modality of swimming and 795 (46.5%; men:  $n = 537$ ; 67.5% and women:  $n = 258$ ; 32.5%) of the modality of athletics. In relation to disability observed predominance of athletes with physical disability ( $n = 1.118$ ; 65.5%), followed by visual deficiency ( $n = 429$ ; 25.1%) and of intellectual deficiency ( $n = 161$ ; 9.4%). In relation to the geographical distribution of these athletes, it was observed that the majority of the Southeast region ( $n = 1.122$ ; 66%), followed by the southern regions ( $n = 189$ ; 11%), Northeast ( $n = 188$ ; 11%), Midwest ( $n = 159$ ; 9%) and North ( $n = 50$ ; 3%). **Discussion** The Brazilian region with higher percentage of paralympic athletes in the modalities athletics and swimming is the Southeast. This region is composed by cities that historical context are responsible for the implementation of the Paralympic sport in Brazil (Araújo, 2011). The predominance of physical disability can be attributed to the greater number of sports classes directed to this type of disability (IPC, 2016th a, 2016th B). This information will contribute to the development of Paralympic sport in Brazil, mainly in the implementation of public policies. From the point of view competitive, this mapping serves as a guiding the actions of CPB in the improvement of infrastructure and in the routing of the training system. **References** Araújo, P. F. (2011). Sport adapted in Brazil. São Paulo: Phorte International Paralympic Committee - IPC. (2016th a) Swimming classification. Available in <http://www.paralympic.org/swimming/classification>. International Paralympic Committee - IPC. (2016th b) Swimming classification. Available in <http://www.paralympic.org/athletics/classification>. **Funding** The authors would like to thank the Research Foundation of the State of Minas Gerais (FAPEMIG) and Brazilian Paralympic Academy of the Brazilian Paralympic Comittee (APB/CPB). **Contact** Andressa Silva, PhD. Universidade Federal de Minas Gerais Email: [silvadressa@gmail.com](mailto:silvadressa@gmail.com)

### THE MOVEMENT SPEED OF DURING THE GAME IN AMPUTEE SOCCER

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**Introduction** Amputee soccer activities are comprised of varying explosive movements like forward and backward shuffles, runs at different intensities and sustained forceful contractions to control the ball against defensive pressure. As with soccer player, which had less time with the ball, players should have spent a lot of time to move. However, there is no indication of the movement speed in amputee soccer. It is possible to evaluate the performance by creating an index of the movement speed. Appropriate training plan is devised by evaluating a performance. The present study was aimed to evaluate the measured performance of the movement speed during the game in amputee soccer players. **Methods** Twelve male amputee soccer players with unilateral lower limb amputees participated in this study voluntarily. In amputee soccer, matches are played between teams of seven players using bilateral crutches. Wearing a prosthetic device is not allowed during match play. The match is played in two equal periods of 25 minutes each. The half time interval must not exceed 15 minutes. The size of the court is a 70m x 50m. To measure the movement speed during the game based on the above official rules. Match activity data were collected using the GPS (15Hz). **Results** The average of the total distance was significantly longer in the first half compare with the second half (1721.8m vs. 1398.4m,  $p<0.05$ ). The movement distance with Walking (0.4-5.0km/h) was longest in both the first half and the second half. The movement distance was significantly higher in the first half compare with the second half in Moderate intensity Running (8.0-13.0km/h) (584.6m vs. 421.6m,  $p<0.05$ ). During the game had a higher rate to move below 13km/h. No significant difference between the first half and the second half was observed in Maximum speed, frequency of High intensity Running and distance per one time of High intensity Running. Below-knee amputation had 0.9km/h faster maximum speed, and 30cm longer in distance per one time of High intensity Running compared with Above-knee amputation. **Discussion** The finding of the present study was suggested that high percentage to move in the following 13km/h during the game, and there was the influence of limb length difference of the remaining portion in the amputation level. **Reference** 1. Ozkan A, Kayhan G, Köklü Y, Ergun N, Koz M, Ersöz G, Dellal A. Journal of Human Kinetics volume 35/2012, 141-146 Contact maehana0608@yahoo.co.jp (2724/3000 characters)

### RELATIONSHIP BETWEEN THE SUBJECTIVE EFFORT AND THE OBJECTIVE PERFORMANCE IN BADMINTON SERVICE AND THE GRIP: IN THE CASE OF THREE PARA-BADMINTON PLAYERS IN JAPAN

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**Introduction** It has been recognized that various adjustments with human movement are performed with the help of the subjective sense of the players. But in many cases, it has been felt that the subjective sense and the real performance do not correspond. If a coach has got a good understanding the error, which has been occurred between the subjective sense and the real performance beforehand, it would help a coach that provide their players coaching. Then we investigated those as to the university and junior high school badminton players (2006, 2009, 2012). And we showed that there were a linear relationship between the subjective effort and the relative performance. Furthermore when a coach without any disabled that provides their para-athletes coaching, it is important all the more. Therefore, the purpose of this study was to investigate the relationship between the subjective effort and the relative performance, in case of the physical disabled badminton players. **Method** The subjects of this study were three well-trained athletes with a physical disabled (upper limbs obstacle player, lower limbs obstacle player and wheelchair player). All the members were male. And they had been higher winning prizes in international badminton meetings. The two kinds of experimental attempts were the service in badminton and the grip with the dominant hand. The subjects performed both experimental attempts at five different subjective efforts range 60% to 100% in the sequence of ascending and descending. The shuttle speed were measured using a high-speed camera (250fps) and an analysis software, FRAMEDIAS (DKH, JAPAN). The relative performance were calculated the ratio of performance for subjective effort 100%. **Result** In case of service in badminton, the relative performance corresponded to 61.2, 71.1, 79.8, 89.6, 100.0, 77.9, 86.7, 77.0, 68.4% in each subjective effort. In case of grip, the relative performance corresponded to 50.5, 54.2, 71.2, 82.4, 100.0, 92.5, 85.4, 80, 2, 69.0% in each subjective effort. **Discussion** As a whole, we observed that the relative performance became increasing with increasing in the subjective effort, and the relative performance became decreasing with decreasing in the subjective effort. We recognized that the subjective effort and the relative performance did not correspond in both experimental attempts. However, in subjective effort 80 and 90% of ascending in the service, the relative performance almost corresponded to the subjective effort exceptionally. And in the service of ascending process, the error was smaller, and then, in descending process, the error were larger and more excessive performance. On the other hand, in the grip of ascending process, we observed that the error tended to a shortage of performance. In the descending process, the error was larger and more excessive performance. We recognized that the trend of error in the service of the descending process that was similar to the grip of the descending. This work was supported by JSPS KAKENHI Grant Number 15K01606.

### EFFECTS OF A PROGRESSIVE RESISTANCE EXERCISE PROGRAM ON ISOKINETIC LEG STRENGTH OF INDIVIDUALS WITH INTELLECTUAL DISABILITIES

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**Introduction:** Muscle strength is an essential variable for maintaining independence and quality of life. Reduced muscle strength is the main cause of impaired functional capacity of the individual with intellectual disabilities (ID). **Objectives:** To examine the effects of a resistance training (RT) program on knee extensors and flexors isokinetic peak torque (PT) in individuals with ID. **Methods:** A total of 40 subjects with ID (age 14-36 years) took part in this quasi-experimental study, who were assigned into experimental group ( $n = 20$ ,  $22.8 \pm 6.3$  years) and control group ( $n = 20$ ,  $20.9 \pm 3.1$  years). Experimental group followed a 12-week RT program, twice a week. All volunteers underwent knee extensors and flexors PT measurements using an isokinetic dynamometer before and after the intervention period. Data were analyzed using ANOVA and significance level was set at  $p<0.05$ . **Results:** For right knee extension, ANOVA revealed a significant time\*group interaction ( $p=0.03$ ). In addition, it was noted significant increase in isokinetic peak torque for the exercised group ( $p=0.004$ ) while it was not observed in the control group ( $p=0.958$ ). For isokinetic knee flexion, although it was not observed significant time\*group interaction ( $p=0.306$ ), significant pre to post increase in the exercised group was noted ( $p=0.031$ ) that was not observed in the control group ( $p=0.441$ ). **Conclusions:** Twelve weeks of RT induces significant increases in knee extensors and flexors isokinetic muscle strength in individuals with ID. These findings may be important for health professionals involved in rehabilitation, sports performance or quality of

life for individuals with ID. References Nolan L. A training programme to improve hip strength in persons with lower limb amputation. *J Rehabil Med* 44: 241-248, 2012. Cowley PM, Ploutz-Snyder LL, Baynard T, Heffernan KS, Jae SY, Hsu S, Lee M, Pitetti KH, Reiman MP, Fernhall B. The effect of progressive resistance training on leg strength, aerobic capacity and functional tasks of daily living in persons with Down syndrome. *Disabil Rehabil* 33: 2229-2236, 2011. Calders P, Elmahgoub S, Meltelinge TR, Vandenbroeck C, Dewandele I, Rombault L, et al. Effect of combined exercise training on physical and metabolic fitness in adults with intellectual disability: a controlled trial. *Clin Rehabil* 25: 1097-1108, 2011. Koutras G, Letsi M, Papadopoulos P, Gigis I, Pappas V. A randomized trial of isokinetic versus isotonic rehabilitation program after arthroscopic meniscectomy. *Int J Sports Phys Ther* 7: 31-38, 2012. Shields N, Taylor NF, Fernhall B. A study protocol of randomized controlled trial to investigate if a community based strength training programme improves work task performance in young adults with Down syndrome. *BMC Pediatr* 25: 10-17, 2010.

## **PALMAR'S PREHENSION STRENGTH, LUMBAR AND LOWER LIMBS IN BEARERS OF MENTAL DEFICIENCY WITH AND WITHOUT DOWN'S SYNDROME**

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**Abstract Objective:** Evaluate the palmar, lumbar and lower members prehension strength in bearers of mental deficiency with and without Down's Syndrome. **Material and Methods:** Descriptive and inferential field study *ex-post-facto*. The sample was constituted by 110 individuals of the masculine gender with ages between 20 and 40 years old distributed in three groups: 40 formed the controls group (GC), for not presenting mental deficiency, 30 formed the group bearing mental's deficiency with Down's Syndrome (GSD) and 40 the formed the group bearing mental's deficiency without the referred syndrome (GDM). The data were analyzed being used the program SPSS for Windows® version 12.0. Firstly, the data were clustered so that there was a general scenery of the variables contrasting the groups (GC, GSD and GDM). The descriptive analysis of the quantitative data surfaced as a location measure (central tendency) – the Average – and as data's dispersion – the Average Deviation. ANOVA was used, comparing the matched samples to establish if there was significance difference among the groups, where the level of significance established was 0,05. **Results:** There is palmar's prehension strength prevalence in function for the right hand in relation to the left one in each and every of the studied groups; the muscular hipotony characteristic of the Down's population generates significant and preoccupying deficit of the strength in this population; there is a low correlation between palmar's prehension and lumbar strength, and also between palmar's prehension strength and the lower limbs. **Conclusion:** It's important to stimulate the practice of physical activity in that population, seeking life quality improvement and the consequential daily life activities (AVD's) performance, also offering a chance for social independence by being economically rewarded for whatever they are capable to produce. It is then placed as challenge for the public health system to include and take care of a growing population. Measures should be taken to guarantee the inclusion as well as the permanence of this population in the job market and to make conscious the professionals that assist it regarding the importance in guaranteeing the functional integrity of the muscle-skeletal system. **References** Bellace JB, Healy D, Besser MP, Bybon T, Hohman L. Validity of the Dexter Evaluation System's Jamar Dynamometer Attachment for Assessment of Hand Grip Strength in a Normal Population. *J. Hand Therapy* 2000; 13: 46-51. Croce RV, Pitteti KH, Horvat M, Miller J. Peak torque, average power, and hamstring/quadriceps ratios in nondisabled adults and adults with mental retardation. *Arch Phys Med Rehabil*. 1996; 77, 369-372. Al Snih S, Markides KS, Ray L, Ostir GV, Goodwin JS. Handgrip strength and mortality in older Mexican Americans. *J Am Geriatr Soc* 2002; 50:1250-1256. Lauretani F, Russo CR, Bandinelli S, Bartali B, Cavazzini C, Di Iorio A, et al. Age-associated changes in skeletal muscles and their effect on mobility: an operational diagnosis of sarcopenia. *J Appl Physiol* 2003; 95:1851-60.

## **EVALUATION OF PHYSICAL PERFORMANCE AMONG CHILDREN PRACTISING ARTISTIC GYMNASTICS, RHYTHMIC GYMNASTICS AND ATHLETICS**

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**Introduction.** Artistic Gymnastics, Rhythmic Gymnastics and Athletics are popular physical activities among children and also have a significant impact in health, fitness and maturation during childhood. Poor physical fitness increases the risk for obesity, chronic diseases and premature mortality among adults (Malina&Katzmarzyk, 2006). Aspects of physical performance has been examined in terms of three components: muscular strength and endurance, cardiorespiratory endurance and motor ability. **Methods.** Twenty-three children (age:10 years, height:136,35±7,14cm, mass:32,4±5,9kg BMI:17,4±2,5 kg/m<sup>2</sup>, training experience 3,8±1,4 years) were assessed in terms of physical fitness. Eight children originated from artistic gymnastics (AG), eight from rhythmic gymnastics (RG) and seven from Athletics (A). Different training background was taken into consideration. Physical performance tests included handgrip strength for both arms, countermovement jump (CMJ), agility T-Test and 20m multi-stage shuttle run test, in this order. One-way ANOVA with repeated measures was used for statistics. **Results.** Regarding handgrip strength with right hand AG scored 8,4±1,6kg, RG 11,8±2,7kg and A 13,9±6,5kg. Values for left hand were 8,8±1,7kg for AG, 10,4±2,4kg for RG and 12,6±6,3kg for A. Jump height for AG was 28,4±4,0cm, for RG 26,4±5,1cm and for A 26,0±3,5cm. AG reported 15,8±1,7sec on agility T-Test, RG 15,1±1,2cm and A 13,9±1,3cm. Performance in 20m multi-stage shuttle run test was 975±256m for AG, 1223±158m for RG and 1217±304m for A. **Discussion.** Statistically significant differences were found among the three groups in right hand strength and T-test performance. Children practising Athletics events had a better agility and strength performance. No other differences were found among groups. All values, except handgrip strength, reported better performance compared with children practising no physical activity. Handgrip strength remains on normal values levels (Hager-Ross&Rosblad, 2002, Gortsila et al., 2013). Overall performance seems to be better among preadolescents who perform physical activities. **References.** Malina, R. M., &Katzmarzyk, P. T. (2006). Food and Nutrition Bulletin, 27(4 suppl5), S295-S313. Hager-Ross, C., &Rosblad, B. (2002). *Acta Paediatrica*, 91(6), 617-625. Gortsila et al. (2013). *Journal of Sports Medicine & Doping Studies*, 2013. Contact pargeit@phed.uoa.gr

## Biomechanics

### RELATIONSHIP BETWEEN MECHANICAL STRESS AND INJURY AROUND THE HIP JOINT DUE TO KICKING ACTION IN FOOTBALL.

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Murakami, K.1, Oda, K.1, Miyakawa, S. 2, 1: Graduate School of Sports Science, Sendai Univ.(Sendai, Japan) 2: Faculty of Sports Science, Sendai Univ.(Sendai, Japan) 3: Graduate School of Comprehensive Human Science, Univ. of Tsukuba. (Tsukuba, Japan) Objectives: In this study, we therefore analyzed the association between kick-induced mechanical stress (stress distribution) and the clinical findings of injuries around the hip joint that are known to be related to kicking actions in football. Methods: We selected 5 healthy football players, They perform the inside kick, instep kick, and infront kick 3 times each for right-footed. A three-dimensional motion analysis device was used to record their motion and measure the duration between maximum hip extension (MHE) and ball impact (BI). The motion analysis software, nMotion (nac, Japan), was used to calculate stress between hip joints and the angle of the hip joint in each kicking motion. In addition, the bone strength analysis software Mechanical Finder (RCCM, Japan) was used to analyze the computed tomography and magnetic resonance imaging data of each subject to develop a finite-element model consisting of the right ilium, sacrum, and femur. Then, stress between hip joints calculated in dynamics analysis was input as a load value into the finite-element model for the stress analysis. Results: At the time of BI, kicking actions produced a high-stress area in the pubic ramus compared with other areas. This value was an equivalent stress value generated in the area of interest (30 mm<sup>3</sup>) in the pubic ramus. Stress generated in the superior and inferior rami of the pubic bone was 3.52 and 2.94 MPa for the inside kick, 7.15 and 5.40 MPa for the instep kick, and 4.47 and 3.33 MPa for the infront kick, respectively. Discussion: The high-stress area on BI was the same area where groin pain syndrome (pubic bone marrow edema) occurs in the clinical examination of football-related hip joint injury and where stress fractures occur in pubic bone rami. Furthermore, in the BI-related area of interest (pubic rami), the values of equivalent stress generated by the inside kick, instep kick, and infront kick in the superior and inferior rami were approximately 3 times, 5 and 4 times, and 3 and 2 times the stress created in the same area by standing by one leg (1.53 and 1.47 MPa in the superior and inferior rami), respectively. The analysis system that integrates motion dynamics into the body structure revealed the relationship between the clinical symptoms of the hip joint and previously reported kick-related injuries around the hip joint. References Pavlor, H. et al. (1982). J Bone Joint Surg Am, 64, 1020-1025. Slavotinek J.P. et al. (2005). Am J Sports Med, 33(6), 894-899. Cunningham, P.M. et al. (2007). Am J Roentgenol, 188, 291-296. Pajajenen, H. et al. (2011). Skeletal Radiol, 40, 89-94. Contact Kenji murakami, kens.m.lab@gmail.jp

### AN INVESTIGATION OF WITHIN AND BETWEEN DAY TEST- RETEST RELIABILITY OF A NEW REACTIVE AGILITY TEST 'VECTOR' COMPARED TO THE 'GOLD STANDARD' T DRILL TEST

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Background: This study examines the role of reactive agility tests that are often used when making decisions about the ability of athletes to return to sport after injury, rehabilitation and prevention of injury, but other factors that are sport specific, such as decision-making of reactive agility and external stimulus, are not often correlated with agility tests sufficiently. Therefore, the aim of this study is to examine the reliability of the intra test-retest of a new reactive agility test, which used timing mats to measure decision-making and task times whilst running forward, with participants reacting to a voice stimulus, as well as comparing the score with the traditional T-drill. Methods: Twenty-one healthy active subjects were included in this study. The main equipment used was Vector to measure decision making time and task time, which consists of five mats designed and built by Cardiff University. Other equipment included four cones, which marked the dimensions for the T-Drill. To collect the T-traditional test time, a stopwatch was used. Other equipment consisted of a tape measure, laptop computer and duct tape to fix mats to the floor. Within day and between days relative reliability was determined by using ICC. Results: ICC's value of using Vector to measure the decision making time in the same day was calculated to be 0.814. However, ICC's value of using Vector to measure the task time in the same day was calculated to be 0.459. ICC's value of using Vector to measure the decision making time between day was calculated to be 0.389, which is moderate. However, ICC's value of using Vector to measure the task time between days was calculated to be -0.096. No correlation was found between the T-drill and task-time as r values were 0.308. Conclusion: The Vector is a reliable measurement tool for agility to measure decision making time in the same day. However, Vector is not a reliable measurement tool for agility to measure task time in the same day. Vector is not being a reliable measurement tool for decision making time and task time in different days. Vector was not a reliable measurement tool to measure task time during a reactive agility test performed by the same subject when compared against the traditional T-Test.

### JUMP PERFORMANCE OF MALE VOLLEYBALL PLAYERS: COMPARATIVE STUDY AMONG AGE CATEGORIES

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Introduction Assessing jump performance as measurements of the maximal power output and the height of jump on a force plate are a typical methods used in laboratory tests. Our recent research (Busko et al., 2012) did not showed significant differences in height of jump (both CMJ and SPJ) and in maximal power in CMJ among age groups of female volleyball players. Thus the aim of the present study was to identify age-related differences in the maximal power output and the height of jump measured in the counter-movement jump (CMJ) and the spike jump (SPJ) of youngsters, cadet, junior and senior male volleyball players. Methods Two hundred and forty elite male volleyball players took part in our study. The study group was comprised of youngsters (n=30), cadets (n=112), juniors (n=35) and seniors (n=63). Their body height were similar in all age groups, albeit significant differences in body weight were observed between youngsters vs juniors and seniors, and between cadets and seniors. Athletes performed two types of vertical jumps: counter-movement jump (CMJ) and spike jump (SPJ) on a force plate. Power output and height of jump were calculated from the registered ground reaction force. Differences among groups were assessed using analysis of variance (one way ANOVA) with post-hoc Scheffé test. Statistical significance was set at p<0.05. Results The relative maximal power output derived from CMJ was similar in all groups. The relative maximal power resulted from CMJ and jump height derived from CMJ and SPJ differed significantly between seniors and youngsters. An age-related difference was only observed in absolute power output in SPJ jump. Discussion Some authors observed significant differences between age groups in jump performance (Aleegre et al., 2009), in turn our recent research (Busko et al., 2012) showed no substantial age-related differences



in height of jump (both CMJ and SPJ) and in maximal power output (CMJ). In our present study all groups of athletes demonstrated similar height of jump, as well as similar relative power output (both CMJ and SPJ), only the absolute maximal power (SPJ) differed among groups. However less relative power output (both CMJ and SPJ) was developed by youngster players in comparison to senior males. Finally, our research showed that age-related differences were only observed between all groups of male athletes in power output of SPJ. Acknowledgements: The study was partly supported by Ministry of Science and Higher Education. References Aleegre LM, Lara AJ, Elvira JL, Aguado X. (2009). J Sports Med Phys Fitness, 49, 320-326. Busko K, Michalski R, Mazur J, Gajewski J. (2012). Biol Sport, 29(4), 317-319. Contact [krzysztof.busko@insp.waw.pl]

## **A CROSS-SECTIONAL INVESTIGATION OF THE AGE-RELATED DEVELOPMENT OF POWER EXERTION IN THE LOWER LIMB AMONG JAPANESE SPEED SKATERS**

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**Introduction** The skating velocity has been confirmed to be affected by the external power output of a skater, as well as air and ice resistances (van Ingen Schenau, 1982; van Ingen Schenau et al., 1987; de Koning et al., 1992). In addition, skaters can attain the skating speed by propulsive support leg extension under the crouched skating posture with a small knee and trunk angle. Therefore, the ability of power exertion in the lower limb is an important factor for speed skaters. This study identified the characteristics of the age-related development of power exertion in the lower limb among speed skaters. **Methods** In total, 118 skaters (67 men and 51 women) provided informed consent and served as the study subjects. The skaters participated in the 500-m race of domestic speed skating competition in Japan or a time trial. The skaters were divided into 6 groups based on their age for each sex. However, senior skaters (over 18 y old) were divided into 2 groups based on the average time of the 500-m race. The age and average time for each group (mean  $\pm$  SD) were as follows: MG1, 9.8  $\pm$  0.4 y, 58.48  $\pm$  12.36 s; MG2, 11.6  $\pm$  0.5 y, 49.34  $\pm$  6.54 s; MG3, 14.1  $\pm$  0.7 y, 43.26  $\pm$  4.11 s; MG4, 16.8  $\pm$  0.9 y, 39.04  $\pm$  1.24 s; MG5, 20.1  $\pm$  1.4 y, 38.03  $\pm$  0.96 s; MG6, 23.4  $\pm$  3.8 y, 36.18  $\pm$  0.56 s; WG1, 9.4  $\pm$  0.5 y, 66.68  $\pm$  20.96 s; WG2, 11.8  $\pm$  0.4 y, 49.87  $\pm$  4.47 s; WG3, 13.9  $\pm$  0.8 y, 45.89  $\pm$  3.10 s; WG4, 16.8  $\pm$  0.9 y, 42.90  $\pm$  1.30 s; WG5, 21.3  $\pm$  4.4 y, 41.60  $\pm$  1.26 s; and WG6, 24.0  $\pm$  3.9 y, 39.72  $\pm$  0.50 s. The skaters performed double- and single-leg skate jump tests on a floor that required maximal effort. The vertical ground reaction forces were determined with a force platform (500 Hz). **Results** In male skaters, the maximum vertical ground reaction force of double-leg gradually increased with growth; by contrast, that of a single-leg increased only slightly. On the other hand, in female skaters, the force of double-leg gradually increased with growth; however, no remarkable difference between groups was observed in that of a single-leg. **Discussion** The level of power exertion in the lower limbs of both male and female speed skaters increased gradually as a result of physical growth and development. However, the development of the power exertion ability under the single-leg condition was lower than that in the double-leg condition. **References** de Koning JJ, de Groot G, van Ingen Schenau GJ (1992). J Biomechanics 25, 565-571. van Ingen Schenau GJ (1982). J Biomechanics, 15, 449-458. van Ingen Schenau GJ, de Boer RW, de Groot G (1987). Int J Sport Biomechanics, 3, 419-431. Contact jyuda@jwcp.ac.jp

## **EFFECT OF NEUROBIKE CYCLING ON EEG BRAIN ACTIVITY AND MATHEMATICAL PERFORMANCE: AN INTERVENTION STUDY**

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**Introduction** The NeuroBike is an instable system applied in sports therapy and sports training. The balance movement is similar to the cross-coat of the human due to the joint in the center of the bicycle frame. In the present study, we investigated effects of training on the NeuroBike on spontaneous EEG activity and on mathematical performance. **Methods** N = 36 young adults performed different trainings (NeuroBike, common bicycle, daily activity) for twenty minutes three times per week in a two-week intervention. Mathematical performance (algebra, geometry, arithmetics) was assessed before and after the intervention by a multiple-choice test on a PC. Spontaneous resting EEG was recorded by the international 10-20 system before, and after each training session at rest, and during the mathematical tests before and after the two-week intervention. Spectral power densities were calculated for the theta (4-7.5 Hz), alpha (8-13 Hz), alpha1 (8-10 Hz), alpha2 (10-13 Hz), beta (13-30 Hz), beta1 (13-15 Hz), beta2 (15-21 Hz), beta3 (21-30 Hz) and gamma (30-70 Hz) band. **Results** Behavioural data show slightly reduced mathematical performance in geometry after the NeuroBike and common bicycle intervention in comparison to daily activity. Heart rate during training sessions revealed no significant difference, although in common cycling higher physical effort was reported. Mental effort in NeuroBike cycling was increased after the two week intervention while physical effort remained stable instead of changes in ordinary cycling. EEG data reveal increased temporal theta power, occipital theta, alpha and beta1 power and parietal beta power after the two week intervention without acute influence of NeuroBike cycling at rest. No changes in acute influence of NeuroBike training as a result of the two week intervention was observed. Repeated NeuroBike training lead to increased frontal power in all frequency bands and temporal theta and alpha power during algebra performance. **Discussion** Changes in EEG at unaffected rest after the two-week intervention indicate a positive effect of NeuroBike training on brain activity. In contrast, mathematical performance was associated a negative impact with cycling. Following the stability of acute influence on brain activity we suggest an independence of NeuroBike exercise repetition on the acute effect, which a subsequent long-term study may possibly verify. Our results demonstrate that training on the NeuroBike fosters a beneficial brain state for learning at resting state, but does not lead to an optimum brain state for active processing in mathematical problem solving. Contact alexjohn@uni-mainz.de

## **MUSCLE ACTIVITIES AND MECHANICAL PROPERTIES ON KNEE EXTENSOR MUSCLES UNDER ISOMETRIC CONDITION**

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**Introduction** Recently, muscle contraction (MC) sensor is possible to evaluate the mechanical property during muscle contraction. It has been reported that muscle activity and MC signal was related to the elbow flexion force in isometric contraction. However, relationship between muscle activity and mechanical property of knee extensor muscle under isometric condition is not clear. Therefore, the purpose of this study was to investigate the relation of electrical activity and mechanical property under isometric contraction in knee extensor muscles. **Methods** Eighteen males (age: 24.7 $\pm$ 5.0yrs, Height: 174.3 $\pm$ 7.5cm, Weight: 69.4 $\pm$ 11.7kg) without disabilities to knee joint were participated in this study. The muscle torque (MT) of knee extension under isometric condition with knee angle of 80 degrees was meas-

ured using dynamometer (Biodex co.). At the same time, the tension of muscle belly for vastus lateralis (VL), rectus femoris (RF) and vastus medialis (VM) as a mechanical properties (FMC) were measured by MC sensor (TMG-BMC co.). MC signal indicate the tension of muscle belly and tendon on contraction. The relative values to the each peak value of MT (%MT) and FMC (%FMC) were calculated in all the subjects. And also, the electrical activities of knee extensor muscle were measured by surface electromyography. In addition, it was integrated (iEMG). Results FMC of VL ( $2.75 \pm 1.64$ N) showed significantly highest values among the muscle groups (RF:  $1.89 \pm 0.81$ N, VM:  $1.59 \pm 0.98$ N). iEMG was closely related to the MT in all the muscles (RF:  $r = 0.994$ , VM:  $r = 0.991$ , VL:  $r = 0.988$ ). And, significant correlation coefficients were obtained between iEMG and %FMC (RF:  $r = 0.992$ , VM:  $r = 0.986$ , VL:  $r = 0.994$ ). Furthermore, high linearity and good dynamic properties were showed between %MF and %FMC of knee extensor muscle (RF:  $r = 0.998$ , VM:  $r = 0.998$ , VL:  $r = 0.997$ ). Discussion In this study, MC signal of vastus lateralis, rectus femoris and vastus medialis muscles were strongly correlated to muscle torque and electrical activities under isometric condition. From these results, it was supported the previous studies for elbow flexor. Therefore, MC sensor may effective method to evaluate the mechanical function of the muscle. References Djordjevic S, Tomazic S, Narici M, Pisot R, Meglic A. (2014), Sensors., 14, 1-16. Djordjevic S, Stancin S, Meglic A, Milutinovic V, Tomazic S. (2011), Sensors., 11, 9411-9425. Djordjevic S, Berdajs M, Modic Z, Gerbec C, Stancin S, Sodnik J, Tomazic S. (2014), TMG: Today and Future, ISOT2014, 23-27 Contact st4986@hotmail.com

## MUSCLE ACTIVITIES AND MECHANICAL PROPERTIES OF THIGH MUSCLE DURING ISOKINETIC KNEE EXTENSOR MUSCLE.

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Introduction Different methods and techniques have been used to assess muscle contraction properties. Such as, recording for torque measurement, electromyography and MC sensor. In here, measurements with MC sensor on the biceps brachii during isometric contraction showed a linear correlation between the isometric force and MC signal amplitudes. However, muscle activities and mechanical properties using MC sensor in isokinetic contractions with knee extension exercise is not clear. Therefore, the purpose of this study was to investigate the relationship between muscle activities and mechanical properties of knee extensor muscle with isokinetic condition. Methods Eighteen males were participated in this study (Age :  $24.7 \pm 5.0$  yrs, Height :  $174.3 \pm 7.5$  cm, Weight :  $69.4 \pm 11.7$  kg). The subjects were performed 30 times knee extension with isokinetic contractions. The muscle torque (MT) was measured using dynamometer (Biodex co.). At the same time, activities of vastus lateralis (VL), vastus medialis (VM) and rectus femoris (RF) were measured by surface electromyography. Integrated electromyography was used as a muscles activities (iEMG). Tension of knee extensor muscles as a mechanical properties (FMC) were measured by MC sensor methods (TMG-BMC co.). Decrease rate of MT (%MT), iEMG (%iEMG) and FMC (%FMC) were normalized to the peak value during 30 times isokinetic contractions with knee extension. Results MF and FMC were decreased with number of isokinetic knee extension in all the muscles. On the other hands, iEMG of VL and VM were showed almost same values during knee extension exercise. Whereas, its value of RF was significant increase with number of contractions during knee extension. Correlation coefficient was obtained between %iEMG of VM and %MT during 30times isokinetic contractions with knee extension. In addition, %iEMG were related to %FMC of RF and VL. %FMC in the all muscles were closely related to %MF. Discussion In this study, a linear correlation between %MT and %FMC were observed in knee extensor muscles. From these results, it was considered that the muscle torque were reflected to tension of knee extensor muscles as a mechanical properties. Reference Djordjevic, S., Tomazic, S., Marco, N., Pist, R, Meglic, A. (2014) sensors., 14, 17848-17863. Djordjevic, S., Stancin, S, Meglic, A., Milutinovic, V., Tomazic, S. (2011) sensors., 11, 9411-9425. Antoine N, Francois H (2010) J. Appl. Physiol., 108, 1389-1394. Contact taroimawaka@outlook.jp

## EFFECT OF REPEATED SHORT-DISTANCE SPRINTS IN ADDITION TO A STANDARDIZED WARM-UP ROUTINE ON SWING VELOCITY

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Introduction: In baseball and softball, an increase in bat swing velocity could be beneficial for improving batting performance. Therefore, baseball players have attempted to increase their bat swing velocity through different warm-up routines. For example, baseball players often perform repeated short-distance sprints in addition to a standardized warm-up routine. Although a few previous studies have examined the effect of using a weighted bat on bat swing velocity (Otsuji T. et al. 2002, Wilson JM. et al. 2012), the effect of repeated short-distance sprints on bat swing velocity remains unclear. Purpose: The purpose of the present study was to investigate the effect of repeated short-distance sprints in addition to a standardized warm-up routine on bat swing velocity in university baseball players. Methods: Three-dimensional batting biomechanics (Mac3D System, Motion Analysis) were measured before (PRE) and after (POST) repeated short-distance sprints in eight male university students. The repeated short-distance sprints comprised ten 30-m sprints with approximately 1 min of active rest between each sprint. In both the PRE and POST conditions, the batter performed 10 swings as fast as possible. The maximum bat velocity and five trials with the highest swing velocity for each PRE and POST period were identified, and the maximum bat velocity and average value of five trials were used for statistical analysis. Significant differences between PRE and POST measurements were determined using the paired t-test. Results and Discussion: There were no significant differences in the maximum and average bat swing velocity (maximum PRE:  $123.6 \pm 7.8$  km/h, maximum POST:  $123.2 \pm 7.4$  km/h,  $P = 0.76$ ; average PRE:  $122.6 \pm 7.7$  km/h, average POST:  $122.0 \pm 7.2$  km/h,  $P = 0.30$ ). An increase in bat swing velocity would provide the batter with more time to see a pitched ball (increased decision time), enabling the batter to make a successful decision concerning whether to swing at a pitched ball (Szymanski DJ et al. 2009). The results of the present study suggested that repeated short-distance sprints in addition to a standardized warm-up routine did not increase batting performance in university baseball players. References: Otsuji T, et al. (2002). Percept Mot Skills, 94(1):119-126. Wilson JM, et al. (2012). J Strength Cond Res, 26(9):2317-2323. Szymanski DJ, et al. (2009). J Strength Cond Res 23(4): 1338-1352.

## MORPHOLOGICAL COMPARISON OF UPPER LIMBS OF RUSSIAN JUNIOR JUDOKAS IN VARIOUS WEIGHT CATEGORIES

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ASU (Maykop, Russia) Introduction Differences in morphological characteristics of judokas in various weight categories may serve as objective data to tailor their competitive activity and training. However, so far there have been very few studies of this kind. It was only

found that heavyweight competitors were taller and had more body fat (Krstulovic et al., 2006; Franchini et al., 2011 et al.). Therefore, the aim of this study was to compare the morphological characteristics of upper limbs of Russian junior judokas belonging to various weight classes. Methods Forty-four judokas (9 first rank athletes, 30 Candidate Masters of Sports and 5 Masters of Sports of Russia) took part in the study. The morphological characteristics of 27 judokas of lighter weight categories (under 60 and 66 kg) and 17 judokas of heavier weight categories (under 73 and 81 kg) were compared. The following measurements were taken: length of upper arm, forearm and hand, arm (relaxed) and forearm girth, hand breadth, triceps and forearm skinfold thickness. Weight-to-height ratio and upper arm, forearm and hand lengths relative to height were calculated. One-way analysis of variance was used to examine the statistical differences of data. Results It was found that heavier judokas have significantly larger lengths of forearms and hands, hand breadth, arm and forearm girths, and triceps skinfold thicknesses ( $p < 0.05$ - $0.001$ ). Non-significant differences in upper arm lengths and forearm skinfold thicknesses were found between the two groups ( $p > 0.05$ ). Judokas of heavier weight categories had larger height and weight-to-height ratio ( $p < 0.01$ - $0.001$ ). Non-significant differences in upper arm and hand lengths relative to height were found between the investigated groups ( $p > 0.05$ ). However, forearm-to-height length ratio was significantly larger for heavier judokas ( $p < 0.05$ ). Discussion Most of the differences in the lengths of body segments of judokas belonging to various weight classes may be explained by their difference in height. However, significantly larger forearm-to-height length ratio in heavier judokas has shown that there are big differences in proportions of upper limbs segments between the compared groups. This may be the reason for the specific techniques of their judo grips and counterwork. Significantly larger weight-to-height ratio in judokas of heavier weight categories may determine their 'force' style, but also may be due to larger body fat percentage which is partly confirmed by significantly larger triceps skinfold thickness. References Franchini, E, Del Vecchio, FB, Matsushigue, KA & Artioli, GG (2011). Physiological profiles of elite judo athletes. *Sports Med*, 41(2), 147-166. Krstulovic, S, Zuvela, F & Katic, R (2006). Biomotor systems in elite junior judoists. *Coll Antropol*, 30(4), 845-851.

## DIFFERENCES IN MUSCULAR ACTIVATION PATTERNS DURING ELASTIC AND WEIGHT RESISTANCE TRAINING

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**Introduction** Elastic resistance training is becoming increasingly common among athletes of varying levels, however there is little understanding about muscle activation patterns elicited by elastic training and how they might differ to weight training. The aim of the current study was to analyse patterns of muscular activation elicited by training with elastic versus weight resistance. **Methods** Seventeen recreationally active males, performed four exercises: bicep curl, lateral raise, leg extension and standing leg curl. Electromyography (EMG) was recorded for the biceps brachii (BB), tricep brachii (TB), deltoid medialis (DM), trapezius descendens (TD), vastus medialis (VM), vastus lateralis (VL), rectus femoris (RF), bicep femoris (BF) and gastrocnemius lateralis (GL) using wireless electrodes and was normalised to maximal voluntary contraction (MVC). Joint angle data was captured for each relevant joint through 3D motion analysis. EMG and 3D data were integrated and the average muscular activation was recorded for every 20° of range of motion (ROM) for three repetitions of each muscle, per condition, per exercise. Exercises were executed at 3 speeds; each exercise was performed with one elastic tube at three different initial lengths: T0 (0% stretch), T10 and T20 (10% and 20% reduction in initial tube length respectively) and a weight of equivalent resistance to the tube (W) as determined by the tube manufacturer. Data for each variable was analysed by within subject repeated measures ANOVA. **Results** Elastic training elicited lower ( $p < 0.05$ ) muscular activation than W at beginning stages of the movement of the bicep curl (BB), leg curl (BF, GL) and leg extension (BF); and higher ( $p < 0.05$ ) activation at final stages of ROM of the bicep curl (BB, TB), lateral raise (DM, TD, BB) and leg extension (VL). T0 elicited lower ( $p < 0.05$ ) activation than T20 at varying stages of the bicep curl (BB, TB), lateral raise (DM, TD, BB) and leg extension (RF, VM, VL, BF). **Discussion** Elastic resistance elicited lower activation than weight resistance at initial stages of movement, and higher activation at final stages of the movement where weight resistance generally showed a drop in muscular activation. Auxiliary muscles were generally more active under elastic resistance, suggesting that elastic resistance may be a more appropriate method for proprioceptive training. Antagonist muscle activation response varied between exercises. In conclusion, elastic training provoked opposing muscular activation patterns to weight training, where as one increased the other decreased, indicating that the two training methods may elicit muscular adaptations at differing muscle lengths, and may be effectively used as complementary training methods. Contact F.Ronca@kingston.ac.uk O.Spendiff@kingston.ac.uk

## A STUDY OF THE STRUCTURE OF THE COMPETITIVE ROUTINES ON HORIZONTAL BAR

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**INTRODUCTION** The development of the exercises on horizontal bar is in constant dynamics. We consider that the study of the structure of the competitive routines will help the specialists to construct more effective and more virtuosic routines that will be executed safely and steadily. The aim of this study is to establish the current tendencies regarding the structure of the competitive routines on horizontal bar. In order to achieve this aim, some groups of tasks were determined. **METHODS** The research is conducted on the basis of video footage containing performances on a horizontal bar during the European games in Baku and The World Championship in Glasgow in 2015. We researched the best horizontal bar routines that were executed by 24 gymnasts that had competed in the all-round. **RESULTS** The survey includes data collection about compositional and technical structure of the routines. The compositional structure was analyzed on the basis of the data collection concerning the relation between the main and additional structural groups exercise, their motor characteristics and difficulty. The technical structure was analyzed on the basis of the collected data about the safety and stability of the routines' executions and biomechanical analysis of the exercises with technical errors. **DISCUSSION** The research of the compositional structure of the routines helped us to find the average number of exercises in one routine (31 and 26) and the number of the different kinds of exercises included in the routines from both competitions (55). The study proved that from all determined structural groups, the biggest part have the giant swings backward elements (36%), "in bar" elements (14-16%) and flight elements (10-12%). According to the difficulty, the most widely used exercises are from groups A and D. The analysis of the technical structure of the routines has proved that the safety and the stability of the researched routines from both competitions are about 88%. There are three interruptions from 24 executed routines. The exercises with technical errors that caused interruptions are from groups C, D and E. The biomechanical analysis of these exercises enables us to determine the causes for these errors. **REFERENCES:** Angelov V. (2015). Investigation of the Composite Structure of the Competitive Combinations at the Pairs in the Sports Acrobatics, University of Ruse. Angelov V, Kyuchukov I, Andreev P, Yanev I. (2015). Investigation of the Structure of the Competitive Combinations at the Floor Exercises in the Artistic Gymnastics, University of Veliko Tarnovo. Gaverdovskii U. (2002). The technique of gymnastic exercises. M., Tera-sport. Kiuchukov I. (2012). Characteristics of transition period from support phase to flight phase on horizontal bar. University of Ruse, vol. 51, book 8.2, pp. 32-35. **CONTACT:** angelov.vl@gmail.com Do not insert authors here

## BIOMECHANICAL CHARACTERISTICS OF THE RADIUS OF CURVATURE ON A NON-MOTORIZED CURVED TREADMILL WALKING AND RUNNING

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**INTRODUCTION:** Non-motorized treadmill with curved surface which enables indoor walking and running exercise without any electricity is a notable alternative for traditional motorized treadmill by its self-adjusting speed controls. Since running surface is concave on the curved treadmill, different physical benefits such as increased oxygen consumption at slow speed, decreased reaction force at initial contact are assumed to compare with flat treadmill. **Purpose:** This investigation was undertaken to examine the biomechanical responses during walking and running on a Non-Motorized Curved Treadmill (NMCT). **METHODS:** In this study, three different radius of curvature (2500mm, 3000mm, 3500mm) of the NMCT were used to treadmill walking and running according to the three different speeds (70, 110, 170 step/min), and the speeds were controlled by cadence. Subjects walked for two minutes with breaks between trials of speed and curvature to prevent fatigue. Twenty-seven retroreflective markers affixed to the full body were used to record three-dimensional kinematics (60Hz, Osprey, Motion Analysis Corp., USA) on the three different curvature of the NMCT with three different speeds. **RESULTS:** With the speed increasing, step length was increased and step width was decreased on the all three different radius of curvature. Initial contact position on the treadmill belt has moved backward at lesser curvature. But the step width and deviation of center of body mass in the Anterior-Posterior direction were increased at the decreased radius of curvature, which mean the stability of walking and running on the NMCT was decreased. **CONCLUSION:** Consequently, the curvature needs larger radius to make stable walking and running, on the other hand, it needs lesser radius to walk and run easily on the NMCT. **REFERENCES:** 1. Patrick O. Riley et al., A kinematic and kinetic comparison of overground and treadmill walking in healthy subjects, *Gait & Posture* 2007; 26, 17–24. 2. I. Van Caekenbergh et al., Overground vs. treadmill walk-to-run transition, *Gait & Posture* 2010; 31, 420–428.

## RUNNING AT DIFFERENT SPEEDS, THE ROLE OF THE INTACT AND PROSTHETIC LIMBS FOR TRANS-TIBIAL AMPUTEES

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**Introduction** Running speed is determined by the step length and cadence, and up to speeds of 7m/s the dominant strategy to run faster by using the ankle muscles to push harder on the ground increasing step length (Dorn et al 2012). Trans-tibial prostheses have a passive ankle, which means that they cannot generate more power than they absorb. It is not known how this responds to increasing speed and how the peak vertical ground reaction force (vGRF), cadence and step length change. Thus the aim was to determine how the intact (I) and prosthetic (P) side of people with a trans-tibial amputation respond to change speeds. It was hypothesised that the P side would not increase peak force or step length when increasing speed while the I limb would increase both force and step length. Finally we hypothesised that with increasing speed the step length and peak vGRF would become asymmetrical. **Methods** Six male recreationally physically active trans-tibial amputees (mean age: 39.5years, height:1.81m and mass 80.93kg) participated in the research. All wore the Endolite Blade XT prosthesis and were free from injury and residual limb pain or skin issues. Amputees were asked to run at 3 self-selected speeds, comfortable jog (SS), 70% of that speed (Slow) and 130% of that speed (Fast) across a forceplate (1000Hz) while their motion was recorded using a synchronised VICON motion capture system (100Hz). Fast and Slow speeds were individually calculated from the SS and were controlled within 5% by speed gates. Five successful trials (clean foot contact on the forceplate, within the speed limit) per leg with were recorded. The effect of running speed on cadence and on each of the I and P step length, and peak vGRF was determined using repeated-measures ANOVA. Significance was set at  $P < 0.05$ . **Results** Speed had an effect on all variables except the peak vGRF on the P side between SS and Fast. I step length (Slow:  $0.83 \pm 0.12$ ; SS  $1.12 \pm 0.14$ ; Fast  $1.29 \pm 0.11$ m) and P Step length (Slow  $0.83 \pm 0.12$ ; SS  $1.09 \pm 0.14$ ; Fast  $1.30 \pm 0.13$ m) also proved to be symmetrical at each speed. The peak vGRF tended to become more asymmetrical as the speed increased (I Slow  $21.81 \pm 4.19$ ; SS  $24.81 \pm 3.86$ ; Fast  $26.63 \pm 3.19$ ; P Slow:  $18.88 \pm 2.17$ ; SS  $21.16 \pm 1.9$ ; Fast  $22.90 \pm 2.58$  N/kg). **Discussion** Amputees were able to increase speed through altering the cadence and the step length on both sides. We had anticipated that the restrictions of the passive ankle would lead to a change only in cadence and I step length, as the ankle on the I side can create a larger force in order to propel the leg further as it swings but the P side step length is restricted by the inability to generate a large peak force to propel it. Although the P peak vGRF did not significantly increase from SS to Fast, the step length increased, suggesting that the length is modulated by other factors. This 'topping-out' of the peak vGRF for amputees is likely due to the passive nature of the prosthesis. **References** Dorn TW, Schache AG, Pandy MG (2012) *J Exp Biol* 215 (Pt11):1944-56

## BIOMECHANICAL COMPARISON OF VERTICAL JUMP PERFORMANCE DURING TAKE-OFF PHASE BETWEEN LAND AND WATER ENVIRONMENTS

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**Introduction** Aquatic-based plyometric training has become an alternative to exercise training on land (Stemm, Jacobson, 2007) because of the same improvement and less impact force through buoyancy (Donoghue, Shimojo, and Takagi, 2011). However, there is no further observation the jump performance under water so far. Therefore, the purpose of this study was to compare the ground reaction forces (GRF) and knee and ankle angle velocities during takeoff of counter movement jump (CMJ) between on land or in pool of water. **Methods** 5 college men were recruited in this study (average height was  $172.35 \pm 3.75$  cm, the average body weight (BW) on land was  $65.14 \pm 3.85$  kg, and the aquatic BW was  $46.30 \pm 3.20$ kg). Then participants were asked to perform counter movement jumps (CMJ) on land or in water randomly on an AMTI waterproof force measurement device. The standing immersion depth of the navel level ( $\pm 3$  cm) was set in this study. We recorded three successful CMJ in land and aquatic based condition with sampling frequency of 1000 Hz and analyzed the peak GRF during takeoff of each jump. The force data were normalized by the body weight in the condition. Besides, the jump performances were captured by commercial camera with a waterproof case with 30 Hz sampling rate. Knee and ankle angle velocities during propulsive phase of jumping were calculated through Siliconcoach motion analysis software. A paired t test was used to exam all parameters of jumps between land and water conditions. **Results** The peak GRFs of CMJ are  $1.78 \pm 0.20$  BW on land and  $2.68 \pm 0.16$  BW in water as well as those of rate of force development are respectively  $2.19 \pm 0.09$  BW/s and  $3.62 \pm 0.07$  BW/s. Both force parameters in aquatic condition are significantly higher than those on land. While, knee angle velocities of  $195.63 \pm 27.93$ ,  $248.89 \pm 39.90$  degree/s were produced on land and in water, respectively, ankle values of  $138.62 \pm 12.51$ ,  $174.46 \pm 80.58$  degree/s. **Discussion** The BW in water is approximate 71% on land because of the buoyancy which can effectively decrease the landing force that may serve as a reduction in



potential muscle damage. However, the aquatic GRFs and rate of force development during takeoff are higher of CMU by 1.51 and 1.62 times respectively. Participants need to generate more force production with quick lower-extremity angle velocities with more to overcome water drag resistance than the gravity on land. Consequently, this finding suggests that aquatic jump is an alternative to exercise training on land. References Donoghue OA., Shimojo H, Takagi H. (2011). *Sports Health*, 3(3), 303-309. Stemm JD, Jacobson BH (2007). *J Strength Cond Res*, 21(2), 568–571.

### ACCURACY OF THREE-DIMENSIONAL MEASUREMENT FOR HIP, KNEE, AND ANKLE JOINT ANGLES DURING WALKING AND RUNNING BY USING INERTIAL MEASUREMENT UNIT

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**Introduction** Inertial measurement unit (IMU) constructed by gyroscope, accelerometer and magnetometer was used to measure the joint angles of lower extremity in three-dimensions (3D) during walking (Favre et al., 2008). Cooper et al. (2009) reported that the accuracy of the IMU for the measurement of the joint angles were decrease with increase in walking speed. This suggests that the accuracy of IMU may be lower for running than for walking. To apply the IMU for running, the accuracy of IMU should be compared to walking and running. The purpose of this study was to examine the difference in the accuracy of IMU for measurement of the joint angles of lower extremity in 3D between walking and running. **Methods** Fourteen healthy young adult males participated in this study. IMUs (Myomotion, Noraxon) and retro-reflective markers were attached to the pelvis and the right lower extremity. Optical motion capture system (OMC) (Vicon MX, Oxford) as a reference system was used to measure the joint angles of lower extremity in 3D. IMU and OMC were electrically synchronized and recorded data at 100 Hz. The subjects performed to walk (1.67 m/s) and run (3.33 m/s) on treadmill. Root-Mean-Squared (RMS) differences between the joint angles determined by using IMU and OMC were calculated to evaluate the accuracy of IMU. Two-way ANOVA with repeated measures was conducted for testing the effects of types of locomotion and directions of joint angles on RMS difference. Post-hoc test with Bonferroni correction was conducted to test the difference in RMS difference between walking and running in the each joint angle. **Results** Mean RMS difference of the hip joint angles for walking (FE: flexion-extension, IER: in-external rotation and ABD: ab-adduction) were 3.7°, 3.8° and 2.8° for FE, IER and ABD, respectively. The corresponding values for running were 5.4°, 5.1° and 4.4°. Mean RMS of the knee joint angles (FE, ABD and IER) were 3.4°, 2.8°, 3.2° in walking and 7.1°, 4.4°, 4.6° in running. Mean RMS of ankle joint angles (plantar-dorsi flexion, in-eversion and IER) were 7.8°, 4.1°, 4.2° in walking and 11.8°, 6.6°, 5.7° in running. Mean RMS of hip, knee, ankle joint angles in running were significantly higher than mean RMS in walking and there were no interaction. **Discussion** Mean RMS differences of the each joint angles for running was larger by 1.3-4.0° than that for walking whereas the direction of joint angles did not influence the mean RMS differences. These results indicate that the accuracy of IMU for the measurement of the joint angles of lower extremity in 3D is lower for running than for walking. References Favre J. et al. (2008), *J Biomech*, 41, 1029-1035. Cooper G. et al. (2009), *J Biomech*, 42, 1678-1685. Contact manabukosaka@gmail.com

### HEAD IMPACT MECHANISMS DURING PRACTICE FOR SOCCER OF JUNIOR ATHLETES

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**Introduction** Since the high number of deaths (suicides) and debilitating head injuries in American Football there has been a lot of attention both by the media and by researchers for head injuries in sport. However, soccer is reported to be responsible for the largest number of head impacts and highest concussion rates among females (Gessel et al., 2007). Only recently the technology to measure head impact mechanisms during practice and competition is available and so there is a dearth of data regarding the magnitudes and frequency of head impacts in soccer for all genders and levels. Therefore the purpose of this study was to measure the head impact characteristics of junior boys during soccer practice. **Methods** Using the xPatch (Biosystems Inc.) head impact data (peak linear acceleration (PLA), peak rotational acceleration (PRA), peak rotational velocity (PRV) and Head injury Criterion (HIC) 15ms) were collected over ten training sessions. Ten junior boys aged between 8 and 12 years of age participated after their parents/ guardians signed the University Hospital approved IRB consent form. Data from the sensor was then backed up on the Biosystems cloud and their proprietary software Impact Management System software was used to output the impact severity related variables. Non-parametric Krushall-Wallis tests were used to investigate the differences in the sessions and among the participants. **Results** During the ten sessions, there were a total of 501 impacts recorded, averaging out at 90 impacts per 100 minutes. The averages and standard deviations for PLA, PRA, PRV and HIC were 17.8±10.3g, 3168 ± 2442deg/s<sup>2</sup>, 16.1 ± 10.6deg/s, 11.4 ± 34.2. The most impacts were located at the back of the head (45.5%), followed by the side (33.7%), front (19.9%) and top (0.9%). According to the PLA guidelines by King (2014) 96.2% were classified as low severity (10-39g), 3.3% medium severity (40-69g), and 0.4% as high severity (>70g). **Discussion** With the exception of a few impacts (2 impacts) the magnitudes recorded in this study were not classified as a high severity. However, because of the high frequency of head impacts in soccer, it is important for those participating and their medical support staff to be aware of the risks associated with repetitive impacts. Future research is needed to maintain a longitudinal design to assess the effects of repetitive low impacts. References Gessel LM, Fiields SK, Collins C, Dick RW, Comstock, RD (2007). *J Athl Train*, 42, 495-503 King D, Hume P, Brughelli, Gissane C. (2014), *Am J Sport Med*, 43(3), 614-624. Contact [davidosullivan@pusan.ac.kr]

### SHOE MIDSOLE HARDNESS EFFECTS ON PLANTAR FORCE DURING HEEL-TOE RUNNING

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**Introduction** The shoe midsole hardness is one of factors, which determine the function of shoes. It was made clear that vertical ground reaction force during stance phase was not influenced by the shoe midsole hardness. However, vertical ground reaction force measured by force platform couldn't explain distribution of plantar force. Thus the effect of shoe midsole hardness on the plantar force in each foot regions during running, for example plantar force in heel region during heel contact has not clear. Therefore, the purpose of present study was to investigate the effect of shoe midsole hardness on the plantar force in each foot region during running. **Methods** Five males without any deficit in their lower limbs served as subjects. Their mean age, height and body weight were 21.8±3.34 yrs, 1.69±0.02 m and 58.0±2.75 kg, respectively. They have three running trial on the treadmill for one minute wearing 3 different hardness condition shoes, respectively. The shoe condition divided only by difference in their midsole hardness: SOFT, MEDIUM and HARD (hardness equal to 48°, 65° and 71°, respectively). Plantar force was measured by in shoe pressure measurement system (Pedar-X, Novell), comprising 99 capaci-

tive sensors. After data collection, we re-construct 99 sensors into 6 regions. Peak pressure, Peak resultant force were evaluated over the six plantar regions. Lower limb motion was captured from right side with video camera. Time-special parameters and Kinematic parameters of lower limb during stance phase were measured from the movie. One-way ANOVA with repeated measures used to determine if there were any differences in various variables from the use of different midsole hardness for running. All significant effects ( $p < 0.05$ ) were followed by Tukey post hoc tests. Results No significant difference was seen among any variables and areas both in peak pressure and peak resultant force. Contrary, significant differences were observed both in the ankle joint angles and ankle joint angular velocities at 60, 70, and 80 % of stance phase, where it apt to be a dorsiflex position and lower in plantar flex velocity in the SOFT condition. Discussion Main results of present study were that significant differences in ankle joint angle and ankle joint angular velocity at 60, 70, and 80% stance phase, although no significant differences was seen in plantar pressure force and kinematic parameters in hip and knee joint. These results lead to the speculation that softer midsole may delay plantar flexion at the latter part of stance phase. Then, coaches and shoe distributor should take these results into consideration, because too softer running shoe midsole may not only train lower limb muscles but also disturb running form of the athletes. References 1) Nigg. B. M, et al., 1987, J Biomech. 20(10):951-959. Contact yoshi-ki95horiguchi@gmail.com

## THE DIFFERENCE IN THE IMPACT OF THE HEAD DURING USHIRO-UKEMI AND UKEMI OF OSOTOGARI IN JUDO

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Introduction Budo had become a compulsory subject in a course of study of Japanese junior high school in 2014. Therefore, most of junior high school students have a possibility to learn judo in physical education class since then. It is very magnificent for us, Japanese people, to experience traditional Budo. On the other hand, we can say that the population of beginner has increased because of its changes in compulsorization. Specifically, external head injury during judo is focusing. Therefore, the purpose of this study was to identify the maximal angular velocity(AV) and angular acceleration(AA) acted on head during Ushiro-ukemi(UU), Yoko-ukemi(YU), and ukemi for Ukemi of Osotogari(OU). It might be very important knowledge for practicing safely in a coaching scene. Methods Six collegiate judo wrestlers, who experienced judo over ten years served as subjects. Subjects did UU and YU. Moreover, they did ukemi after there were thrown with OU. Four retro-reflective markers were put on the subject's head surrounding during the experiment. The coordinate values were measured using 3D motion capture system (Vicon MX,Oxford). A coordinate system of a head was defined from the marker loaded on a head. And the AV and an AA were calculated. The maximum of an AV and the AA was presumed as the impact, which acts on a head. Results Maximum resultant AV during UU, YU, and OU were  $347 \pm 80.3 \text{ deg/s}$ ,  $318 \pm 29.9 \text{ deg/s}$ , and  $394 \pm 82.3 \text{ deg/s}$  respectively. Significant difference was seen among maximum velocities during UU and YU. And No significant difference was seen between YO and OU. Then, maximum resultant AA were.  $5011 \pm 983.3 \text{ deg/s}^2$ ,  $7028 \pm 2324.6 \text{ deg/s}^2$ , and  $7990 \pm 3349.8 \text{ deg/s}^2$ . Significant difference was seen between UU and YU. And No significant difference was seen between YO and OU. Discussion AV during OU indicated higher value compared with UU, though angular velocities didn't differ among UU and OU. Hitosugi et al (2014) buried accelerometer in dummy doll's head and reported the higher acceleration values during ukemi compared with the acceleration of present study. Therefore, it can be said that the originality of present study was to measure acceleration of head during ukemi in vivo, though the reported values were different from the reported values in present studies. As a result of this study, the acceleration during OU was significantly higher value compared with UU. In the course of study of in physical education in Japanese junior high school, OU was acquired immediately after UU. However, the result of present study indicate that asotogari should be taught after students acquire YU because of avoiding heavy head injury caused by OU. References Hitosugi, M et al (2014). Biomedical Research, 35(5), 339-344. Contact taira6664@gmail.com

## SHEAR WAVE ELASTOGRAPHY OF MUSCLE AND TENDON BEFORE AND AFTER DYNAMIC STRETCHING: A PILOT STUDY.

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Introduction Shear wave ultrasound elastography (SWE) allows shear wave speed, which is related to stiffness, to be measured in vivo in individual muscles and tendons. SWE measurements might provide reliable material property measurements by aligning the transducer imaging plane with the muscle fibre orientation (Miyamoto et al., 2015, Eby et al., 2015). Our aim was to evaluate the material properties, specifically stiffness, as quantified based on shear wave speed in the medial gastrocnemius muscle (MGM) and Achilles tendon before and after an acute bout of dynamic stretching (DS). Methods A convenient sample of 6 persons volunteered for this study. The shear wave speed of the MGM belly and Achilles tendon were measured using the Aixplorer® ultrasound shear wave elastography (SuperSonic Imagine, France) before (PRE) and immediately after (POST) a DS protocol. Elastograms were taken with the participant lying prone and the ankle fixed at 10 degrees of dorsiflexion on a Cybex NORM dynamometer (Cybex International Inc., UK). The ultrasound probe (5-cm width) was applied very lightly with generous amount of contact gel, held in parallel with the MGM fascicles or Achilles tendon line of action and kept still for 10 s for the optimal acquisition of elastography images. Shear wave speed was measured as the average velocity  $\pm$  SD of the selected region of interest. The probe position was marked on the skin so that it was identical during the PRE and POST measurements. A standardised published DS protocol was adopted (Holt et al., 2008). Participants were instructed to perform 3 sets of 20 repetitions of active dorsi- and plantar flexion of both ankle joints through the full range of motion to a rhythm of 80 beats per minute provided by a metronome. Results A trend for an increase in MGM shear wave speed from PRE (6.80 m/s) to POST (7.25 m/s) was found (6.62%). The effect of DS on tendon shear wave speed was minor (1.54%; 9.08 m/s vs 9.22 m/s, respectively). Discussion A trend for a larger increase in shear wave speed in the muscle as compared to the tendon suggests that the effect of DS on tissue stiffness might be greater in muscle than in tendon. This pilot study demonstrates the potential of SWE as a non-invasive tool for investigating mechanisms of altered muscle properties after an intervention. References Eby, S.F., Cloud, B.A., Brandenburg, J.E., Giambini, H., Song, P., Chen, S., LeBrasseur, N.K and An, K.N. (2015) Shear wave elastography of passive skeletal muscle stiffness: influences of sex and age throughout adulthood. Clinical Biomechanics, 30, 22–27 Holt, L. E., Pelham, T. W., & Holt, J. (2008). Stretching the Major Muscle Groups of the Lower Limb. In Flexibility: A Concise Guide, Totowa, NJ: Humana Press. Miyamoto, N., Hirata, K., Kanehisa, H., and Yoshitake, Y. (2015). Validity of measurement of shear modulus by ultrasound shear wave elastography in human pennate muscle. PLoS ONE, 10: e0124311.

## KINETIC ANALYSIS OF PELVIS HORIZONTAL ROTATION OF ANGLED INSTEP KICKING IN SOCCER

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**Introduction** Previous study illustrated that matured instep kick included appreciable pelvis counter-clockwise rotation and that motion was induced by torques mainly due to ground reaction force (Inoue et al., 2014). However, mechanical factors that induce the pelvis rotation have not been revealed when players kick the ball to varied angles. This study aimed, therefore, to clarify the kinetic aspects of the pelvis rotation when players kick the ball towards angled directions. **Methods** Nine male soccer players performed maximum instep kicks towards three angled directions (15, 45 and 75 deg.). Their motions and ground reaction forces were recorded by a motion capture system at 500 Hz. Angular velocity and torque vectors regarding the support leg and the pelvis were calculated, and then the components that induce the pelvis rotation on the horizontal plane were extracted. **Results** An increase of the angle of kicking direction led to a significant ( $p < 0.05$ ) increase of the range of the pelvis rotation. With increasing the kicking angle, the higher hip joint torques of the support leg were observed. The angular impulses due to the hip joint torques were systematically and significantly ( $p < 0.05$ ) increased with an increase of kicking direction angle. The ranges of foot segment rotation (ROM) of the support leg were also systematically emphasized with an increase of the kicking direction angle while the torques for the foot rotation were small to be negligible in all the kicking directions. **Discussion** Scurr & Hall (2009) reported that soccer players displayed a greater pelvic rotation when using a wider approach angle. Levanon & Dapena (1998) argued that the pelvic rotation has a role to face the anterior half of the thigh (kicking leg side) onto the target direction. In this study, we succeeded in illustrating how the kinetic background changes when players kick the ball to angled directions. Inoue et al. (2014) already demonstrated that the interaction torque due to ground reaction force is the main drive in producing the pelvis rotation in normal straight instep kicking. We accumulated additional knowledge about the emphasized pelvis rotation when the ball was kicked to angled directions. The pelvis rotation was emphasized in response to the increased kicking angles. The hip joint torque (angular impulse) of the support leg was the kinetic factor systematically corresponded to the change of kicking directions. Thus, it can be assumed that the hip joint torque of the support leg is responsible for the increased pelvic rotations. Likewise, we observed the foot rotation was increased with an increase of the kicking angles. However, this motion was not accompanied by the action of the torque. Hence, it is most likely that the foot rotation is passively induced by some other factors such as partial friction of the floor acting on the foot segment. **References** Inoue K et al. (2014). *J Sports Sci*, 32, 1023–32. Levanon J & Dapena J. (1998). *Med Sci Sports Exer*, 30, 917–27. Scurr J & Hall B. (2009). *J Sports Med*, 8, 230–4. Contact inoue@e.yamagata-u.ac.jp

## RELATIONSHIP MAXIMAL AND EXPLOSIVE POWER TO PERFORMANCE OF MOTOR ACTIONS IN WEIGHTLIFTING

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**Introduction** Identification of the most informative indicators of special physical fitness of athletes, as well as the assessment of their impact on the realizable efficiency of motor actions allows to obtain objective data for the development of more effective models of training and improvement of quality control by correcting the direction, structure and content of the training sessions. The purpose of research – to investigate the relationship of maximal and explosive power and performance of motor actions in weightlifting. **Methods** The study took part lifters of high qualification, aged 20–23 years ( $n=10$ ). To determine the explosive power, which was estimated by the duration of the flight phase in the jumping tests, we use tensometric platform. Jumping carried out with a stop and with fast switching in the legs by bending at the extension. Jumps were performed with a barbell on your shoulders and weighing 50 and 100 kg and without complications. To determine the maximum strength applied squats on his shoulders with a maximum weight. Using test determined the maximum result in the snatch. **Results** The result in the snatch is a high degree of relationship with maximum strength ( $r=0.85$ ). In addition to the high significance of the maximum strength to result in the snatch, an essential feature is the explosive power. Analysis of the relationship results in the snatch and jumping tests indicate that the greatest values coefficients of correlation are the results of such tests, like jumping up without burdening with fast switching in the muscles of the lower extremities with inferior mode to overcoming ( $r=0.80$ ). Through the use of regression analysis of the parameters studied found that with an increase in the squat result (the maximum strength) of 10 kg in the snatch result increases by an average of 5.2 kg, and the increase of the flight phase jump time 10 ms increases to result in the snatch 18.3 kg. **Discussion / Conclusion** It is found that the tightness of relationship of results in the snatch, squats and squat jumps, at their joint effect is increased ( $r=0.87$ ), and determines the result to sports 76.0%, and 50.0% is necessary to share the maximum power while the share of explosive power of 26.0%. Results in jumping to the stop and fast switching leg from bending at the extension at their joint effect, a high degree of correlation with the result in snatch ( $r=0.85$ ) and its variation is determined at 72.0%. The share of jumps with a stop there are only 7.0%, while the share of jumps with fast switching in the muscles necessary to 65.0%. This confirms the importance of the use of stored elastic energy of the working muscles during rapid switching cycle «tension – reducing». **References** I. Turkileri, E. The Program of Long-term Preparation of Weightlifters / E. Turkileri, I.P. Sivokhin, A.G. Ni, L.N. Don. – Kostanay: Kostanay State Pedagogical Institute, 2005. – 56 p. Contact Sivokhin Ivan, Fyodorov Alexander: sportscience@mail.ru; <http://www.sportconference.jimdo.com>

## HIP ROTATION AS A PREDISPOSING FACTOR OF THE SCREENING TESTS FOR ANTERIOR CRUCIATE LIGAMENT INJURY IN FEMALE ATHLETES

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**Background** Anterior cruciate ligament (ACL) injury occurs with a higher incidence in female athletes compared with males. No specific hip joint anatomy has been identified as a risk factor for ACL injury in females. Video analyses of non-contact ACL injuries indicate that the hip with an adducted and internally rotated femur and in little hip flexion creates knee valgus, tibial external rotation and forefoot pronation. Therefore, the knee injury could be the result of more proximal hip position. Understanding of proximal anatomical factors may be necessary to identify female athletes at high risk of ACL injury. However, no previous study has demonstrated the relationship of specific hip anatomy with ACL injuries or the risky landing pattern of ACL injuries in females. **Purpose** This study was conducted to clarify the association of hip rotations with knee valgus motion during ACL injury screening tasks that is the strong predictor of ACL injury. **Methods** The 6 measures of hip joint motion (flexion, extension, abduction, adduction, external rotation, and internal rotation) and the 2 measures of knee joint motion (flexion and extension) were collected with the standard procedure using a goniometer. Medial knee displacement in the frontal plane induced during the screening tests for ACL injury (drop vertical jump and single-leg squat tests) was evaluated as the representative of the knee valgus motion by the two dimensional video analysis method that has been shown to provide reliable evalua-

tions of frontal plane knee valgus motion. Results Knee valgus was induced in 24 and 22 of the 31 healthy female volunteers by drop vertical jump and single-leg squat tests, respectively. The knee valgus-positive females showed smaller range of hip external rotation than the negative ones, which was significantly associated with knee valgus during the screening tests. Hip internal rotation dominance (internal rotation range is greater than external one) was significantly related to knee valgus induced by each screening test. In contrast to the females, the male subjects showed lower rates of knee valgus induction by the screening tests, whereas there was no clear association between hip internal rotation dominance and the knee valgus induction. Discussion Female athletes with smaller external rotation of the hip by greater femoral anteversion may maintain the femoral head within the acetabular cavity through internal rotation of the hip. Such compensatory changes in the femoral internal rotation could lead to the knee valgus during the ACL injury screening tests. The present findings may indicate a predisposing role of hip rotation measurement in identification of females at risk for ACL injury.

### LOWER LEG QUASI-STATIC STIFFNESS RELATED TO INJURY IN ELITE NETBALLERS

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**Introduction** Relatively high lower-body stiffness has previously been related to an increased incidence of bony (Williams et al., 2004) and soft-tissue injuries (Watsford et al., 2010). The aim of this research was to determine if similar relationships exist between quasi-static stiffness of individual muscles and lower-body injury incidence in female netballers. **Methods** Four lower leg sites of an entire elite female netball team (n=10) were assessed for bilateral quasi-static stiffness using myometry (soleus, Achilles tendon, medial & lateral gastrocnemius). Any injury that occurred throughout the playing season was reported. Participants were first divided into injured and non-injured groups to compare the stiffness characteristics of each group in an injury segmentation analysis, and secondly divided into relatively stiff and relatively compliant groups to perform a stiffness segmentation analysis. **Results** The injured group exhibited significantly higher stiffness of the soleus ( $p=0.037$ ) and Achilles tendon ( $p=0.004$ ) compared to the non-injured group. The stiffness segmentation analysis revealed that odds of elite netballers sustaining a lower-body injury were 16 times higher with a relatively stiff medial gastrocnemius or soleus and 121 times higher with a relatively stiff Achilles tendon. **Discussion** The stiffness segmentation analysis suggested that athletes with relatively stiff medial gastrocnemii are at higher risk of injury however, the injury segmentation analysis did not reveal any significant results for this site. There were no significant differences in either analysis when considering the lateral gastrocnemius. These results suggest that the stiffness of the gastrocnemius complex does not contribute to lower-body injuries in netballers. A comparison of the injury incidence between the relatively stiff and relatively compliant groups revealed a higher injury incidence in participants exhibiting relatively stiff soleus and Achilles tendon complexes. Further, when comparing injured and non-injured groups, injured participants presented significantly higher stiffness of the soleus (22%) and Achilles tendon (35%). These results suggest that the stiffness of the ankle joint musculature is important when considering lower-body injury risk in elite netballers. This relationship is plausibly due to the high ankle joint loading during repetitive cutting and jumping movements performed in netball and has implications for strength and conditioning specialists when considering optimal preparation for netballers. **References** Williams D, Davis I, Scholz J, Hamill J, Buchanan T. (2004) Gait Posture, 19(3), 263-269. Watsford M, Murphy A, McLachlan K, Bryant A, Cameron M, Crossley K, Makdissi M. (2010) Am J Sports Med, 38(10), 2058-2064. Contact elizabeth.pickeringrodriguez@uts.edu.au

### CORRELATION BETWEEN THE CONFORT OF RUNNING SHOES AND ANTHROPOMETRIC CHARACTERISTICS OF FEET OF THE RUNNER'S

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**INTRODUCTION** Running-related injuries are common and previous research has suggested that the magnitude of rearfoot pronation, plantar arch and shoes comfort are potential risk factors that can contribute to the development of these injuries [1,2]. However, the results on associations of the anthropometric feet with the comfort are still inconclusive regarding the running shoes. **OBJECTIVE** The objective of this study was to verify the correlation between the arch plantar and rearfoot angle with the comfort of the running shoe in runners. **METHODS** Twenty eight recreational runners were evaluated (age:  $35.6 \pm 9.0$  years old; body weight:  $72.1 \pm 12.0$  kg; height:  $1.72 \pm 0.09$  cm). The runners underwent a running on the asphalt (40 m long track) and the shoes general comfort was acquired. After a running, the runner rated nine aspects of the shoe related to its perceived general comfort. Comfort Scale evaluated the perception of comfort for shoe evaluated (cushioning technology: EVA midsole) [1]. The static clinical measures were determined by footprint image on the podoscope to analyze plantar arch and the photogrammetry to measure the rearfoot angle [2]. Pearson correlation coefficient was applied ( $p < 0.05$ ). **RESULTS AND DISCUSSION** The shoes general comfort was not found to have a significant correlation with the plantar arch right ( $0.19 \pm 0.07$  cm:  $r = 0.10$ ,  $p = 0.640$ ) and left ( $0.20 \pm 0.08$  cm:  $r = 0.07$ ,  $p = 0.749$ ), but rearfoot angle had a moderate correlation with the general comfort aspects of shoe ( $6.5 \pm 3.9$  degrees right:  $r = 0.27$ ,  $p = 0.021$  and  $4.2 \pm 3.1$  degrees left:  $r = 0.41$ ,  $p = 0.067$ ). **DISCUSSION** Studies demonstrated relationships between comfort perception of shoes (EVA and Adiprene cushioning) and dynamics biomechanical variables [1,3]. Interesting finding study was the association of shoes general comfort with the static rearfoot angle, but not with plantar arch, which can better target the purchase of the running shoes. This association was observed only for the EVA technology of the shoe. However, it was not possible to infer that the results found could be reproduced in other market technologies. **CONCLUSIONS** The results demonstrate significant relationships between the perception of comfort and rearfoot angle, but did not showed with the plantar arch index for the running shoes investigated. **REFERENCES** [1] Dinato RC, Ribeiro AP, Butugan MK, Pereira IL, Onodera AN, Sacco IC. J Sci Med Sport. 2015 Jan;18(1):93-7 [2] Ribeiro AP, Sacco IC, Dinato RC and João SM. Braz J Phys Ther. 2016 Jan 19 (In press). [3] Hennig EM, Valiant GA, Liu Q. J Appl Biomech 1996;12(2):143-150.

## Coaching

### THE ACUTE EFFECTS OF POST-ACTIVATION POTENTIATION ON SHOT PUT PERFORMANCE IN FEMALE THROWERS

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**Introduction** Limited research is available on the subsequent effects of the upper-body post-activation potentiation (PAP) on the competitive throwing activity in trained experts (Terzis et al., 2009). Therefore, the aim of this study was to evaluate the precise responses of two



upper-body PAP protocols on the shot put performance in experienced female throwers. Methods Ten ( $n=10$ ) female collegiate throwers aged  $18.9 \pm 1.2$  yrs participated in this study. In the initial screening, the throwers' personal best in Shot Put event was recorded and the 1RM in bench press lift was tested. The throwers performed in competitive conditions, in counterbalanced order in 2 testing trials with a 48-hour interval: 1st = 3 throws with a 10min rest (noPAP1) & 4 plyometric push-ups prior to the 3 throws (PAP1) and 2nd = 3 throws with a 10min rest (noPAP2) & 6s isometric push-ups prior to the 3 throws (PAP2). Their performance was carried out from the final release position with regulation weight implement. The Wilcoxon test and the Spearman's rho correlation were applied for the continuous data analysis. Results The statistical procedures revealed that the female throwers improved their performance by applying both PAP protocols: noPAP1=8.03m vs PAP1=8.15m, ( $p=0.31$ ) & noPAP2=7.99m vs PAP2=8.13m, ( $p=0.50$ ). In addition, the Spearman's analysis showed that the performance which was recorded by using the PAP1 was highly correlated with the throwers' personal best in shot put (0.76,  $p<0.05$ ) but not with their bench press lift, (0.37,  $p=0.30$ ). Similarly, the PAP2 protocol indicated high correlation with the female throwers' personal best in shot put (0.75,  $p<0.05$ ) while no correlation was observed between the 6s isometric push-ups and their bench press lift, (0.49,  $p=0.16$ ). Discussion The major finding of this study was that the plyometric push-ups seem to be more beneficial than the isometric push-ups or the no-treatment in the female shot put throwers. Thus, in conjunction with relevant bibliography (Bellar & Judge, 2011), this study confirms that the plyometric exercise highly influences the ballistic throwing performance. Furthermore, the direct correlation between both PAP protocols and the female throwers' personal best in shot put proves that, the higher the training level, the greater the effect of their upper-body PAP treatment. Conclusively, the present study confirms that the post-activation potentiation by applying the plyometric push-ups affects positively the competitive performance of expert female throwers. References Bellar D. & Judge LW. (2011). *Applied Res Coach Athletics Annual*, 26, 108-119. Terzis G, Spengos K, Karampatsos G, Manta P, Georgiadis G. (2009). *J Str Cond Res*, 23(9), 2592-2597. Contact: thpilian@phyed.duth.gr

### THE CHARACTERISTICS OF TURN RHYTHM PATTERNS IN THE MEN'S HAMMER THROW

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INTRODUCTION: The hammer throwers use turn movement to accelerate the hammer head. The duration time of turn is showed in previous researches (Gutiérrez et al., 2002; Isele and Nixdorf, 2010). Bartonietz (2000) noted that the turn rhythm is one of the important components for the hammer throw technique. However, turn rhythm patterns were seldom studied in previous researches. The aim of this study is to identify the specific rhythm pattern for each thrower. METHODS: We analyzed the duration time of turn for the 116 men's hammer throwers in the competitions. Their range of record was 49.11-85.20m and all throwers use 4 turns. These competitions included the Olympic Games, the World Championships, the Asian/European Championships and the Local Championships. We determined the duration time of turn from recorded movies and downloaded publicly available Internet broadcasts. Frame rates of analyzed movies were 30 to 100 fps. The duration time of turn is measured from instant of right foot takeoff from the ground in the first turn to instant of release in the last turn. Ward's method of the cluster analysis was used to classify turn rhythm patterns. RESULTS: Turn rhythm patterns were divided into 3 types: fast start (F-type,  $n=29$ ), slow start (S-type,  $n=38$ ), and middle (M-type,  $n=50$ ). There were significant correlations between the total time of turn and the throwing record in all types. There were no significant differences in the throwing record between three types. The duration time at 1st turn of F-type was significantly shorter than M-type and S-type. The duration time at 4th turn of F-type was significantly longer than M-type and S-type. Total time of F-type was significantly shorter than M-type and S-type. DISCUSSION: Turn rhythm patterns are not the determinant for throwing record. In addition, decreasing the total time of turn leads to a longer throwing distance for all types. These results suggest that each turn rhythm pattern corresponds to different strategy to accelerate the hammer head and we can not suggest athletes/coaches should select what type of turn rhythm pattern. The duration time at 1st turn of F-type is shorter, but 4th turn is longer. In addition, F-type requires shorter total time to throw the same record compared to other types. In contrast, the duration time at 1st turn of S-type is longer, but 4th turn is shorter. Therefore, S-type requires faster speed than that of F-type at 4th turn. REFERENCES: Bartonietz K. (2000). *Hammer Throwing: Problems and Prospects*, 458-486. Blackwell Science Ltd, Oxford. Gutiérrez M, Soto VM, and Rojas FJ. (2002). *New Studies in Athletics*, 17, 15-26. Isele R, and Nixdorf E. (2010). *New Studies in Athletics*, 25, 37-59.

### A STUDY OF THE "IDEAL COACH" FOR THE ELITE LEVEL RUGBY FOOTBALL PLAYERS IN JAPAN

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Introduction Studies of the ideal coach have typically been asked to coaches what an ideal coach is (Yamamoto and Jogo, 2009). Therefore in previous researches, what players think about an ideal coach was not focused on. This study aims to examine what Japanese elite rugby football players think about an ideal coach. Methods Players from nine teams grouped into three different categories, are studied; high school teams, university teams, and company teams. All the teams studied, played in the semifinals of the national tournament in each category in 2011. A free answer method was adapted to collect the data. The data were classified by the KJ method, and analyzed by statistical methods using Fisher's exact test and Ryan's method. Results As a result, the four factors; 1) guiding skills, 2) coaching skills, 3) perceived knowledge of rugby, and 4) personality are found in all the team categories which define the recognition of an "ideal coach" for players. The factor "team management skills" is found for company team players only. While high school team players emphasize "guiding skills", university players also evaluate "coaching skills". Players in company teams regard "perceived knowledge of rugby" more than players from the other categories. Discussion Players in high school teams tend to demand guiding skills of coaches. That is resulted from that they are on the stages in which they build their identities (Takenouchi, et al., 2006). Players in university teams tend to demand coaching skills of coaches. That is resulted from that their identities are more stable than high school players and they have high motivation about improvement of their rugby football skills (Saijo, et al., 1993). Players in company teams tend to demand perceived knowledge of rugby football coaches. That is resulted from that they have already been matured as persons and as rugby football players. References Saijo O, Suda K, Takada M, Yonechi T, Shibata K. (1993) *Bulletin of Nippon Sport Science University*, 22(2),135-138. Takenouchi T, Taguchi T, Okuda A. (2006) *Journal of Sport and Health Sciences*, 51(6),766. Yamamoto Y, Jogo Y. (2009) *Bulletin of Hokkaido University of Education*, 60(1),216. Contact Email: washi200612021@yahoo.co.jp

## THE POST ACTIVATION POTENTIATION EFFECTS OF PLYOMETRIC EXERCISES ON JUMPPERFORMANCE IN WELL TRAINED GYMNASTS

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**Introduction** Plyometric training has been used as a warm-up method in order to improve subsequent power and strength especially in the sports of gymnastics. Drop jump (DJ) is a task that includes the so-called stretch-shortening cycle (SSC), where an eccentric contraction precedes a concentric contraction. The purpose of this study was to examine the acute post activation potentiation effects of different plyometric exercises on drop jump performance in well trained gymnasts. **Methods** Thirty-five male and female well trained gymnasts (age  $20.37 \pm 4.20$  years, body mass  $58.41 \pm 10.14$  Kg, height  $1.66 \pm 0.09$  m) volunteered to participate in this study. The condition stimuli were two different plyometric exercises (Rondat & Tuck jumps) performed under two separate visits to assess drop jump performance. A Pre test performed before the start of the intervention program which consisted of 1 set of 10 Rondats and 2 set of 5 tuck jumps (TJ). A post test was performed immediately after and 3 mins (Post 3), 6 mins (Post 6) and 9 mins (Post 9) after the end of the intervention program. **Results** Significant DJ height main effects for time and gender were found indicating that men performed better than women and that DJ height was increased over time. Further, a time x gender DJ height main effect for time was found and the Post hoc analyses for DJ height comparing the baseline values showed large differences immediately after and after 6 and 9 min for males and immediately after, remaining unchanged thereafter for females respectively. **Discussion** Both plyometric exercises had a positive effect on drop jump performance (Hilfiker et al, 2007), throughout the rest interval range of 1-9 minutes in the male gymnasts, with no change in performance in the female gymnasts. Plyometric exercises were effective warm-up methods and produce PAP effect thus performance was improved. **References** Hilfiker, R, Hubner, K, Lorenz, T, Marti, B. (2007). J Strength Cond Res 21: 550-555. Marina, M., Jemni, M., Rodriguez, F.A., Jimenez, A. (2012). J Strength Cond Res 26(7): 1879-1886. Contact gdallas@phed.uoa.gr

## THE ALTERNATION OF BRAIN ACTIVITY IN FRONTAL CORTEX WITH PROFICIENCY LEVELS IN TRAMPOLINE ATHLETES

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**Introduction** It is generally concerned to be difficult to discover the future skills development in beginner athletes, especially in the sports events that have a few athletes like the trampoline. Coaches have to predict, depending on their subjective evaluation, whether a beginner athlete will be a competent athlete having good potential and skills or not, in the athletes' early practical stage. If the coaches are able to know athletes' future skills in the early stage of the training process or athletes' skills development, it will provide them a lot more time to train athletes and improve their skills. In previous studies of motor learning which demonstrated the relationship between brain activity and motor learning, a brain activity will change according to process of motor learning. In this study, we hypothesized that there are some alternation of brain activities during the acquisition process of the trampoline jumping skills. To observe these alternations, we examined brain activities in frontal lobe with motor imagery of trampoline jumping action. **Methods** 3 trampoline athletes were voluntarily recruited for this study. To observe spacio-temporal brain activity in frontal lobe, we used optical topography ETG-7100 (Hitachi medical, co. Ltd., Japan). Optical probe (22ch) were put on the forehead, and subjects kept rest for few minutes before the measurement. The measurement protocol consisted by 15blocks. Each block includes 30seconds resting state period and 30seconds stimulation period. During stimulation period, subjects imaged the scene that the subjects are jumping. Jumping variation includes following 3 jumps: straight jump, double back and double twist. Each jump was included 5times in 15blocks sequence. **Results and Discussion** We analyzed the difference in brain activity according to subjects' completion of jumping skills. Brain activity in frontal cortex few changed in the jump variation which the subject has already completed. However, in the jump variation which the subject hasn't complete yet, the frontal cortex brain activity significantly changed in many measurement channels. In previous study, in the process of motor learning alter the brain activity especially in supplementary motor area. Once the person acquired the movement, the brain activity observed in motor area changes to supplementary motor area that controls the movement based on memories. Thought we didn't investigate about the brain activity by real body movement, we suggest that movement acquisition might change the brain activity. **References** Volkmann J., et al., Handedness and asymmetry of hand representation in human motor cortex, J. Neurophysiol, 79, 2149-2154, 1998

## EFFECTIVENESS OF TACTICAL ACTIONS IN ELITE MEN'S ÉPÉE

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**Introduction** Few scientific publications are devoted to the analysis of the temporal dynamics, technical and tactical determinants in fencing. To apply various actions (offensive, defensive and counter-offensive) successfully fencers should use preparatory actions. (Czajkowski, Z., 2009). The aim of this study is to analyse the different tactical actions and their impact on the score in elite men's épée. **Methods** This was done using an observational methodology based on an open and systematic process of non-participant observation with a nomothetic, punctual, multidimensional design (Anguera et al., 2011). 29 men's épée assaults were recorded in two World Championships (2013-14). The observation instrument used was an adaptation of the ESGRIMOB (Tarragó et al. 2015), and the LANCE v.1.1 (Gabin et al., 2012) software was the recording tool. **Results** A total of 1,466 phrases (379 different configurations) were recorded. 40% ended up in touch, with 17% in favour of the fencer who initiates the offensive action (fencer "A"), 15% opponent (fencer "B") and 8% touched twice. Only 2% of the phrases were performed by a single action between fencers, 72.4% in two actions and the remaining 15% appeared a third action; the remaining 11% is held by 4-9 exchanges of actions. Table 1 shows the distribution and effectiveness of the various tactical interactions in response to the pressure and prior preparation in relation to the fencer who initiates action (fencer "A"), and even a third level of interaction between rival ('A' vs. 'B'). **Discussion** As the main contribution of this study we emphasize that for the first time has been made a structuring of distribution and effectiveness of tactical actions in fencing. The offensive actions were the most commonly used (44.9%) followed by the defensive (33.0%) and counter-offensive (22.1%). The systematizing tactical actions performed proposes an excellent tool of tactical analysis in fencing, through which we can see how the effectiveness of the same phrase is different depending on the situation before -pressing and preparation- by two fencers. We emphasize that the counteroffensive actions are performed less but more effective for both fencers. **References** Anguera, M.T., Blanco-Villaseñor, A., Hernández-Mendo, A., & Losada, J.L. (2011). Cuadernos de Psicología del Deporte, 11(2), 63-76. Czajkowski, Z. (2009). Studies in Physical Culture and Tourism, 16(4), 371-377. Gabin, B., Camerino, O., Anguera, M.T., & Castañer, M. (2012). Procedia-Social and Behavioral Sciences, 46, 4692-4694. Tarragó, R., Iglesias, X., Michavila, J.J., Chaverri, D., Ruiz-Sanchis, L. y Anguera, M.T. (2015). Cuadernos de Psicología del Deporte, 15(1), 149-158. Contact xiglesias@gmail.com

## WORK TO REST RATIO IN FENCING: A ELITE MEN'S ÉPÉE STUDY

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**Introduction** The first chronometric analyses published on fencing were made from the world championships épée 1981 (Lavoie et al., 1984). The measurement of work-to-rest ratios is important when investigating the physiological demands of intermittent sports such as fencing. The aim of this study is to determine the work-to-rest ratio in fencing competition and the temporal structure of the assaults in elite men's épée. **Methods** This was done using an observational methodology based on an open and systematic process. 29 men's épée assaults were recorded in two World Championships (2013 & 2014). The LINC v.1.1 (Gabin et al., 2012) software was the recording tool. The Shapiro-Wilks test determined the non-normal distribution of temporal parameters. The differences between periods were analyzed through non-parametric Kruskal-Wallis test with pairwise comparison by Mann-Whitney. **Results** In the 29 assaults completed, all reached the 2nd period and of these, only five did not reach the 3rd period. The work time is 163,5 s ( $\pm$  39,3) in the 1st period, 160,2 s ( $\pm$  36,4) in the 2nd, and 118,8 s ( $\pm$  59,7) in the 3rd period (3rd period < 1st & 2nd;  $p < 0.05$ ). The rest time in the periods was 131,9 s ( $\pm$  63,5), 146,1 s ( $\pm$  81,7), and 169,1 s ( $\pm$  121,5) respectively. The pause time between periods was, in the three periods of assault, 71,9 s ( $\pm$  27,5), 80,2 s ( $\pm$  23,8) and 29,6 s ( $\pm$  8,8) (3rd period < 1st & 2nd;  $p < 0.001$ ). The average "allez" time in each period was respectively 26,3 s ( $\pm$  15,1), 21,5 s ( $\pm$  10,3), and 16,4 s ( $\pm$  11,6) (3rd period < 1st & 2nd;  $p < 0.001$ ); and the average "halte" time was 16,7s ( $\pm$  5,2), 18,0 s ( $\pm$  7,2), and 19,3 s ( $\pm$  8,1). The total assault time in direct elimination men's épée was 353,7 s ( $\pm$  121,2), 367,6 s ( $\pm$  114,7), and 281,1 s ( $\pm$  177,9). **Discussion** The results of our study determine a work-to-rest ratio of 1:0.9 for men's epee assaults, similar to the 1:0.6 described by Lavoie et al. (1984) or the 1:1 cited by Roi & Bianchedi (2008). The ratio is similar to the women's foil (1:1.1) recently described by Wylde et al. (2013), and very different from the values observed in men's sabre assaults (1:6.5) and female (1:5.1). The work-to-rest ratio analysis data can help the coach identify specific physiological demands for each fencing modality: épée, foil and sabre. **References** Aquili, A. et al. (2013). The Journal of Strength & Conditioning Research, 27(3), 624-630. Lavoie, J.M. et al. (1984). La Revue Québécoise de l'Activité Physique, 3(2), 91-95. Roi, G. S., & Bianchedi, D. (2008). Sports Medicine, 38(6), 465-481. Wylde, M.J. et al. (2013). International Journal of Performance Analysis in Sport, 13(2), 365-376. Contact xiglesias@gmail.com

## KINEMATIC ANALYSIS OF JAVELIN THROWING IN JAPANESE ELITE THROWER.

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**Introduction** The aim of this study was to investigate the kinematic factors of javelin throwing due to improvement of athletic performance in Japanese elite javelin thrower. **Methods** Subject of this study was Japanese male elite javelin thrower (Height: 186cm, Weight: 104kg, personal record: 85.96m (2013)) who participated in the 2008 and 2012 Olympic games. He performed Japanese 2nd ranking of 85.96m at the 47th Mikio Oda Memorial international amateur athletic game (Domestically competition) in 2013. Three dimensional analyses of javelin throwing were measured two competitions in Japan (91th Japan championship in athletics (2007) and 47th Mikio Oda Memorial international amateur athletic game (2013)). Throwing motion was recorded by two digital video cameras (120Hz) in each competitions. One of the video cameras was placed at the right side of the approach runway, the other one was placed behind the approach runway. Throwing motion was analyzed by using Frame-DIAS V for Windows application (DKH, Japan). In this study, horizontal velocity of wrist, elbow and shoulder in throwing arm were kinematic analyzed in each trials. And also, we calculated in joint angle of elbow in throwing arm and relative horizontal distance of grip position to shoulder joint during javelin throwing. **Results** In this study, subject was improved competition result from 2007 to 2013 season. He was competed in the two-time Olympic game and many of the world championship. And also, He had gold medal at the Asian games in 2011 (83.15m). In kinematic factors of javelin throwing in 2013 season, horizontal velocity of each joint was slightly increase after the left foot grounded compared to 2007 season. Elbow joint angle in 2007 season was more flexion from left foot grounded to release than the 2013 season. And also, relative horizontal distance of grip position to shoulder joint in 2013 season was located in backward from right foot to left foot grounded compare to the 2007 season. **Discussion** In generally, if flexed elbow from right foot to left foot grounded during javelin throwing, it is not possible to increase the javelin acceleration distance. In 2013 season, elbow joint angle was extended and increased javelin acceleration distance as compared to the 2007 season. From these result, it was considered that javelin throwing performance may affect by movement of the body including elbow joint angle in elite thrower. **References** R.J. Best, R.M. Bartlett C.J. Morriss. J Sports Sci. 11(4):315-328. 1993. Liu, H., Leigh, S., Yu, B. J Sports Sci. 28(13):1459-1467, 2010

## OPTIMAL TRAINING LOAD FOR DEVELOPING MUSCULAR POWER

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Training with a load that optimises the development of muscular power is fundamental in field-based athletes. Previous research however, exploring optimal load in field-based sports is conflicting. The purpose of this study was to identify the optimal training load for development of muscular power in the back squat (BS) and bench press (BP) exercises and to determine if baseline strength levels affect optimal load. 50 field-based athletes (mean ( $\pm$ SD) age 21.6  $\pm$  3.22yrs; body mass 82.39  $\pm$  8.09kg; height 1.81  $\pm$  0.572m) volunteered to participate in this investigation. Each participant's 1 repetition maximum (1RM) for the BS and BP was initially determined using standardised procedures. Participants subsequently performed the BS and BP exercises at loads of 20-90% of their predetermined 1RM in a randomised order. Repeated measures ANOVA revealed that the optimal load for development of muscular power in the BP exercise was 50% and 60% of 1RM. Mean and peak power output, determined using a Fitrodyne, was significantly higher at 50% and 60% of 1RM compared to all other loads. The optimal load for development of muscular power in the BS was 70% and 90% of 1RM. The results of this study suggest show that relative load has a significant effect on average and peak power output in both the BS and BP exercises. Considerable inter-individual differences were also found in this study indicating that the load that maximises power output varies across individual athletes. Furthermore, stronger athletes generate optimal power outputs at a lower relative load compared to weaker athletes. The nature of the exercise as well as baseline strength levels need careful consideration when prescribing training load for the development of muscular power in field-based athletes.

## EFFECTS OF ALTITUDE CONCURRENT STRENGTH AND ENDURANCE TRAINING ON NEUROMUSCULAR FUNCTION

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**Introduction** Most elite sportsmen, especially from endurance disciplines, use altitude training. At the normal altitudes, the concurrent strength and endurance training compromises the development of muscle mass, strength, and power compared with undertaking resistance exercise alone (Fyfe et al., 2014). No study has examined what happened with neuromuscular function after the concurrent training at high altitude. Therefore, the aim of this study was to analyze effects of altitude concurrent strength and endurance training on neuromuscular function. **Methods** Sixteen swimmers belonging to the National Slovenian swimming team (age =  $33.5 \pm 6.7$  years, height =  $173 \pm 9$  cm, mass =  $73.5 \pm 13.9$  kg) volunteered in the study. They performed three weeks of concurrent strength and endurance training at normal (295 m asl) and increased altitude (2320 m asl). The training content was in both cases kept similar as much as possible. Both training periods were performed at the same calendar time, but with a year difference. Before and after each training period the subjects performed isometric steady and explosive knee extension. Additionally, femoral nerve was stimulated to obtained maximal twitch of the knee extensors. **Results** After the increased altitude training MVC knee torque significantly increased ( $P < 0.05$ ) but not after the normal altitude training, however, the differences in training effect were not different. Rate of torque development was not significantly changed after any of training regimes as well as twitch peak torque. **Discussion** After the altitude training MVC knee torque increased but not after the sea level training. Since the differences between training effects were not significantly different, this cannot be considered as a strong evidence that altitude training attenuate muscle strength. Furthermore, the increased maximal knee torque may be related to acute improvement in strength due to increased altitude (Feriche et al., 2014). As there were no significant changes in twitch parameters, it can be expected that increased MVC resulted from improved muscle activation. It was concluded that concurrent training at increased altitude was not more effective in changing neuromuscular function than training at normal altitude. **References** Feriche B, García-Ramos A, Calderón-Soto C, Drobnic F, Bonitch-Góngora JG, Galilea PA, Riera J, Padial P. (2014) PLoS One, 9(12), e114072. Fyfe JJ, Bishop DJ, Stepto NK. (2014). Sports Medicine, 44(6), 743-762. Contact vojko.strojn timer@fsp.uni-lj.si

## QUANTITATIVELY MEASURED VARIATION OF PLAY BY SUBSTITUTED TEAM MEMBERS IN BALL GAMES

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**Introduction** Substitution of a player is a tactics in the ball game. Yet no quantitatively study on play effected by substituted team members exists. The purpose of this study is to achieve the quantitative variation of the play caused by substituted players. **Methods** Samples were 24 students (17 men and 7 women, aged  $21.79 \pm 0.83$  years/ Faculty of Health & Sports Science). The experiment was conducted based on the rules of "Anbieten & Orientieren Test Heidelberg Ballschule". That is, a ball game conducted by 2 teams of 3 players each on 9 meters square court. Players can neither walk nor run in possession of a ball. Total of successful pass of the ball was competed in the game. All subjects played 24 games in total with different teams. The game was a set of 2 minutes play 2 minutes break. 4 factors (running frequency, average running time, average exercise intensity METs and running rate) were calculated with the measured data by Three-Axis Acceleration Bracelet. The variation of the play caused by substituted players was evaluated by the standard deviate (SD) of the 4 factors. **Results** The running frequency were  $7.38 \pm 0.83$  times, the average running time were  $22.99 \pm 13.54$  sec., METs were  $6.88 \pm 0.73$  METs and the running rate were  $90.0 \pm 4$  %. The SD of the running frequency of 1 subject was more than double SD, the SD of the average running times of 4 subjects were more than double SD, the SD of the running rate of 4 subjects were more than double SD. There is no subject who had 2 or more factors more than double SD. **Discussion** It was suggested as follows. There are players who change their play adjusted to other players. 3 factors: average running time, running frequency and running rate in a game are the characteristic of the players. **Conclusion** This study is the first quantitative study investigated the variation of plays of player in the ball games. It shows that there are players who changes and adjusts their play by other team players. **Acknowledgement** This research is partially supported by the Center of Innovation Program from Japan Science and Technology Agency, JST. Contact stazu-ke@mail.doshisha.ac.jp

## SKILL TESTS FOCUSING ON BALL MANIPULATION AND AGILITY IN BASKETBALL CLASSES FOR PHYSICAL EDUCATION MAJORS

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**Introduction** Evaluations using skill tests are effective in university basketball classes. However, in faculties related to physical education, many students regularly practice ball sports other than basketball. For such players, the results of basketball skill tests do not always depend on the effect of basketball classes, but rather on the training effects of the student's sport of choice. Thus, this study aimed to investigate which skill tests can discriminate between students who regularly play basketball and those who do not, which is useful when grading students in basketball classes at sport-related universities or faculties. **Methods** Subjects were 144 physical education majors enrolled in a basketball class at a sport-related university (31 basketball players and 113 novices who did not play basketball regularly). Fifteen skill tests were originally developed by the authors based on the fundamental skill tests recommended by JBA (2002). The Student's t-test was applied to test the differences in skill test results between basketball players and novices. **Results** The t-test showed significant differences between the two groups in the following seven tests: 1) Kick (basketball players' mean [BP's] = 4.736 sec [standard deviation (SD)=0.807 sec], novices' mean [N's] = 4.424 sec [SD=0.777 sec],  $t_{(142)}=1.95$ ,  $p<0.05$ ); 2) Front turn (BP's = 6.255 sec [0.569], N's = 6.597 sec [0.510],  $t_{(142)}=2.88$ ,  $p<0.01$ ); 3) Back turn (BP's = 6.973 sec [0.533], N's = 7.214 sec [0.535],  $t_{(142)}=2.20$ ,  $p<0.05$ ); 4) Figure eight (BP's = 16.532 times [4.682], N's = 14.819 times [3.072],  $t_{(142)}=1.89$ ,  $p<0.05$ ); 5) Body circle (BP's = 17.677 times [9.748], N's = 11.677 times [2.622],  $t_{(142)}=3.34$ ,  $p<0.01$ ); 6) Body circle B (BP's = 12.952 times [3.666], N's = 12.952 times [2.929],  $t_{(142)}=3.63$ ,  $p<0.01$ ); and 7) Catching the ball at the back and front of the body while throwing it between legs (BP's = 15.968 [6.222], N's = 13.885 times [3.855],  $t_{(142)}=1.75$ ,  $p<0.05$ ). Since significant differences between basketball players and novices were detected in Front turn, Back turn and Kick, which are tests related to footwork, it can be assumed that the footwork and turns specific to basketball differ from those of baseball and volleyball. Significant differences were also detected in the ball manipulation tests Figure eight, Body circle, Body circle B and Catching the ball at the back and front of the body while throwing it between legs. One possible explanation is that volleyball or



rugby players who do not play basketball do not frequently roll the ball and are not familiar with maneuvering with a large ball like a basketball.

## SELECTION OF THE OLDEST: RELATIVE AGE EFFECTS IN THE UEFA YOUTH LEAGUE

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**Introduction** Differences in age within annual cohorts (relative age) result in performance discrepancies between children and youth which are referred to as relative age effects (RAEs) (Cobley, Baker, Wattie, & McKenna, 2009). Being relatively older compared to being relatively younger, is predictive of better physical capacities such as aerobic power, muscular strength, endurance and speed. This generates consistent participation inequalities, selection biases and may lead to a drop out of potential talents. **Methods** In this study, 1208 male youth soccer players (age:  $16.9 \pm 0.9$ ) who participated in the new UEFA Youth League, which has the aim to promote talent for elite soccer, were evaluated. The prevalence of RAEs according to playing positions and countries was analysed. All data were obtained from the FIFA website. The year was divided into four quarters (Q1: Jan. to Mar.; Q2: Apr. to Jun.; Q3: Jul. to Sept.; Q4: Oct. to Dec.). From the original data, chi-square tests, effect sizes and odds ratios (ORs) were calculated. Results Our comparisons showed significant RAEs with medium effects. Youth players born in Q1 were 3.35 times more likely to be selected than players born in Q4. Significant RAEs were found for every age group (1996, 1997, 1998 and 1999). The effect size in the different age groups varied between medium (1996 and 1997) and large (1998 and 1999). The younger age groups showed significantly higher RAEs than the older age groups. The analysis did not reveal any influence of playing position on the size of the RAEs. However, the results showed significant differences in relation to country, as well as the absence of RAEs in teams from Belgium, Bulgaria, Cyprus and Slovenia. **Discussion** Overall, the UEFA Youth League is highly biased by RAEs. Thus, it seems RAEs reflect a type of developmental barrier that may be preventable by implementing appropriate solutions in the future (Cobley, et al., 2009; Romann & Cobley, 2015). Therefore, international and national federations should adopt detailed regulations that force clubs to improve their talent identification processes. Especially for a small country like Switzerland, which has a rather small talent pool, any future reduction of RAEs may provide a substantial performance enhancement at elite senior level. **References** - Cobley, S., Baker, J., Wattie, N., & McKenna, J. (2009). Annual Age-Grouping and Athlete Development: A Meta-Analytical Review of Relative Age Effects in Sport. *Sports Medicine*, 39(3), 235-256. - Romann, M., & Cobley, S. (2015). Relative age effects in athletic sprinting and corrective adjustments as a solution for their removal. *PLoS One*, 20(3). Contact michael.romann@baspo.admin.ch

## EFFECTS OF THE LONG TIME CYCLING ON THE OUTPUT OF THE LOWER EXTREMITY MUSCLES IN THE BIKE COMPETITION

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**Introduction** In long-distance bicycle racing, cyclists must maintain or increase their speed depending on the circumstances. This requires both improving the endurance of the circulatory organs and efficient muscle output. Although cycling movements have been well studied, few previous investigations have investigated the output of the leg muscles from the association between actual cycling for long periods and the simulators frequently used in training. In this study, we compared muscle output during actual cycling and simulated cycling, with the aim of obtaining basic knowledge useful for providing guidance on cycling movements over long periods. **Methods** The subjects were a total of six of the male college student three skilled persons, and three unskilled persons belonging to the cycling team of the University. In actual cycling, the subjects cycled along an undulating route often used in training by competitive cyclists, while in simulated cycling they used a simulator. Both sessions 60 minutes for trial time. In both sessions the subjects adopted the posture they normally used when cycling, and pedaled at whatever rate they chose. As they cycled, they used a heart rate monitor to maintain their heart rate at 75%–80% of their previously measured maximum heart rate. Tibialis anterior muscle, gastrocnemius, vastus medialis, vastus lateralis, rectus femoris, biceps femoris, gluteus maximus, gluteus medius muscle was measured during cycling. Results Skilled person from the second half of the trial had increased activity of hip extension muscles, such as gluteus medius and gluteus maximus muscles. On the other hand, Unskilled person had increased the activity of the knee joint extension muscle group, such as vastus medialis and vastus lateralis muscle. In addition, in the simulation trial, activity time of lower limb muscles was decreased. **Discussion** We found that compared with inexperienced cyclists, experienced cyclists did not increase muscle activity during the first half of the session, while during the second half they increased the activity of the gluteus medius, gluteus maximus, and other hip extensor muscles. **References** Graham, E. C., James, M. H., Steve, D. M., and LiLi. (1999). *J Appl Biomech*, 15, 166-181. Ingen-Schenau, G.J. (1989). *Hum mov sci*, 8, 301-337. Contact tago@kagawa.bunri-u.ac.jp

## THE ANALYSIS OF TACTICAL SKILLS IN BALL GAMES IN LOWER GRADE ELEMENTARY SCHOOL CHILDREN

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**Introduction** In the ball game, it is important to win that players improve physical fitness as well as tactical skills. Previous studies investigated effects of cognitive training on tactical skills for ball games and/or game performance (e.g., game performance assessment instruments) in laboratory or field settings (Griffin, 1999). Participants in these studies were higher grade elementary school children, but not lower grade elementary school children. It is important to understand that how children acquire naturally tactical skills for ball games. The purpose of this study was to investigate the tactical skills for ball games in lower grade elementary school children. **Methods** First, 2nd and 5th grade elementary school children participated (1st graders, 6-7 years,  $n = 57$ ; 2nd graders, 7-8 years,  $n = 54$ ; 5th graders, 10-11 years,  $n = 54$ ). The children played a 5-min 7-versus-7 generic ball game with 2 goals at each end. In the ball game, children pass a ball to playmate to goal, but are not able to dribble a ball. A digital video camera was placed to record positional information of students and a ball during games. Positional data of a ball and children were calculated by the direct linear transformation method. Tactical skills of "off the ball movement" were assessed by the 3 categories for decision-making of the play by Stiehler et al. (1988). Three categories were Level 1, "children moved to appropriate position", Level 2, "children moved to inappropriate position", and Level 3, "children just watched, and did not move". Data of lower graders were compared with those of 5th graders. X2 test was used for comparison. Statistical significance was set at 5%. Results First graders showed  $3.84 \pm 3.27$  sec of ball possession from catching a ball to passing the ball to a playmate,  $3.45 \pm 2.28$  m of passing distance, and  $3.38 \pm 1.83$  m/sec of passing ball velocity. Second graders showed shorter duration of ball possession ( $3.00 \pm 2.42$  sec), longer passing distance ( $5.70 \pm 4.46$  m), and higher passing ball velocity ( $5.14 \pm 8.18$  m/sec), compared to 1st

graders. In off the ball movement of 1st graders, 39.2% of behaviors were categorized into Level 1 in a 5-min goal game. Second graders showed 48.1% of Level 1 behaviors in a game. X2 test for off the ball movement between 1st and 5th graders demonstrated significant difference ( $X^2 = 7.61$ ,  $df=2$ ,  $p=0.011$ ). Difference between 1st and 2nd graders by X2 test was significant ( $X^2 = 5.67$ ,  $df=2$ ,  $p=0.029$ ). Discussion Our results from the present study suggested that compared to 1st graders, 2nd graders improved ball game performances and decision-making ability in off the ball movement. References Stiehler, G., Konzag, I. and Döbler, H. (1988) Sportspiele - Theorie und Methodik der Sportspiele Basketball, Fußball, Handball, Volleyball. Sport. Griffin, L. L. Mitchell, S. A. Oslin, J. L. (1997) Teaching sports concepts and skills: a tactical games approach. Human Kinetics. Contact okuda.tomoyasu@i.hokkyodai.ac.jp

### RELATIONSHIP BETWEEN SPRINTING ABILITY WITH CHANGE OF DIRECTION IN THE REACTIVE CONDITION AND REACTION TIME IN FEMALE SOCCER PLAYERS

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Background: Soccer players are required to accelerate, decelerate, and change directions throughout the game. These movements are often in response to game cues, such as the movements of the ball and actions of other players (Bangsbo, 2015). The purpose of this study was to investigate the relationship between sprinting ability with change of direction (COD) in the reactive condition and reaction time (RT). Methods: Seventeen female university soccer players participated in this study. From a 20-meter (m) sprint test, we measured the sprint time for COD in the reactive and planned conditions. For COD in the reactive condition, the subjects had to make a 90-degree cutting movement at the 10 m point, where they had to decide whether to turn right or left according to a light stimulant at 7.5 m from infrared Smartspeed timing gates. Similarly, for COD in the planned condition, the subjects made a 90-degree cutting movement at the 10 m point. The time to perform each test was registered, and the difference between the two conditions was calculated to determine the reactive time. We also measured the RT using a visual stimulus system. Results: The mean values and standard deviations from the 20 m sprint test were  $3.641 \pm 0.113$  seconds (sec) : the sprint time for COD in the planned condition was  $4.466 \pm 0.139$  sec, and for COD in the reactive condition,  $4.769 \pm 0.182$  sec ; the reactive time was  $0.303 \pm 0.179$  sec ; and the RT was  $0.348 \pm 0.030$  sec. The sprint time for COD was longer in the reactive than the planned condition. Furthermore, the sprint time for COD in the reactive condition was associated with the reactive time, but not with RT. Conclusion: This study suggested that the sprint time for COD in the reactive condition was not correlated to the RT.

## Health and Fitness

### COMPARISON OF UPPER BODY STRENGTH GAINS BETWEEN MEN AND WOMEN AFTER 10 WEEKS OF RESISTANCE TRAINING

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Introduction Resistance training (RT) offers benefits to both men and women. However, the studies about sex's difference in response to a RT program are not conclusive and few data are available about upper body strength response. The aim of this study was to compare elbow flexor strength gains in men and women after 10 weeks of RT. Methods Forty four college-aged men ( $22.63 \pm 2.34$  years) and forty seven college-aged women ( $21.62 \pm 2.96$  years) participated in the study. RT was performed two days a week for 10 weeks. Peak torque (PT) of the elbow flexors was measured with an isokinetic dynamometer before and after the training period. Results PT was greater in men than women pre- ( $49.35 \pm 10.18$  vs.  $25.09 \pm 4.89$ ) and post-training ( $55.08 \pm 9.95$  vs.  $28.04 \pm 5.52$ ). Both males and females significantly increased elbow flexor strength ( $p < 0.05$ ), however, strength changes did not differ between sexes (11.61 and 11.76% for men and women, respectively). Effect sizes were 0.57 and 0.56 for men and women respectively. Discussion Previous studies showed that female's strength, when normalized to muscle mass, is comparable to male's values (Hannah et al., 2012) and that the higher male absolute strength is mainly due to higher muscle mass (Ivey et al., 2000). Therefore, one can suggest that the relatively short period of training of the present study could be insufficient to produce a significant muscle growth, which resulted in similar strength increases between sexes. However, this does not seem to be the case as Abe et al. (2000) also reported similar degrees of hypertrophy for males and females after ~6 weeks into an RT intervention with a similar time course of changes for both strength and hypertrophy between sexes. Although the anabolic and ergogenic effects of testosterone are well known, evidence suggests that progesterone may also have an important anabolic effect (Sakamaki et al., 2012; Smith et al., 2014), which could explain the similar adaptations between sexes. In summary, there seems to be no limitations in upper body strength development in women. References Abe T, DeHoyos DV, Pollock ML & Garzarella L. (2000). Eur J Appl Physiol 81, 174-180. Hannah R, Minshull C, Buckthorpe MW & Folland JP. (2012). Exp Physiol 97, 618-629. Ivey FM, Roth SM, Ferrell RE, Tracy BL, Lemmer JT, Hurlbut DE, Martel GF, Siegel EL, Fozard JL, Jeffrey Metter E, Fleg JL & Hurley BF. (2000). J Gerontol A Biol Sci Med Sci 55, M641-648. Sakamaki M, Yasuda T & Abe T. (2012). Clin Physiol Funct Imaging 32, 185-191. Smith GI, Yoshino J, Reeds DN, Bradley D, Burrows RE, Heisey HD, Moseley AC & Mittendorfer B. (2014). J Clin Endocrinol Metab 99, 256-265.

### THE ASSOCIATION OF PHYSICAL ACTIVITY WITH BODY COMPOSITION AND GLYCEMIC MARKERS IN MIDDLE-AGED AND OLDER JAPANESE

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Introduction: Sedentary behavior and reduced physical activity are associated with not only increased body fat but also loss of muscle mass and strength (sarcopenia) especially in elderly individuals. In recent years, it has been revealed that muscle fatty infiltration as well as visceral fat accumulation and sarcopenia, due to physical inactivity contributes to decreased insulin sensitivity and abnormal glucose tolerance. Therefore, it is necessary to evaluate the association of physical activity with body fat, muscle, and glycemic markers to prevent metabolic syndrome and type 2 diabetes. Methods: Subjects were 79 males (age;  $64.1 \pm 12.5$ , BMI;  $24.0 \pm 3.2$ ) and 90 females (age;  $65.4 \pm 10.5$ , BMI;  $22.2 \pm 4.3$ ) participated in the medical checkup in Keio University Hospital (Tokyo, Japan). In addition to exercise habit and subjective walking speed (slow, normal or fast) by the questionnaire used in specific medical examination, sedentary time (ST) was evalu-

ated using an original questionnaire. The subjects were divided to active group ( $ST \geq$  median values) and sedentary group ( $ST <$  median values). Visceral fat area (VFA) and cross-sectional areas (CSA) of anterior abdominal walls (AAW), psoas major muscles (PM), and erector spinal muscles (ES) were measured by CT images at the umbilical level. CT values of them were also measured as the index of intramuscular fat. Unpaired T test and one-way analysis of variance (ANOVA) were used to assess the association of physical activity with VFA, CSA and CT value of AAW, PM, and ES, and glycemic markers (fasting plasma glucose, HbA1c, and HOMA-R) in each sex. Multivariate logistic regression analysis was used to adjust for age and BMI. Results: 63.3% of males and 52.2% of females had exercise habit. The percentage of slow, normal, and fast subjective walking speed were 24.1, 45.6, and 30.4% in males, 20.0, 53.3, and 26.7% in females. The median values of ST were 6.0 and 5.6 h/day in males and females. After adjustment for age and BMI, exercise habit was positively associated with CSA of AWW and ES ( $p=0.004$  and  $0.021$ ) in male, CSA of AWW, PM, and ES ( $p=0.026$ ,  $0.028$ , and  $0.037$ ) in females. Slow walking speed was negatively associated with CSA of AWW and ES in males ( $p=0.006$  and  $0.003$ ). In active group, CSA of PM was significantly higher than sedentary group ( $p=0.009$ ) in males. Physical activity was not associated with VFA, CT values, and glycemic markers in both males and females. Conclusion: Physical activity was associated with CSA of abdominal muscles. Different associations of walking speed and sedentary behavior with body composition by sex were also implied. This study also suggested the possibility that exercise and sedentary behavior have influence on the different muscles in males.

## RE-VERIFICATION WITH REGARD TO SCAMMON'S GROWTH CURVE — ANALYSIS BASED ON WAVELET INTERPOLATION MODEL AND CROSS CORRELATION FUNCTION—

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**Introduction** The Scammon's growth curve, even during the 80 years since, has been applied to a number of fields. However, one has to wonder if all human characteristics are included in this 4 pattern growth curve classification. Till now, the Scammon's growth curve has yet to be subjected to scientific verification. In this study, this assessment was verified by applying a cross-correlation function in analyzing changes from collapsing one of the curves to examine their similarity. Because of that, cross correlation function can then be applied to the quantified curve by Wavelet Interpolation Method. **Methods** : The data utilized for analysis, cross-sectional growth data from age one to 20 was used for the four attributes classified by the Scammon growth curve. This data was comprised of brain weight (neural type), thymus (lymphoid type), testicle (genital type), and liver (general type). :A cross correlation function is used to show the similarity between two waveforms, and the cross correlation function may be evaluated by convolving one function. In this study, a cross correlation function was assumed from the velocity curve values found from differentiation using the WIM for Scammon's growth types. < Analytical procedure>: WIM (Wavelet Interpolation Method) was applied to longitudinal growth data consisting of attributes and organs. A cross correlation function was applied to the measured developmental indicators found by WIM and the velocity curve values. Results Visual assessment of the behavior of the velocity curves suggests similarity with the four patterns proposed by Scammon. Thus the dissimilarity between the growth curves was first examined by applying a cross correlation function. Dissimilarity between the four physical attributes was derived by cross correlation function with the supposition that the dissimilarity might vary between each of the patterns.  $R = 0.75$  between brain weight (neural type) and thymus (lymphoid type), with an inverse correlation between brain weight and testicle (reproductive type) of  $r = -0.45$ . There was also an inverse correlation between brain weight and liver (general type) with  $r = -0.63$ . High correlation was indicated between thymus and testicle ( $r = -0.7$ ), thymus and liver ( $r = -0.8$ ), and testes and liver ( $r = 0.9$ ). Discussion There are unanticipated possibilities of similarity between brain weight and thymus, and testicle and liver. What can be newly proposed, therefore, is that growth curve types can be classified as neural, lymphoid, and general body types, with the genital type included in the general body type. The genital type, visceral type, and morphological type are included within the general body type. References Fujii K, and Matsuura Y. (1999) Analysis of the growth velocity curve for height by the Wavelet Interpolation Method in children classified by maturity rate. Am J Hum Biol, 11, 13-30. Contact : fujii@aittech.ac.jp

## SECULAR TRENDS IN PHYSICAL GROWTH INDICATORS IN INFANTS AND YOUNG CHILDREN

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**Introduction** There have been no analyses in Japan that used mathematical functions to investigate changes over time in physical growth records of infants and young children. In this study, we investigated secular changes in growth velocity in the physical growth of infants and young children using the wavelet interpolation method, and examined the composition of secular changes in physical growth indicators. **Methods** The subject data were physical growth survey records for young boys and girls published by the Ministry of Health, Labor and Welfare in 1960 and 2000. The physical growth items used in the study were height, weight, chest circumference, and head circumference. The wavelet interpolation method was applied to these items for the period from age 0 to 6 years, and the derived growth distance curves and growth velocity curves were analyzed. Results It was shown that the values at birth were higher in 1960 than in 2000 for both boys and girls, but that after 6 months of age the values for 2000 exceeded those for 1960. From the largest peak velocity (LPV) soon after birth, obtained from the analysis of the growth velocity curve, there were no findings that showed clear secular changes in either boys or girls. However, a clear increasing trend was seen in the LPV for all items in both boys and girls in 2000, compared with 1960. The age at first local peak velocity (FLPV) remained unchanged in boys compared with the past, but in girls slightly earlier trends were seen in all items. Discussion Thus, in the secular changes in the composition of physical growth indicators in infants and young children, it was found that in 2000 children were slightly smaller at birth, but then matured quickly, and grew larger compared with children in 1960. References Fujii K, and Matsuura Y. (1999) Analysis of the growth velocity curve for height by the Wavelet Interpolation Method in children classified by maturity rate. Am J Hum Biol, 11, 13-30. Contact : nikosaito@gmail.com

## CHANGES OF BODY WEIGHT AND SELF-IMAGE IN STUDENTS IN SCHOOL FULL-TIME

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**Introduction** The increase in overweight rate among adolescents has been of concern today. In addition to being overweight are associated with many diseases in adulthood and also the social pressure of an ideal body and may cause great anxiety. Therefore important to evaluate the image that adolescents enrolled in schools Full time has on your body weight and check how much this is true. **Methods** Observational, cross-sectional, conducted in three schools full-time. The questionnaire Youth Risk Behavior Surveillance (YRBS) was ap-

plied followed by collection of anthropometric data (weight and height) and calculated BMI z score by Anthro plus the World Health Organization (WHO) program, obtained the same day the questionnaires. Results 270 adolescents were evaluated and 150 girls with an average age boys  $12.67 \pm 1.05$  and  $12.68 \pm 1.15$ . 184 (68.14%) individuals self-reported being with adequate weight and 86 (31.85%) reported being with the weight higher than expected. When compared with the results obtained through the BMI z score 60 (22.44%) were overweight and the other weighing adequate or below normal for age and height ( $p = 0.20 \times 2 = 1.13$ ). And, for sex, 99 girls (66%) reported being of normal weight and 51 (34%) above the weight. The calculus BMI showed 117 girls (78%) were evaluated eutrophic and 33 (22%) with excess weight ( $p = 0.34$ ,  $x^2 = 0.87$ ). In boys, 85 (70.83%) reported being with adequate weight and 35 (29.16%) overweight. The BMI calculation showed 93 (77.5%) children with normal BMI and 27 (22.5%) overweight ( $p = 0.76 \times 2 = 0.09$ ). Discussion The body appearance has received great emphasis and value in today's society. The search for a body image often idealized by the media, social groups and the adolescents own sometimes triggers behaviors that can compromise the healthy. The results of this study show that adolescents do not have a distorted image of their body weight when we analyze the differences between proportions. Girls tend to be more dissatisfied with their body image compared to boys. Conclusion Students Full-Time seem to have satisfactory image and true body weight.

### ONE-YEAR CHANGES IN ACTIVE TRAVEL TO SCHOOL AND PHYSICAL ACTIVITY IN CHINESE CHILDREN

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**Introduction** Cross-sectional studies have shown a positive association between active travel to school and overall physical activity (PA) in school-aged children. However, the longitudinal relationship between active travel to school and PA is far from clear. This study aimed to investigate the association between a change in travel mode to school and one-year changes in PA among children in Hong Kong. **Methods** Data from 677 children aged 7–10 years (56% boys) who participated in the Understanding Children's Activity and Nutrition (UCAN) study were analyzed. During the 2010/11 and 2011/12 school years, the children wore an accelerometer for a week and their parents completed a questionnaire about the children's modes of travel to school and non-school destinations. Associations between a change in the mode of travel to school and changes in moderate-to-vigorous PA (MVPA) on weekdays and over a week were determined using linear mixed models, adjusting for age, sex, child's body weight status, parental educational attainment, baseline values, and frequency of walking to non-school destinations. **Results** Compared to children who consistently used passive travel modes, a change from passive to active travel to school was positively associated with changes in the percentage of time spent in MVPA ( $b = 1.32$ , 95% CI = 0.63, 2.02) and MVPA min/day ( $b = 10.97$ , 95% CI = 5.26, 16.68) on weekdays. Similar results were found for weekly MVPA. **Discussion** Age-related decline in MVPA was obvious in all of the children except those who changed from a passive to an active mode of travel to school. Compared to consistent passive commuting, a change from a passive to an active mode of travel to school was positively associated with changes in MVPA. The findings suggest that promoting active travel to school may be helpful in combating age-related decline in PA for some children. Maintaining active travel to school may not on its own be sufficient to hinder the decreasing trend in MVPA with age. Contact [hsswong@cuhk.edu.hk](mailto:hsswong@cuhk.edu.hk)

### WHOLE BODY VIBRATION TRAINING AS A PREVENTIVE WORKPLACE-BASED SPORTS ACTIVITY: A RCT

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**Introduction** The workplace is a suitable place for the introduction of health-orientated physical activity interventions and physical activity in workplace health promotion can improve physical capacity (Shephard, 1996). Whole body vibration training (WBVT) is considered to be an effective and well-suited preventive intervention for unfit people (Marin & Rhea, 2010a; Marin & Rhea 2010b). The goal of this study was to determine whether WBVT can improve basic physical abilities. Additionally, the study addresses its safety, suitability and the compliance with it. **Methods** 119 subjects (78% female, mean age  $41.6 \pm 9.8$  yrs, mean BMI  $25.4 \pm 4.1$  kg/m<sup>2</sup>) were randomly allocated to an intervention group (INT,  $n=60$ ) and a control group (CON,  $n=59$ ). The INT participated in an unsupervised WBVT 2.5 times per week for 6 months with a progressive increase of intensity. At the beginning and after the intervention period, data were collected using jumping mechanography, progressive isointernal lifting evaluation and a static posturography. **Results** There were no significant differences between the groups regarding mean change from baseline in maximum power (INT:  $0.02 \pm 0.17$  kW, CON:  $-0.03 \pm 0.19$  kW,  $p=0.41$ ), maximum velocity (INT:  $0.01 \pm 0.07$  m/s, CON:  $0.01 \pm 0.09$  m/s,  $p=0.53$ ) or any other outcome parameter. However, we found a trend ( $p=0.062$ ) regarding a positive effect of the intervention on the maximum jumping height in the exercise group. Whereas it improved in the exercise group (BT  $0.3 \pm 0.1$  m, AT  $0.4 \pm 0.1$  m), it was unchanged in the control group (BT  $0.3 \pm 0.1$  m, AT  $0.3 \pm 0.1$  m). The overall attendance rate was 71.6% and no unwanted side effects were detected. **Conclusion** The intervention showed no significant effects on the measured parameters of physical capability in the study population. However, we found a trend regarding a positive effect on the muscular capacity of the lower extremities in terms of the maximum jumping height. The lack of effectiveness of WBVT might be due to suboptimal individually configured training parameters (Cochrane, 2011). The compliance with the unsupervised WBVT was good, and we showed that this intervention is safe and feasible as workplace health promotion within the study population. Certainly, WBVT appears to be ineffective as a stand-alone intervention for primary prevention. The optimal training parameters for the use of it as a preventive workplace-based intervention should be studied further. **References** Shephard RJ. Worksite Fitness and Exercise Programs: A review of methodology and health impact. *Am J Health Promot.* 1996;10(6):436-452. Marin PJ, Rhea MR. Effects of vibration training on muscle strength: A Meta-Analysis. *J Strength Cond Res.* 2010a;24(2):548-556. Marin PJ, Rhea MR. Effects of vibration training on muscle power: A Meta-Analysis. *J Strength Cond Res.* 2010b;24(3):871-878. Cochrane DJ. Vibration Exercise: The Potential Benefits. In: *Int J Sports Med.* 2011;32:75-99. Contact E-Mail: [tobias.kaeding@uni-oldenburg.de](mailto:tobias.kaeding@uni-oldenburg.de)

### STRENGTH TRAINING USAGE WITH SKOLIOSIS OF S II DEGREE IN VIEW OF BODY DEFECTS FOR GIRLS 17-19 YEARS OLD

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**Introduction** When scoliosis due to anatomical changes to chest and the gibbus formation observed on girls 17-19 years old cosmetic side analysis of the disease are deeper [2]. The relevance of the present study caused by necessity to study the effectiveness strength training usage over the cosmetic correction of body deformities on girls 17-19 years old who have scoliosis I-II degree. **Methods** For cosmetic defects of the body attributed: the asymmetry of shoulder blades and waist triangles, the deviation of body from longitudinal axis. Data



which are presented from work obtained in the survey basis of 86 girls of 17-19 years old with scoliosis I-II degree, diagnosed by radiograph. Results Independent of strain localization in 87% of the surveyed girls with I scoliosis degree recorded an asymmetry blades and waist triangles and the deviation of body from longitudinal axis. In general, the scoliosis of I degree, regardless of age, location, and shape deformation, cosmetic changes of the body are small and are not subject to a visual self-esteem. When II degree scoliosis severity of symptoms was associated with visual abnormalities in body structure. In 46% of surveyed women occurred horizontal asymmetry of the breasts. In general, in II degree scoliosis cosmetic value of 17-19 years old girls was exacerbated by structural changes in the body shape that is not amenable to self-correction. For training major muscle groups, taking into account the structural changes in the body shape in girls with I-II degree scoliosis was used fitness equipment of various modifications. The basis of the designed strength training is a cyclic repetition weight training, selected in accordance with a particular scheme and carried out in a consistent manner simulators change. Received data give reason to believe that in the course of regular use of weight training in the gym, girls are significantly increases the efficiency of motor stereotypes built on muscular effort and volitional factors. Discussion Considering cosmetic body defects - scoliosis can be attributed to the conditions that lead to the exit of the patient beyond the standard framework of existence, the usual for most healthy people. Experimentally proved that the leading role of force exposure as a correction actions, leveling body cosmetic defects and ensure the stability of the spine, especially in females. References Fischenko V.Y., Verdiev V.G. Scoliosis on adults // orthopedist traumatologist - 1990. - №8. - P.70-76. Shklyarenko A.P. Scoliosis and Physical Education: Educational handbook. - Volgograd: Volgograd Scientific Publishing House, 2007. - 196 p. Do not insert authors here

### **HYPERGLYCEMIA IS REDUCED AT POSTPRANDIAL MOMENTS OF 24 HOURS AFTER LOW INTENSITY RESISTANCE EXERCISE IN WOMEN WITH TYPE 2 DIABETES.**

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Introduction Type 2 diabetes (T2DM) is characterized by postprandial hyperglycemia, which is a major predictor of chronic vascular complications and aerobic exercise has been suggested in reducing the hyperglycemic state (Manders et al., 2010). However, few evidence of resistance exercise (RE) has been demonstrated by comparing the effect of different intensities in the postprandial moments. Objective To compare the postprandial hyperglycemia prevalence between different intensities of RE sessions in women with T2DM. Methods Twelve women with T2DM (55.2±4.0 years; 70.1±11.4 kg; 155.7±3.3 cm; Diabetes: 5.7±3.7 years) participated in a randomized order of experimental interventions, as follows: a) Control sessions without RE on day one (CONT40%1RM or CONT80%1RM) followed by; b) RE sessions (40%1RM or 80%1RM) on day two. The RE sessions were performed from 3 circuits with 7 exercises lasting 40min (08:20–09:00 a.m.) each (40%1RM - 16 reps or 80%1RM - 08 reps). Continuous glucose monitoring occurred every 5min for 24h post-intervention. The prevalence of hyperglycemia (glucose concentration >160 mg.dL<sup>-1</sup>) was analyzed in the postprandial time of breakfast (08:00–12:00h), lunch (13:00–18:00h) and dinner (19:00–23:00h). Results The glucose concentration was reduced in 24h ( $p<0.05$ ) after 40%1RM session (142.6±26.1 mg.dL<sup>-1</sup>) vs. CONT40%1RM (194.3±17.9 mg.dL<sup>-1</sup>), CONT80%1RM (186.5±26.4 mg.dL<sup>-1</sup>) and 80%1RM (190.2±43.3 mg.dL<sup>-1</sup>). Lower prevalence of hyperglycemia ( $p<0.05$ ) in postprandial moments was found in the 40%1RM session vs. CONT40%1RM, CONT80%1RM and 80%1RM after breakfast (35.4±22.5 % vs. 100.0±0.0 %, 91.7±22.2 % and 85.4±29.1 %, respectively), lunch (28.3±41.3 % vs. 98.3±5.8 %, 88.3±28.9 % and 73.3±42.1 %, respectively) and dinner (6.3±11.3 % vs. 81.3±18.8 %, 85.4±19.8 % and 70.8±38.2 %, respectively). Discussion The reduction mechanism of postprandial hyperglycemia is possibly associated with the muscular contraction of AMP kinase signaling, which can promote GLUT4 translocation and glucose uptake (Richter & Hargreaves, 2013). It is speculated that the lack of response of high intensity RE at the postprandial moments may be due to an exponential increase of counter regulatory hormones (Kjaer et al., 1990). Conclusion A single low intensity RE session reduced the prevalence of postprandial hyperglycemia at moments of 24 hours of women with T2DM. References Manders RJF, Van Dijk JWM, Van Loon LIC. Low-intensity exercise reduces the prevalence of hyperglycemia in type 2 diabetes. *Med Sci Sports Exerc* 2010;42:219–225. Richter EA, Hargreaves M. Exercise, GLUT4, and skeletal muscle glucose uptake. *Physiol Rev* 2013;93:993–1017. Kjaer M, Hollenbeck CB, Frey-Hewitt B, Galbo H, Haskell W, Reaven GM. Glucoregulation and hormonal responses to maximal exercise in noninsulin-dependent diabetes. *J Appl Physiol* 1990;68:2067–2074. Contact karoline.t.andrade@gmail.com

### **DISSIMILARITY IN PERIODIC FLUCTUATION AND SEASONAL VARIATION IN PHYSICAL GROWTH**

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Introduction Fujii et al. (2007) advocated periodic fluctuation in height growth during preschool. In other words, the variation is not from the environmental factor of season; rather, height growth is achieved with periodic variations due to genetic factors. Based on this logic, wavelet interpolation was applied to observed data values measured three times a year in this study to investigate the periodic fluctuations in height and weight growth in elementary school children, and an attempt was made to verify the periodic fluctuations from the behavior of the derived velocity curve. Methods : The longitudinal time series information on subjects' height and weight were measured three times a year from the first to sixth grades. The data used in the analysis were for 17 boys and 11 girls. < Analytical procedure>: WIM (Wavelet Interpolation Method) was applied to longitudinal growth data consisting of attributes and organs. A cross correlation function was applied to the measured developmental indicators found by WIM and the velocity curve values. Results The results showed that the height growth pattern is essentially achieved with periodic fluctuations, and that there are seasonal stimulating phenomena within that periodicity. If this growth mechanism also applies to body weight, growth in body weight would occur together with increases in height, but with additional seasonal stimulating effects weight would be affected not only by genetic factors as height is, but also by seasonal environmental factors. Discussion It may be that the height growth pattern is essentially achieved by periodic fluctuations, with a seasonal acceleration phenomenon acting in this periodicity. If this growth mechanism functions for weight, growth in weight would accompany increases in height. However, since there is an additional seasonal stimulatory effect there are not only genetic factors as in height growth but also effects from seasonal environmental factors. From this study, however, we cannot comment any further on weight growth. References Fujii K, and Matsuura Y. (1999) Analysis of the growth velocity curve for height by the Wavelet Interpolation Method in children classified by maturity rate. *Am J Hum Biol*, 11, 13-30. Fujii K., Kasuga K. and Hanai T. (2007) An approach to time series analysis for one year in physical growth of infant by wavelet interpolation method. *The Journal of Education and Health Science*, 53, 194-204.

## RELATIONSHIP BETWEEN LOWER EXTREMITY RANGE OF MOTION, MUSCLE STRENGTH, AND PHYSICAL PERFORMANCE IN ELDERLY INDIVIDUALS

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**Introduction** Reduced lower extremity range of motion (ROM) and muscle strength were significantly correlated with functional disability in older individuals who are dependent for one or more activity daily living (Beissner et al., 2000). Therefore, the purpose of this study was to determine the extent to which the lower extremity ROM and muscle strength are associated with physical performance tests in older people. **Methods** One hundred thirteen community-dwelling elderly individuals (mean age  $\pm$  SD, 71.0  $\pm$  4.8 years; age range, 65–87 years) were recruited for this study. Active ROM for 7 lower extremity (hip flexion, hip extension, knee flexion, internal and external hip rotation, ankle dorsiflexion, and ankle plantar flexion) and 2 Muscle strengths (knee extension and flexion) were measured. Physical performance tests (Functional Reach Test, 5-m Gait Test, Four Square Step Test, Timed Up and Go Test, and Five Times Sit-to-Stand Test) were assessed. We conducted the principal component analysis to extract the physical performance scores from the five physical performance tests. To establish the influence of lower extremity range of motion and muscle strength on the physical performance, stepwise multiple regression analyses were constructed using physical performance measures and physical performance scores as the dependent variables. **Results** Most of the lower extremity ROM and muscle strength measures were consistently associated with physical performance tests ( $r = 0.22$  to  $0.56$ ). The physical performance scores were obtained by principal component analysis using the five physical performance tests and accounted for 65.2% of the variance. Stepwise regression models for the physical performance scores revealed that hip extension and ankle plantar flexion ROM and knee extension strength were significant predictors of physical performance. This regression model explained 41% of the variance. **Discussion** The findings of this study demonstrated that lower extremity ROM and muscle strength were significantly associated with most physical performance tests using the lower limbs in adults aged  $\geq 65$  years. Thus, lower extremity ROM and muscle strength improvement can provide protection against the onset of restricted physical performance capacity, leading to functional disability. **References** Beissner KL, Collins JE, Holmes H. Muscle force and range of motion as predictors of function in older adults. *Phys Ther* 80:556–63,2000.

## ASSOCIATIONS AMONG NEIGHBOURHOOD ENVIRONMENT, PHYSICAL ACTIVITY, AND QUALITY OF LIFE: AN ECOLOGICAL STRUCTURAL MODEL IN ADULTS

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**Introduction** Over the last years, there has been an increased interest in investigating mediators of the Physical Activity (PA) and Quality of Life (QoL) association. In particular, PA has been found to promote QoL through the intermediary effects of exercise self-efficacy, and physical (PCS) and psychological (MCS) health. In addition, neighbourhood environment has been positively associated with PA, which in turn has improved PCS, MCS, and QoL. However, the aforementioned concepts haven't been examined within the context of the same theoretical model so far. The current study assessed an ecological model of neighbourhood environment, and QoL through the mediating effects of family and friend support for PA, exercise self-efficacy, PA, PCS, and MCS. The proposed model was separately examined for each one of the following PA indexes: walking PA, moderate PA, vigorous PA, and total PA. **Methods** 684 physically active adults ( $M=39.16$ ,  $SD=13.52$  years), living in Athens, Greece, completed a series of valid and reliable questionnaires measuring PA, QoL, exercise self-efficacy, PCS, MCS, neighbourhood environment, and family and friend support for PA. Structural equation modeling utilizing maximum likelihood estimation was conducted to assess the fit of the structural models. **Results** The ecological models proved to be of appropriate fit (PAwalking: CFI=0.960, GFI=0.926, RMSEA=0.036 / PAmoderate: CFI=0.961, GFI=0.926, RMSEA=0.035 / PAvigorous: CFI=0.957, GFI=0.923, RMSEA=0.037 / PAtotal: CFI=0.958, GFI=0.924, RMSEA=0.037). The models accounted for 14%–16% of the variance in QoL. Within the models, neighbourhood environment positively influenced QoL through the intermediary effects of family and friend support for PA, exercise self-efficacy, PA, PCS, and MCS. Further, the association between exercise self-efficacy and PA was reciprocal, whereas MCS had the highest positive effect on QoL. These findings were verified for the four PA indexes. **Discussion** The findings demonstrated the role of neighbourhood environment in enhancing PA, and QoL. Further, the most important mediators in the examined models were exercise self-efficacy, MCS, and PA. A key feature of the study was the investigation of the ecological model for each one of the four examined PA indexes. No such study has been carried out until now in the literature. Future studies should be carried out applying longitudinal data for a better understanding of these associations over time. **References** Craig CL et al. (2003). *Med Sci Sports Exerc* 2003;35:1381-95. Ishii K et al. (2010). *Int J Behav Nutr Phys Act*, 7(61). Kline RB. New York: Guilford; 2005. McAuley E, et al. (2008). *Ann Behav Med*, 36, 13-20.

## DIFFERENCES IN THE REASON FOR DIETING BETWEEN GENDERS AND JAPANESE AND ASIAN OVERSEAS STUDENTS

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**Introduction** Recently, more young people are devoting themselves to unnecessary dieting because of their strong desire to be slim, and this is becoming a public health concern. Why do young people diet? The reasons can be different between men and women and between countries with different cultural norms and ways of thinking regarding the body and health. This study aimed to investigate the differences in the reason for dieting between Japanese students (J-students) and Asian overseas students (O-students) by gender. **Methods** A questionnaire survey based on Nishioka et al. (1993) consisting of 27 items on the reason for dieting, such as "in order to dress up," "for good health" and "because my friends are dieting," was conducted in January 2015. Participants were 1003 J- and O-students at N-university in Japan. The 463 students (301 O-students and 162 J-students; 293 males and 170 females) who indicated that they had previous dieting experience were included in the analyses. Responses were given on a five-point scale ranging from "completely agree" to "completely disagree." Factor analysis with principle factor solution and normal varimax criterion was applied and then factor scores were computed using the regression method based on the derived factor loadings. T-tests were conducted in order to statistically test the difference between the two sets of means of J- and O-students by gender. **Results** Five factors with eigenvalues of 1.0 or greater were extracted and interpreted as follows: "factor 1 (F1), influence from friends and mass media," "F2, self-awareness," "F3, for good health," "F4, economic and convenient reasons" and "F5, to improve one's looks." In the analysis of gender differences combining J- and O-students, a significant difference at the 5% level was found in F4, showing that more female students chose this as a reason for dieting than male students. Significantly more male students agreed to items related to F1, F2 and F5 as reasons for dieting. As a consequence of

examining the difference between J- and O-students by gender, among male students, significantly more J-students agreed with items related to F1 as the reason for dieting, but O-students tended to agree with items related to F3. Among females, J-students dieted because of F4 whereas O-students dieted because of F5. That is, among males, more O-students dieted due to internal and substantial reasoning, but J-students dieted due to external factors such as suggestions from others or the mass media. On the other hand, among females, J-students dieted for economic reasons but O-students want to look cute or good.

## EFFECTS OF INTERACTIVE VIDEO GAMES ON BRAIN AND CARDIOVASCULAR RESPONSES IN ELDERLY

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**Introduction** Although physical activity is important for improving cardiovascular and muscle strengths, there is growing interest in study of effect of physical activity on the brain function, especially in elderly. In recent years, an interactive video game is very popular in adults and adolescents. It is a virtual-reality based game in which body movement is used to control the game which is displayed on a television. Since it requires body movements, interactive video games can be developed to promote health, fitness and happiness. The aim of this study was to investigate the effect of interactive video game on the brain and cardiovascular functions in the elderly. **Methods** Ten males and ten females, aged 55-70 years old participated in this study. They were divided into two groups: sedentary (SW) and active (AW) groups. On the experimental day, their brain wave activities were measured by EEG with closed eye condition for 5 minutes at pre and post exercises. The cardiovascular variables such as HR, SV and EF were measured by non-invasive cardiovascular technique (PhysioFlow) throughout experiment. The participants played Wii games (Nintendo) at 50-70% of the maximum heart rate during warming up for 10 minutes and exercise for 20 minutes. The experimental data between the groups and within groups were compared by using unpaired t-test and paired t-test, respectively. **Results** The results showed that the amplitudes of theta and alpha waves in AW and SW groups did not change significantly when they were compared within the groups. Whereas the percent change of beta wave in AW and SW groups increased by 5.47% and 6.63%, respectively. However, theta/beta ratio in both groups were not significantly different. HR during exercise by Wii game in SW increased significantly and was higher than that of AW. SV and EF in AW were higher significantly than that in SW group at rest, during exercise and recovery periods. **Discussion** The effects of exercise on cortical activity in cerebral cortex which correlates with the arousal and increase in blood flows to the brain may caused the increase of the beta wave in SW more than that in AW after exercise. It is clear that active person will have higher performance especially in cardiovascular responses during exercise than the sedentary person. **References** Carvalho A, Rea IM, Parimon T, Cusack BJ (2014). Clin Interv Aging, 9, 661-682. Timinkul A, Omori T, Wanpen S, Yamada Y, Soya H (2010). J Med Techno Phys Ther, 22 (1), 82-91. **Acknowledgement** This project was partly funded by Graduate Studies of Mahidol University Alumni Association. Contact waree.widjaja@yahoo.com

## ANNUAL TRENDS DUE TO THE EFFECTS OF THE GREAT EAST JAPAN EARTHQUAKE TO THE PHYSICAL FITNESS OF UNIVERSITY STUDENTS

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**Introduction** In Fukushima Prefecture, long outdoor activities are restricted because of the effects of the nuclear disaster at Tokyo Electric Power Company's Fukushima Daiichi Plant that occurred with the Great East Japan Earthquake. In this study we investigated the effects of earthquake on university students in Fukushima Prefecture from changes over time in the physical fitness, as well as the level of accumulated body fat based on differences in morphological properties. **Methods** The subjects were about 1,000 male students who started university from the years of 2004 to 2015. Considering this background, we calculated the statistics over time for physique, body composition, and motor performance. **Results** We adopted analysis of variance (ANOVA) from the years of 2004 to 2015. In first semester, grip strength, side step, standing long jump, significant difference were observed ( $p < 0.05$ ). In second semester, weight, BMI, grip strength, 20m shuttle run, side step, standing long jump, significant difference were observed ( $p < 0.05$ ). In grip strength, certain trends were observed. In annual trends of grip strength, we have applied cubic least squares approximation polynomial. As shown cubic polynomial, gradually began to decrease from around 2006, in 2012 and 2013 to become the most recessed point, the upward trend has been shown again. Regarding annual trend of fat accumulation rate by difference of morphological quality based on evaluation of regression polynomial of %fat for BMI, it was basically no difference in compared with first semester and second semester from 2004 to 2015. **Discussion** In this study, effects on physique were not observed. In motor performance, although significant difference was observed, a clear trend was not observed. The results of an analysis of variance showed a significant difference in grip strength. Assessing annual trends in grip strength from a least squares approximation polynomial, it was shown that grip strength decreased until 2012 and that currently there is a slightly rising trend. In present study, the results did not showed the clear effects of earthquake on university students in Fukushima Prefecture. In the future, it is considered that there is a need for further analysis study were classified subject in detail. **References** Fujii K, et al (2009) Comparison between Japanese and Korean School Students in Physical Fitness Based on Difference of Morphological Quality, The journal of Education and Health Science, 55, 145-154. twatanab@jc.u-aizu.ac.jp

## RELATIONSHIPS BETWEEN DIETING METHOD AND THE FACTORS OF GENDER DIFFERENCE AND NUTRITIONAL KNOWLEDGE AMONG ATHLETES AND DIETITIANS

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**Introduction** Athletes are required to maintain their optimal weight to perform well in their sport. However, it is thought that gender differences exist in the methods used to maintain body weight. Furthermore, when an individual has insufficient nutrition knowledge, it is possible that they will use inadequate dieting methods and be overly conscious of the effects of dieting. This study aimed to examine gender differences and the appropriateness of dieting methods among athletes by comparing them with students in the Department of Food Science and Nutrition, who were the same age as the athletes and thought to have sufficient nutritional knowledge. **Methods** Referring to Matsumoto et al. (1997), a questionnaire survey comprised of 22 items was conducted with 518 sports-related faculty students at K-university (365 males and 153 females) and 137 nutrition-related faculty students at F-university (only female) in Japan in April 2015. Subjects were asked to choose one of the following responses: "I am doing it now (now)", "I did it in the past (past)", and "I have never done it and I have no interest in it (never)." The answers were tallied into a cross table by male students enrolled in a sports-related

faculty (male athletes), female students enrolled in a sports-related faculty (female athletes), and female students enrolled in a food science and nutrition-related faculty (female dietitian). The relational tendency was investigated based on cells showing a significantly greater adjusted residual. Results Twelve items indicated the pattern of female athletes having a significant adjusted residual in "now" and male athletes in "never." Another two items showed the pattern of combinations of female athletes and "past" and male athletes and "never." In short, participating in sports forced female athletes to diet, but this was not the case for male athletes. The fact that female dietitians answered "past" in four items such as "I care a lot about what I eat." led us to believe that their dieting methods require strong self-awareness and willpower. Furthermore, in "I take laxatives in order to lose weight.", female dietitians showed a distinct negative attitude by choosing "never"; in contrast, female athletes demonstrated a positive attitude by choosing "past." Although people who are well informed about nutrition avoid inappropriate dieting methods, female athletes, who possibly did not have the necessary understanding of nutrition, used improper methods, because of pressure to reduce their body weight.

### SHORT TERM SECULAR CHANGE IN BODY SIZE AND PHYSICAL FITNESS OF YOUTH 7-15 YEARS IN SOUTHWESTERN POLAND: 2001-2002 AND 2010-2011

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Short term secular change in body size and physical fitness of Polish youth 7-15 years of age resident in an industrial region of Lower Silesia in southwestern Poland were considered across two surveys, 2001-2002 and 2010-2011. Subjects were students in the same schools in both surveys 1892 boys and 1992 girls in the first and 1237 boys and 1236 girls in the second. In addition to height and weight, performances on six Eurofit fitness tests were measured. Height, weight and BMI increased significantly across surveys. Statistically controlling for secular gains in height and weight, only grip strength and agility/speed shuttle run improved significantly between surveys across three age groups (7-9, 10-12, 13-15 years), while sit-ups, the sit and reach and speed of upper limb movement declined between surveys, except for sit-ups in boys 13-15 years. The standing long jump improved among girls 7-9 and 10-12 years and boys in the three ages groups, though not all differences were significant; however, the jumping performance of adolescent girls 13-15 years declined significantly. In conclusion, comparisons across one decade showed a secular increase in body size, but variable changes in several physical fitness items.

### EXAMINING WEIGHT CONTROL AND DIET BEHAVIOR AMONG UNIVERSITY STUDENTS IN JAPAN AND SOUTH KOREA

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Introduction Among Japanese youths, the rate of those controlling their own weight is higher among females than it is among males (Ikeda & Ikeda, 2004). Health problems derived from controlling one's weight despite being of an appropriate weight are common among Japanese youths generally (Hand & Oguro, 2006). Similarly in South Korea, weight control has been linked with health-damaging eating disorders (Woo, 2014). The purpose of this study was to investigate the nature of weight control and diet behavior among university students in Japan and South Korea. Methods The research participants were 1,810 students in Japan and South Korea. All the participants were surveyed on whether they were practicing or not practicing weight control. Those controlling their weight completed the Scale of Diet Behavior (SDB) (Matsumoto et al., 1997). A chi-square test was applied to investigate the relationship between practicing/not practicing weight control, gender, and country. A two-way layout ANOVA with general linear model was applied to the factor scores on the SDB in order to find differences pertaining to gender and nationality. Results The ratios of female students practicing weight control to male students in both countries were as follows: JPN, M: 18.4%, F: 58.7%, chi-square =151.892; KOR, M: 42.3%, F: 61.1%, chi-square =32.601. Among male students, weight control was more prevalent among Koreans while, among female students, there was no significant difference between the two countries (chi-square =59.682). Factor analysis extracted two factors pertaining to diet behavior; one, known as the 'structural diet: SD' being healthy, and the other being unhealthy ('unstructured diet: UD'). The ANOVA for SD showed that there was a significant difference relating to gender ( $F(1, 803) = 39.4, M < F$ ) but not relating to nationality. In UD, there was interaction between gender and nationality. In a multiple comparison test, female UD was greater than male UD in Korea ( $t(475) = -3.3$ ) and, among females, Korean UD was greater than Japanese UD ( $t(544) = -6.1$ ). Discussion Far more females control their own weight than males in both Japan and South Korea. In terms of their diet behavior, more female students are SD than males. In this respect there is little difference between Japan and South Korea. Nevertheless, more Korean females are UD than Japanese females and/or Korean males. The results of this study revealed the characteristics of weight control and diet behavior and show the importance of health education for Japanese and Korean youths. References • Hando, T. and Oguro, N. (2006). Bulletin of Niigata Seiryō University, 6: 1-6. • Ikeda, T. and Ikeda, T. (2004). J. Nishi-kyushu University & Saga Junior College, 34: 135-139. • Miyazaki, Y. (2010). J. Nutr. Diet, 68(2): 65-77. • Woo (2014) J. Exerc. Nutrition Biochem, 18(3): 287-92. Contact: ikeda.tomo313@gmail.com

### EFFECTS OF 4 WEEKS OF HORSEBACK RIDING ON ANXIETY, DEPRESSION, SELF-ESTEEM IN CHILDREN WITH ADHD

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Introduction: Attention-deficit hyperactivity disorder (ADHD) is a common neurodevelopmental disorder that characterized by developmentally inappropriate levels of inattention, overactivity, distractibility, and impulsiveness, which manifest during childhood. Horseback riding is a physical therapy intervention that aims to improve postural stability, increase of sensory inputs, decrease muscle tone, and improve postural muscle activities. Until now no research has been published on horseback riding effective in improving the ADHD symptoms. PURPOSE: To determine the effects of 4 weeks of horseback riding on anxiety, depression, self-esteem in children with ADHD. METHODS: The subjects comprised a convenience sample of 10 children aged 10-12 years with ADHD and 10 children without ADHD. Horseback riding sessions were performed 2 times (40 minutes/day) per week for 4 weeks. Before and after the horseback riding program, we measured the children's anxiety, depression, self-esteem. The pre- and post-tests scores were analyzed with repeated-measures ANOVA. RESULTS: After the participation of the 4 weeks of horseback riding program, anxiety ( $p < .05$ ), and depression ( $p < .01$ ) were significantly improved in ADHD group. CONCLUSION: These results indicate that the 4 weeks of horseback riding program used in this study was very effective for producing significant improvements to anxiety and depression in children with ADHD.



## PHYSICAL PERFORMANCE AND THE DIURNAL CYCLE OF CORTISOL IN OLDER ADULTS WITH AND WITHOUT COGNITIVE IMPAIRMENT

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**Introduction:** Chronic stress and aging can lead to dysfunction of the hypothalamic–pituitary–adrenal (HPA) axis, leading to aberrant circadian patterns of cortisol secretion and a cascade of negative downstream events, including increased risk of developing Alzheimer's disease. There is evidence showing that physical activity can have restorative effects on the stress neuroendocrine system, although results are not always conclusive. The circadian pattern of cortisol secretion is complex and it has not been contemplated in many studies, which may explain some of the inconsistencies in the literature. **Methods:** The present study examined the diurnal cycle of salivary cortisol (Waking, 30 minutes post waking, 12:00, 17:00, 21:00) and physical performance (Six minute walk test; Walking speed; Timed get up and go test; Chair stand test) in a sample of older adults without cognitive impairment (n=45) and with Amnesic Mild Cognitive Impairment (n=40). The Cortisol Awakening Response (CAR), the drop between the peak of the CAR and 12:00 levels, and the mean level of cortisol after the CAR (mean of samples at 12:00, 17:00 and 21:00) were calculated. **Results:** Correlation analysis showed that lower mean day cortisol levels were associated with better physical performance as measured in the speed of walking ( $r=0.405$ ;  $p<0.001$ ), the Six-minute walk test ( $r=-0.267$ ;  $p<0.05$ ), and the Timed get up and go test ( $r=0.286$ ;  $p<0.05$ ). When a regression model was applied controlling for age and gender, the three test remained as predictive variables for the mean day cortisol ( $p<0.01$ ), with speed of walking being the stronger predictor of all three tests. **Discussion:** Two explaining mechanisms can be suggested based on these findings. First, the HPA axis and the diurnal cycle of cortisol might have a role in physical decline (Arsenault-Lapierre, Chertkow & Lupien, 2010). Second, physical activity and changes in physical performance may induce alterations in the HPA axis and the diurnal cycle of cortisol (Kumari et al. 2010). **References:** Arsenault-Lapierre G, Chertkow H, Lupien S. Seasonal effects on cortisol secretion in normal aging, mild cognitive impairment and Alzheimer's disease. *Neurobiology of aging*. 2010;31(6):1051-4. Kumari M, Badrick E, Sacker A, Kirschbaum C, Marmot M, Chandola T. Identifying patterns in cortisol secretion in an older population. Findings from the Whitehall II study. *Psychoneuroendocrinology*. 2010;35(7):1091-9. Contact: [juan.tortosa@ua.es](mailto:juan.tortosa@ua.es)

## CHANGES IN OXIDATIVE STRESS MARKERS OF MUSCLE INJURY IN RESPONSE TO CROSSFIT TRAINING

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**Introduction** CrossFit training is associated with substantially enhanced production of free radicals and other reactive oxygen and nitrogen species (ROS/RNS), widely regarded as factors that may contribute to exercise-induced muscle damage (Kliszczewicz et al., 2015). The purpose of this study was to assess the oxidative stress responses to a graded maximal cycling test following a 6-week CrossFit training. **Methods** Nine apparently healthy male volunteers (aged  $24.1 \pm 2.7$  years,  $\dot{V}O_{2\max}$   $47.5 \pm 5.0$  ml/min/kg) involved in CrossFit training performed a graded cycle exercise test to volitional fatigue twice, i.e. before starting training (1st trial) and then once more after 6 weeks of CrossFit training (2nd trial). Activities of creatine kinase (CK), lactate dehydrogenase (LDH), aspartate aminotransferase (AST), as well as malondialdehyde (MDA) and ferric reducing ability of plasma (FRAP) were estimated in blood plasma samples at rest, immediately post-test and after 1 hour of recovery. **Results** A graded maximal cycling test induced a significant increase ( $P<0.05$ ) in post-test activities in LDH and AST in the 1st trial, as well as a significant rise in post – test activities of CK, LDH, AST and MDA level in the 2nd trial. Six weeks of CrossFit training led to significant increase ( $P<0.05$ ) in pre- test activities of CK, LDH and MDA content compared to values recorded during the 1st trial, whereas both pre – and post - test FRAP levels were only not significantly higher from baseline levels. **Discussion** Exercise-induced oxidative stress is considered the main cause of tissue damage consequent to peroxidation of membrane lipids, leading to increase in the permeability of cell membranes, which results in the leakage of tissue enzymes into the blood stream. On the other hand, ROS generated during muscle contraction play an important signaling role in muscle adaptation to exercise (Powers et al., 2011). Our findings indicating that in spite of some enhancement of antioxidant defense capacities evidenced by FRAP, a 6-week CrossFit training led to marked increase in muscle damage markers kept, however, within the reference limits for highly active athletes (Mougios, 2007), reflect the effects of inadequate recovery time between individual training workouts. **References** Kliszczewicz B, Quindry CJ, Blessing LD et al. (2015). Acute exercise and oxidative stress: CrossFit™ vs. Treadmill Bout. *J Hum Kinet*, 29(47), 81–90. Mougios V. (2007). Reference intervals for serum creatine kinase in athletes. *Br J Sports Med*, 41, 674-678. Powers SK, Nelson WB, Hudson MB. (2011). Exercise-induced oxidative stress in humans: cause and consequences. *Free Rad Biol Med*, 51(5), 942-950. Contact [e.sadowska-krupa@awf.katowice.pl](mailto:e.sadowska-krupa@awf.katowice.pl)

## IMPROVEMENT IN SLEEP, TASK EXECUTION, AND FUNCTIONING OF THE AUTONOMIC NERVOUS SYSTEM OF CHILDREN DURING LONG-DURATION CAMPING <30 NIGHTS AND 31 DAYS>

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**Introduction** Currently, life in Japan is too competitive, suppressive, convenient, and comfortable; this lifestyle can affect the sleep and progress of mind of children and lead to poor physical fitness. Activities such as camping are expected to solve these problems. Therefore, the aim of this study was to examine the changes in sleep, task execution, and functioning of the autonomic nervous system of children during long-duration camping. **Methods** This study, conducted from 2007–2015, included 180 children (age,  $10.6 \pm 1.2$  years; 148 boys and 32 girls) who participated in a long-duration summer camp (30 nights and 31 days). In this study, a salivary melatonin concentration measurement survey in 2011, go/no-go task surveys in 2007–2015, and a cold pressor test (CPT) surveys in 2007–2012 were performed. Saliva for melatonin concentration measurement survey was collected at 5 instances at night (9:30 pm) and in the morning (6:30 am) on the 9th and 10th day before camping; 2nd and 3rd day, 16th and 17th day, and the 29th and 30th day during camping; 30th and 31st day after camping. The go/no-go task and the CPT, in which the fingertip of the right hand was stimulated with cold water at 4°C, were carried out in the early, middle, and final stage of each camping period. **Results** The salivary melatonin concentration during camping was increased at night and decreased in the morning. However, after camping, the salivary melatonin concentration returned to the initial level. Conversely, the false reaction numbers to go/no-go task and the vasopressor response to cold water had decreased in the middle stage compared to in the early stage, and in the final stage compared to in the middle stage during camping. **Discussion** As well known, exposure to light at night suppresses melatonin secretion in humans (Lewy et al., 1980), while exposure to light during the day

increases nocturnal melatonin secretion (Mishima et al., 2001). Additionally, other studies have also suggested that doing physical exercise during daytime (Miyazaki et al., 2001) and maintaining regular mealtimes (Hara et al., 2001) may affect the biological rhythm. Such a lifestyle can be maintained during camping. Thus, we suggest that the lifestyle in a camp improves one's biological rhythm and has a good influence on task execution and autonomic nervous system functioning. In conclusion, we suggest that incorporating activities such as camping into daily living of children should be a future practice to improve the spirit of a child. References Hara R et al. (2001) *Genes Cells*, 6, 269-278. Lewy AJ et al. (1980) *Science*, 210, 1267-1269. Mishima K et al. (2001) *JCEM*, 86, 129-134. Miyazaki T et al. (2001) *Am J Physiol Regul Integr Comp Physiol*, 281, 197-205 Contact nois@nittai.ac.jp

### **CANCER SURVIVORS' PHYSICAL ACTIVITY AND CHRONIC COMORBIDITY CONDITIONS: KOREA NATIONAL HEALTH AND NUTRITION EXAMINATION SURVEY 2008-2011**

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Introduction Research shows that chronic comorbidity affects poor cancer survival (Sogaard et al., 2013). Nevertheless, cancer survivors are also at risk for developing these conditions (Edgington & Morgan, 2011). Therefore, this study was purposed to investigate the associations between physical activity and comorbidity conditions among cancer survivors in Korea. Methods Subsamples of cancer survivors (N=611) from 2008-2011 Korea National Health and Nutrition Examination Survey data were analyzed. Using IPAQ, weekly hours spent in vigorous (VPA) and moderate physical activity (MPA), and walking, and muscular strengthening activity adherence (2+ days/week) were measured. Chronic comorbidity conditions as dependent variables were dyslipidemia, hypertension, obesity (BMI>25), diabetes, osteopenia/osteoporosis, depression and quality of life (EQ-5D). Age-group-specific (middle-aged: 30-64 years; older adults: 65+ years old) regression analyses were performed for each dependent variables, controlling for age, sex, caloric intake, and years since cancer diagnosis as covariates. Results In middle-age cancer survivors, VPA and was inversely associated with the incidence of dyslipidemia (OR=.92, p=.012). Muscular strengthening activity was positively associated with quality of life (r=3.55, p=.038). On the contrary, middle-aged adult cancer survivors who spent more hours in MPA were more likely to be obese (OR=1.05, p=.009). Among older adults, time spent in walking was associated with better quality of life (r=.40, p=.029). In contrast, muscular strengthening activity was positively associated with incidence of dyslipidemia (OR=2.98, p=.035) and diabetes (OR=4.02, p=.009). Discussion Studies consistently supports importance of physical activity in preventing chronic diseases (PAGAC, 2008). The current study largely supports that physical activity can play positive roles in preventing chronic conditions among cancer survivors, too. Because MPA among middle-aged survivors and muscle strengthening activities among older survivors were associated with higher incidence rate of obesity, dyslipidemia, and diabetes, nevertheless, future studies should investigate potential confounding factors and cause-and-effect associations. References Edgington A, Morgan MA (2011). Looking beyond recurrence: comorbidities in cancer survivors. *Clin J Oncol Nurs*, 15, E3-12. PAGAC (2008). Physical Activity Guidelines Advisory Committee Report. US Department of Human Services, Washington, DC. Sogaard M, Thomsen RW, Bossen KS, Sorensen HT, Norgaard M (2013). The impact of comorbidity on cancer survival: a review. *Clin Epidemiol*, 5, S3-29. Contact hy-olee@smu.ac.kr

### **EFFECT INSPECTION OF "WALK" AMONG CHILDREN**

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Introduction The increasing incidences of children with sleep and concentration problems are of concern in Japan. In this study, we confirmed that melatonin rhythm was improved during attendance of a long-duration camping (30 nights and 31 days) (Noi et al., 2009; Noi et al., 2013). However, it is not easy to implement the long-duration camping in a real-world setting. Therefore, the challenge has been to determine which principles of the long-duration camping are most effective in real-world settings. In this context, the routine walk practiced in the nursery has recently attracted attention. This study assessed the effects of routine walking on sleep and execution function in infants. Methods This study included 53 infants who routinely walked for around an hour. The survey was performed from October to November 2014. Saliva samples were collected at night (21:00 p.m.) and the next morning (6:30 a.m.) on both "walk days" and "no-walk days." Additionally, the numbers of false reactions to a go/no-go task were collected at same time on "walk days" and "no-walk days." We compared the melatonin concentration and the false reaction numbers by go/no-go task of "walk days" and "no-walk days." Results Comparison of saliva melatonin concentrations by two-way repeated analysis of variation revealed an interaction between walking and time. On the other hand, comparison of the numbers of false reactions to the go/no-go task by repeated t-tests showed significantly lower numbers for "walk days" than for "no-walk days." Discussion Exposure to light (Mishima et al., 2001) and physical exercise (Miyazaki et al., 2001) during the daytime is well known to increase nocturnal melatonin concentrations. In addition, the results of our study confirm that physical activity improves execution functions (Best, 2010.) Thus, the result of this study supports the results of these precedence studies. Based on these findings, we conclude that routine walking in the nursery may be an effective solution to sleep and execution function problems among Japanese children. References Best JR (2010) *Dev Rev*, 30, 331-551 Mishima K et al. (2001) *JCEM*, 86, 129-134. Miyazaki T et al. (2001) *Am J Physiol Regul Integr Comp Physiol*, 281, 197-205 Noi S et al. (2009) *Jpn J Hum Growth and Dev Res*, 41, 36-43 (in Japanese with English abstract) Noi S et al. (2013) *Jpn J Hum Growth and Dev Res*, 58, 25-33 (in Japanese with English abstract)

### **THE ACTUAL CONDITIONS OF SLEEP, SUBJECTIVE FATIGUE, MOOD DYSREGULATION TENDENCY, AND INTERNET ADDICTION TENDENCY AMONG JUNIOR HIGH SCHOOL STUDENTS IN A CERTAIN AREA OF JAPAN**

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Introduction In Japan, the health of children has long been a concern. In later years, anxiety about nightlife, fatigue, depression, and Internet addiction, in particular, increase. There are many reports about these situations. However, there are extremely few large-scale investigations carried out on the same target person and examining the actual situations and relations among those problems. Under such circumstances, the Setagaya Ward Board of Education and the Nippon Sport Science University constituted a consortium and are working to improve health promotion and children's physical fitness. As part of its activities, the present study was carried out to clarify the actual conditions of sleep, fatigue, mood dysregulation tendency, and Internet addiction tendency and their relations in all public junior high school students in Setagaya Ward, Tokyo. Methods Subjects were 9,628 1st to 3rd grade students (5,255 boys and 4,373 girls) from

all public junior high schools in Setagaya Ward. This study was carried in March, 2015. In this study, data about bedtime, wake-up time, sleep problems, subjective symptom of fatigue, mood dysregulation tendency, and Internet addiction tendency were collected using a self-completed questionnaire survey. Results Bedtime and wake-up time were slowed with the start of the school year. Sleep problems increased with advancing grades. Fatigue rose as grade increased in boys, but there was no change in girls. Mood dysregulation tendency increased in boys but decreased in girls as grade increased. The proportion of those with a tendency toward Internet addiction determined to be pathological use and maladaptive use increased with increasing grade. In addition, people with strong Internet dependence were found to have a tendency toward sleep problems of slow bedtime, frequent fatigue, and mood dysregulation. Discussion The results of this study showed a similar tendency of late sleeping as in another report (Japanese Society of School Health, 2014) in Japan in 2013. On the other hand, the Internet-dependent trend of the present study in people with strong sleep problems was supported by the results of previous study (Oka et al., 2008) that sleep routines worsen in bedrooms with electronic media. In Japan, the spread of electronic media can be expected to proceed in the future, and there is concern that sleep problems in children will continue to worsen. References Japanese Society of School Health (2014) Enterprise report on the health status surveillance among the child (in Japanese) Oka et al. (2008) *Behav Sleep Med*, 6, 220-233

### **ASSOCIATION BETWEEN SKELETAL MUSCLE MASS AND DEPRESSIVE SYMPTOMS IN JAPANESE COMMUNITY-DWELLING ELDERLY WOMEN : A CROSS-SECTIONAL STUDY.**

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**INTRODUCTION:** Previous studies indicated that the depressive scores were associated with skeletal muscle mass (SMM) and/or sarcopenia in elderly men (Jenny et al., 2007; Ying et al., 2014). However it still remains unclear whether SMM associates with depressive symptoms as covariate of comprehensive analysis with objective physical activity. Therefore, we test the hypothesis that SMM associates with depressive symptoms as covariate of comprehensive analysis with objective physical activity. **PURPOSE:** The aim of the present study was to investigate whether SMM associates with depressive symptoms as covariate of comprehensive analysis with objective physical activity in elderly women. **METHODS:** This cross-sectional study involved a total of 153 healthy elderly woman aged 65 and over (mean age  $74 \pm 6$  years) in Aichi prefecture, Japan. All measurements were performed at the community centers from August to September of 2015. This study was approved by the Seijoh University ethics committee. All participants provided written informed consent. The SMM was measured by bioelectrical impedance analysis (BIA). Depressive symptoms was evaluated by 15-item Geriatric Depression Scale (GDS-15). All participants were divided into two groups (GDS-15 score of 6 or more; depressive symptoms group (D group), <5; non-depression symptoms (non-D group). We examined the relationship between height-adjusted appendicular SMM (ASM) and depressive symptoms using one-way ANCOVA, adjusted for age, economic conditions, lifestyle habit, social situation, and physical activity measured by accelerometer. All tests were two-sided and a P value of <0.05 was taken as statistically significant. **RESULTS:** In this study, 13.1% ( $n=20$ ) of participants were categorized as the D group. After adjustment for all factors, height-adjusted ASM were significantly lower in the D group ( $5.73 \pm 0.33$  kg/m<sup>2</sup>) than in the non-D group ( $6.38 \pm 0.83$  kg/m<sup>2</sup>). **CONCLUSION:** Low height-adjusted ASM was associated with depressive symptoms independently various factors. These results suggest that increase in SMM may prevent depressive symptoms in elderly women. Future studies will need to assess the effect of exercise intervention on depressive symptoms in elderly women.

### **TRAINING EFFECT DURING THE POLARNIGHT IN DIFFERENT CHRONOTYPES**

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**Introduction** In a previous study we have found that adults with different chronotypes have responded differently to exercise performed in day-light or darkness (Vitale, Calogiuri, & Weydahl, 2013). Above 70° North, the sun is not above the horizon for about 8 weeks, giving the people living there very little daylight. The aim of this paper is to study the effect of training during the polar nights in relation to the individual's chronotype. To the best of our knowledge, no past studies investigated this topic. **Method** We used Horne and Östberg questionnaire to determine chronotype in 265 inhabitants wanting to participate. 10 M-, 10 N- and 10 E-types were chosen to participate. The last week before the polar night, we found the participants' anaerobic lactic acid profile (AT) and their maximal oxygen consumption (VO<sub>2</sub> max) (test 1). During the polar night period the participants trained in a group one hour out-of-doors and one hour indoors each week in addition to every-day homework, like going outside at least 10 minutes and some flexibility, balance and strength exercise. The week after the polar night, the subjects were retested (test 2). Subjects that did not participate in training or test 2 were excluded in the further analyses. We run multiple regression analyses to check for a possible relationship between chronotype and the % of changes from test 1 to test 2. Results Fifteen subjects completed the study: 8 females and 7 males with mean age 37 years, BMI: 28. They were 3 E-types, 5 N-types and 7 M-types. Mean values at test 1: VO<sub>2</sub>max: 36.9 ml/min x kg and HR at AT: 82% of HRmax. No significant relations were observed from multiple regression analyses looking at the % of changes in VO<sub>2</sub> max ( $R^2$ : 0.07,  $p=0.369$ ) and AT ( $R^2$ : 0.02  $p=0.61$ ) and the MEQ scores of each subjects. The data for VO<sub>2</sub>max and AT were normally distributed therefore we performed a paired t-test from test 1 to test 2 conditions for the whole group. We observed that the subjects increased significantly their VO<sub>2</sub> max (from 36.9 to 39.6 with a  $p=0.02$ ). **Discussion** The increased VO<sub>2</sub>max is expected since the subjects trained for several weeks nevertheless, this increase was significant only for E-types and N-types but not for M-types. We can hypothesized that M-types did not increase their VO<sub>2</sub> max because they were disadvantaged during the training period with darkness. We did not observe a real overall chronotype effect on test results performed after the period of polar nights. The group size is a limiting factor, it is advisable to continue the study to include more subjects. **References:** Vitale, J. A., Calogiuri, G., & Weydahl, A. (2013). Influence of chronotype on responses to a standardized, self-paced walking task in the morning vs afternoon: A pilot study 1. *Perceptual & Motor Skills*, 116(3), 1020-1028.

### **PHYSICAL ACTIVITY LEVEL AND ITS CORRELATES IN THE CROATIAN ADULT POPULATION**

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**Introduction** Understanding physical activity (PA) levels and its correlates can aid in planning PA promotion interventions. This is the first study to examine the PA level in the Croatian adult population by means of the EPIC-Norfolk Physical Activity Questionnaire (EPAQ2) – assessing past year's PA in different contexts. The aims of the study were: a) to determine the PA level (total and domain-specific) of the

adult Croatian population and b) to determine the relationship between total PA and selected socio-demographic, lifestyle, and health characteristics. Methods The sample consisted of 551 participants (58.6% females; age (mean $\pm$ SD) 41 $\pm$ 15 yrs (females) and 44 $\pm$ 16 yrs (males)). Public health institutes across Croatian counties were requested to randomly select 10 primary care physicians, which were then instructed to recruit 10 of their adult patients to participate in this study. The participants filled out the EPAQ2 questionnaire and responded to a set of questions on potential correlates of PA (age, body mass index, household income, education, type of settlement, smoking habits, and self-perceived health). Total PA level and PA levels in four domains (work, commuting, home, recreation) were calculated and expressed in MET-hour/week. Results Total PA was significantly higher in females than in males (medians: 133.7 vs 114.8 MET-hour/week, Mann-Whitney U test  $p=0.002$ ). Significant differences between sexes were observed for PA levels in home (females: 56.9, males: 22.6,  $p<0.001$ ), recreation (females: 21.1, males: 6.82,  $p=0.001$ ) and work domains (females: 32.8, males: 60.2,  $p<0.001$ ). No difference between sexes was found for active transport, where most females and males reported no participation ( $p=0.076$ ). Additionally, a multiple regression analysis showed that household income ( $p<0.001$ ) and self-perceived health ( $p=0.028$ ) are positively, while living in an urban area ( $p=0.001$ ) is negatively related to total PA. Discussion Total PA level in both sexes was significantly higher than in previous Croatian studies, possibly due to methodological differences. According to the results on domain-specific PA levels and PA correlates, future public health initiatives should be directed toward promotion of PA in transport and leisure time contexts, and focused on low-income persons, suburban and urban areas, and people with poor health. References Bauman AE, et al. (2012). *Lancet*. 380, 258-271. Jurakić D, et al. (2009). *Croat Med J*, 50, 165-173. Wareham NJ, et al. (2002). *Int J Epidemiol*. 31, 168-174. Contact marija.rakovac@kif.hr

### THE DECREASE IN BLOOD CHOLESTEROL INDUCED BY NORDIC WALKING TRAINING IS MODULATED BY VITAMIN D SUPPLEMENTATION IN ELDERLY WOMEN

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Introduction Vitamin D3 deficiency and high blood cholesterol concentration is commonly observed conditions in modern society. Limited outdoor physical activity is considered to be a contributing factor, as vitamin D is synthesized in the skin from cholesterol. Some study showed that physical activity lowers blood cholesterol (Paoli et al., 2013) and plasma 25-hydroxyvitamin D (25-OH-D) is inversely associated with triglycerides and total cholesterol (Garcia-Bailo et al., 2013). The combined effect of exercise and vitamin D supplementation on blood lipid profile, however, has not been studied. Methods Here we investigated the effects of vitamin D3 supplementation (800 IU and 4000 IU) and 12 weeks of Nordic walking training on serum lipids in elderly women aged 67 $\pm$  7.8 yrs. The subjects were divided into two groups following the same training schedule, but different supplementation scheme: one received 800 IU/day (I), while the other received 4000 IU/day (II). Plasma, total triacylglycerol (TG), total cholesterol (TC), high-density lipoprotein (HDL-C) and low-density lipoprotein (LDL-C) cholesterol were determined pre- and post-intervention. The ratios of TC/HDL-C and LDL-C/HDL-C were also calculated. Results The applied training program and supplementation 4000 IU/day were found to have caused a significant decrease in TC 224  $\pm$  39 vs 199 $\pm$ 35mg-dL<sup>-1</sup> ( $p<0.05$ ) and HDL-C (73.8 $\pm$ 16.3 vs 4.9 $\pm$ 14.9mg-dL<sup>-1</sup>). LDL-C values also dropped, yet the changes were not statistically significant. In comparison in group I a minor decrease in both TC and LDL did not account for a statistically significant change. Discussion The present study demonstrates, that regular Nordic walking training, when accompanied by vitamin D supplementation, induced a significant decrease in blood total cholesterol in elderly women. It is important to note that changes in HDL cholesterol were more pronounced compared to LDL. Previously published studies are partially in agreement with our data, as it has been shown that plasma 25-OH-D was inversely associated with triglycerides, total cholesterol, low-density lipoprotein cholesterol, and the ratio of total to high-density lipoprotein cholesterol. In conclusion, our data suggest that the effects of regular exercise on blood lipid profile depends on vitamin D3 concentration. Garcia-Bailo, B., Da Costa, L.A., Arora, P., Karmali, M., El-Sohemy, A., and Badawi, A. (2013). Preventing chronic disease 10, E91. Paoli, A., Pacelli, Q.F., Moro, T., Marcolin, G., Neri, M., Battaglia, G., Sergi, G., Bolzetta, F., and Bianco, A. (2013). Lipids in health and disease 12, 131. jakubantonikortas@gmail.com

### AGE-ASSOCIATED CHANGES OF GROUND REACTION FORCE PARAMETERS DURING SIT-TO-STAND MOVEMENT IN 801 WOMEN AGED 18–89 YEARS

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Introduction Physical functioning during daily activities, such as climbing stairs or rising from a chair, requires muscular strength and power. This ability declines with advancing age, with the loss of muscle mass and impaired neuromotor control (Martin et al., 2000). This study aimed to examine age-associated changes in vertical ground reaction force (GRF) during sit-to-stand (STS) movements in healthy Japanese women aged 18–89 years. Methods Eight hundred and one healthy women participated in this study and were divided into seven age groups as follows: 18–29 years (20s), 30–39 years (30s), 40–49 years (40s), 50–59 years (50s), 60–69 years (60s), 70–79 years (70s), and 80–89 years (80s). All participants could stand up from sitting on a chair without holding onto anything for support. Participants sat in an adjustable chair with their feet on a force plate, and stood as quickly as possible. The body weight overshoot (SUI), rate of rise in GRF (RFD), and reaction time (RT) parameters were measured during STS movement (Freming et al., 1991). Results The vertical GRF parameters during STS movement were inversely related with aging in healthy women. Correlation coefficients in the age-related GRF parameters were SUI ( $r = -0.64$ ,  $P < 0.05$ ), RFD ( $r = -0.54$ ,  $P < 0.05$ ), RFD/kg ( $r = -0.62$ ,  $P < 0.05$ ) and RT ( $r = 0.30$ ,  $P < 0.05$ ). SUI, RFD, and RFD/kg decreased rapidly already in the 30s and RT decreased slowly in the 70s. The oldest age group (80s) had lower SUI (18.4%), RFD (45.7%), RFD/kg (32.6%), and RT (32.4%) values when compared with the youngest group (20s). Percent changes for SUI, RFD, RFD/kg, and RT were 3.2%, 8.3%, 6.3%, and 6.6% per decade, respectively. Discussion The main finding of this study is that the age-associated decline in GRF parameters during STS movement seems to accelerate with advancing age in healthy women. The percent changes for explosive force production or anaerobic power were 10%–12% per decade in healthy adults (Izuquiedo et al., 1999; Kostka et al., 2009). In this study, the age-associated changes of SUI, RFD, and RFD/kg per decade during STS movement were smaller than those in previous studies. References Freming BE, Wilson DR, Pendergast DR (1991) *Arch Phys Med Rehabil*, 72, 886-889. Izuquiedo M, Aguado X, Gonzalez R, Lopez JL, Hakkinen K (1999) *Eur J Appl Physiol*, 79, 260-267. Kostka T, Drygas W, Jegier A, Zaniewicz D (2009) *Int J Sports Med*, 30, 225-230. Martin JC, Farrar RP, Wagner BM, Spirduso WW (2000) *J Gerontol Med Sci*, 55A(6), M311-M316. Contact toshiaki@sta.tenri-u.ac.jp



## PHYSICAL FITNESS OF LITHUANIAN PRIMARY SCHOOL CHILDREN. PILOT STUDY

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**Introduction** At present, studies have shown that despite the physical activity recommendations and greater investment in the promotion of children's physical activity, there is still not enough attention paid to testing children's physical fitness. In particular, there is a lack of analysis of younger school-age children's physical fitness and its influencing factors. It is well known that underdeveloped physical abilities of children have a negative impact on their health and well-being in childhood and adulthood (Corbin et al., 2014). Therefore, such studies are very important aiming at improving children's health indicators. **Methods** Data from 242 primary school students aged 7 – 11 years were gathered, 52.7% of them were boys. The 9 items test battery, developed by Fjørtoft et al. (2011), included the following tests: standing broad jump, jumping a distance of 7 m on 2 feet, jumping a distance of 7 m on one foot, throwing a tennis ball with one hand, pushing a medicine ball with 2 hands, climbing wall bars, performing a 10 x 5 m shuttle run, running 20 m as fast as possible, and performing a reduced Cooper test (6 minutes). Results Boys performed better than girls ( $p < .05$ ) on total fitness and most separate tests, except for performing a 10 x 5 m shuttle run, jumping a distance of 7 m on 2 and 1 feet. Comparison of physical abilities of differently aged boys has shown that strength and endurance indicators improve with age. Agility, coordination, aerobic endurance did not statistically significantly differ comparing the indicators for 7-, 8-, 9-, and 10- year-old boys. Comparing physical fitness indicators for differently aged girls we did not find statistically significant differences. Height, weight, BMI and body fat mass were not related to the total physical fitness. Pushing a medicine ball with 2 hands was associated with a higher score on height, weight and BMI ( $r = .332, .343, .260$ , respectively). **Discussion** Results obtained from the girls do not reflect the distribution of the overall children's physical fitness indicators in the aspect of age groups. While the improvement of these indicators is observed with age, it is not statistically significant ( $p > .05$ ). These findings may be influenced by the small sample size which is characteristic of the pilot study. We did not observe significant differences comparing physical fitness indicators for children in Lithuania and other countries. Boys' physical fitness indicators improved with age and were statistically significantly ( $p < .05$ ) different from those of girls. **References** Corbin, C. B., Welk, G. J., Richardson, C., Vowell, C., Lambdin, D., & Wikgren, S. (2014). *Recreation & Dance*, 85(2), 24-31. Fjørtoft, I., Pedersen, A. V., Sigmundsson, H., & Vereijken, B. (2011). *Physical Therapy*, 91(7), 1087-1095.

## EFFECTS OF RESISTANCE TRAINING WITH ELASTIC BANDS AT DIFFERENT LEVELS OF INTENSITY ON THE IMMUNE SYSTEM OF OLDER ADULTS

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1: University of Valencia (Valencia, Spain), 2: Clinical Analysis Service, University Hospital Dr. Peset, (Valencia, Spain). **Introduction** Resistance training has proven to be an efficient method for the improvement of the immune system (IS) in older adults (OA) but there are no evidences that the use of elastic bands is efficient for these purposes. The main objective of this study was to analyse the chronic effects of a strength training program with elastic bands at different intensities, on the IS parameters and the inflammatory profile of OA. **Methods** 86 OA ( $69.47 \pm 5.16$ ), were randomized in 3 groups: Control group (CG) ( $n=37$ ), Moderate Intensity Training Group (MITG) ( $n=26$ ) and High Intensity Training Group (HITG) ( $n=23$ ). 16 weeks (WK) of elastic bands (TheraBand) resistance training program was conducted, twice a WK, with 6 exercises. The training groups exercised at moderate and high intensity, performing 15 and 6 repetitions respectively, with a perceived exertion of 6-7 OMNI-RES for the first 4 WK and 8-9 the next 12 WK. Leukocytes (LK), neutrophils (NT), lymphocytes (LP), monocytes (MN), eosinophils (EN), basophils (BS), C-reactive protein (CRP) and interleukin 6 (IL) were measured. Non parametric tests were performed. **Results** Main results showed significant differences between HITG and MITG in LP and MN ( $p < 0.05$ ) and a tendency in LK post measurement ( $p < 0.09$ ) was detected. Differences in between the HITG and CG were found in LK and MN ( $p < 0.05$ ). Significant differences occurred in the intragroup results of HITG in the LK (-7.27%) and monocyte variable (-20%). In the intragroup analysis, in MITG and HITG CRP diminished (-22,1% and -18,58% respectively), whereas CG increased IL-6 (+15,78%). **Discussion** Training protocol performed improved the immune response of both groups, even though high intensity is linked to a worsening of it. So, although it is claimed that there are no chronic changes in the IS in studies of less than 6 months of duration (Walsh et al., 2011), it has been proven that, after 4 months, signs of improvement of this system can be detected. **References** Walsh NP, Gleeson M, Shephard RJ, Gleeson M, Woods JA, Bishop NC, Flesher M, Green C, Pedersen BK, Hoffman-Goetz L, Rogers CJ, Northoff H, Abbasi A, Simon P. (2011). Position statement part one: immune function and exercise. *Exerc Immunol Rev*, 17, 64-103. Gleeson M, Bishop NC, Stensel DJ, Lindley MR, Mastana SS, Nimmo MA. (2011). The anti-inflammatory effects of exercise: mechanisms and implications for the prevention and treatment of disease. *Nat Rev Immunol*, 11(9), 607-615. Contact: Victor.m.cutillas@gmail.com

## THE RELATIONSHIP BETWEEN PHYSICAL ACTIVITY, INACTIVITY AND PHYSICAL FITNESS AMONG LITHUANIAN PRIMARY SCHOOL CHILDREN

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**Introduction** Recently it is emphasized that physical education should focus on physical fitness rather than physical activity (Corbin et al., 2014). Health related physical fitness acts as a preventive factor to various chronic diseases. The aim of this study is to examine the relationship of physical fitness and physical activity as well as inactivity in Lithuanian primary school students. **Methods** Data from 242 primary school students from grade 1 to grade 4 were gathered, 52.7% were boys. The 9-item test battery was applied to measure physical fitness. The test battery was developed by Fjørtoft et al. (2011) and included tests: standing broad jump, jumping a distance of 7 m on 2 feet, jumping a distance of 7 m on one foot, throwing a tennis ball with one hand, pushing a medicine ball with 2 hands, climbing wall bars, performing a 10 x 5 m shuttle run, running 20 m as fast as possible, and performing a reduced Cooper test (6 minutes). Data about leisure time physical activity and sitting time were also gathered. **Results** Regression analysis revealed that physical activity was related to total physical fitness ( $\beta = .228, t = -2.590, p = .011$ ) and added 5% to total physical fitness variance until the inactivity was added to the equation. Then it became insignificant ( $p > .05$ ). The results were obtained controlling for gender and age. Meanwhile, physical inactivity predicted lower total physical fitness ( $\beta = -.278, t = -3.057, p = .003$ ) and added 6% to the explanation of physical fitness variance. Physical activity had positive predictive value on reduced Cooper test ( $\beta = .200, t = -1.955, p = .05$ ). Physical inactivity predicted lower scores on throwing a tennis ball, running 20 m, performing a 10 x 5 m shuttle run ( $\beta = -.225, t = -2.593, p = .011$ ;  $\beta = .205, t = 2.003, p = .048$ ;  $\beta = -.275, t = -2.623, p = .010$ , respectively). **Discussion** Results of this study support the premise that poor physical fitness related to low physical activity,

extra sitting hours in leisure time and vice versa. Physical activity predicts higher endurance, which is closely related to cardiovascular health. Although the strength of physical activity and inactivity relationships varies for different components of fitness among primary school students, it is important to teach about these relationships in fitness education programs, and to measure all health-related fitness components (Corbin et al., 2014). References Corbin, C. B., Welk, G. J., Richardson, C., Vowell, C., Lambdin, D., & Wikgren, S. (2014). *J of Physical Education, Recreation & Dance*, 85(2), 24-31. Fjørtoft, I., Pedersen, A. V., Sigmundsson, H., & Vereijken, B. (2011). *Phys therapy*, 91(7), 1087-1095. Contact arunas.emeljanovas@lsu.lt

### CHANGE IN THE RELATIONSHIP AMONG SALIVARY BIOMARKERS OF CHILDREN AND ADOLESCENTS IN THE EARTH-QUAKE AND TSUNAMI DISASTER AREA.

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**Introduction** We have periodically investigated about the psychosomatic health of the elementary and junior high school students in the disaster area from September 2011 after half year of the Great East Japan Earthquake and tsunami. As a result, our study group reported that the subjects who survive the earthquake and tsunami experience a decrease in physical activity levels (Okazaki 2015). In addition, a significant fluctuation was observed by both of stress and immune index in the subjects (Sakamoto 2014), but the details are still unclear about these relations. The purpose of this study was to examine the relation between salivary stress and immune biomarkers in children and adolescents living in a town affected by the Great East Japan Earthquake and tsunami 2011. **Methods** Participants were 403 elementary and junior high school students (as of the first investigation in September, 2011) aged 9-14 lived in the town of Onagawa (the place where housing damage affected 60% of participants). The survey was performed 4 times in September 2011 (the disaster after six months; 6m), March 2012 (after 1 year; 1y), March 2013 (after 2 years; 2y) and March 2014 (after 3 years; 3y). Whole stimulated whole saliva samples were collected using Sali-kids Salivette tube, and saliva flow (SF; ml/min), secretory IgA (SIgA) concentration (SIgA-C; µg/ml), SIgA secretion rate (SIgA-SR; µg/min), and cortisol concentration (COR; µg/dL) were determined. Results COR was significantly decreased after 1y, 2y and 3y comparison with disaster after 6m, but SIgA-C was significantly increased after 1y, 2y and 3y. In addition, a significant change was observed about SF and SIgA-SR through the survey period. Interestingly, COR was significantly increased after 3y comparison with disaster after 2y. So, when COR of 6m and 3y were respectively divided into two groups based on the median and compared each groups of salivary immune marker, there were significant difference observed with SIgA-SR of 6m, but there was not significant difference in each immune markers of 3y. **Conclusion** A long-term fluctuation was observed by the stress and immune marker of children and adolescents in the disaster area. In addition, these results suggest the possibility that different association was found between stress and immune markers with 6m and 3y. This study was supported by the Japan Society for the Promotion of Science (24680065 and 26750323). References Okazaki K, et al. (2015) Physical activity and sedentary behavior among children and adolescents living in an area affected by the 2011 Great East Japan earthquake and tsunami for 3 years. *Preventive Medicine Reports* 2, 720-4. Sakamoto Y, et al. (2014) Change in salivary biomarkers of children and adolescents in a tsunami disaster area. 19th ECSS Congress (Amsterdam, NED). Contact: ysakamoto@mail.tohoku-gakuin.ac.jp

### VALIDATION OF PHYSICAL FITNESS TEST BATTERY IN LITHUANIAN PRIMARY SCHOOL CHILDREN: PILOT STUDY

MIEZIENE, B., EMELJANOVAS, A., CESNAITIENE, V., PAGIRSKAS, J., LIUDZIUS, D., FJØRTOFT, I.2, KJØNNIKSEN, L.2

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**Introduction** Physical fitness (PF) is one of the main factors for health status. Studies show that poor PF in childhood and adolescence is a risk factor for future cardiovascular health. PF in high school children decrease over decades. There is a lack of instruments to measure PF in primary school. **Methods** Data from 129 first grade students were gathered. The 9-item test battery, developed by Fjørtoft et al. (2011), included tests: standing broad jump, jumping a distance of 7 m on 2 feet, jumping a distance of 7 m on one foot, throwing a tennis ball with one hand, pushing a medicine ball with 2 hands, climbing wall bars, performing a 10 x 5 m shuttle run, running 20 m as fast as possible, and performing a reduced Cooper test (6 minutes). Data about organized physical activity (PA), leisure sitting time and motor abilities (Herrmann et al., 2015) were also gathered. Results EFA confirmed one factor model. Means on each PF test were close to those of the Norwegian sample (Fjørtoft et al., 2011). Internal consistency of PF scale was good – Cronbach alpha .80. Test-retest reliability varied in the range from .561 to .768. Tests correlated with each other in the range from .174 to .575. Tests correlated with the total PF in the range from .579 to .795. Boys performed better than girls ( $p < .05$ ) on total PF and most separate tests, except on jumping a distance of 7 m on 1 and 2 feet. PA had no relationship with total PF or separate tests in neither boys nor girls. Leisure sitting time was negatively related to 10 x 5 m shuttle run, running 20 m and total PF performance. PF was significantly associated with various motor abilities (e.g. bouncing, catching, dribbling) in the range from .242 to .514. **Discussion** PF tests battery for primary school children was developed as it should consist of compound activities that recruit various combinations of underlying components, such as strength, endurance, motor coordination, balance, and agility. Results show that the individual tests correlated reasonably well with each other. All of the individual tests' scores contributed to the total test score, without either very high or very low correlations. These results support the internal consistency of test battery. Test-retest reliability can be considered satisfactory. Construct validity is partly supported as girls performed worse than boys and those who are more inactive worse than less inactive. The relationship with motor abilities provided support for PF tests battery concurrent validity. References Fjørtoft, I., Pedersen, A. V., Sigmundsson, H., & Vereijken, B. (2011). *Phys ther*, 91(7), 1087-1095. Herrmann, C., Gerlach, E., & Seelig, H. (2015). *Measurement in Phys Edu and Exerc Sci*, 19(2), 80-90. Contact brigita.mieziene@lsu.lt

### LEAN BODY MASS INCREASE COULD SLOW DECREASE IN RESTING METABOLIC RATE AFTER WEIGHT LOSS

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**Introduction** A weight loss around 10% could be considered clinically meaningful (Sherwood et al, 2016). Some studies indicated a decrease in resting metabolic rate (RMR) after a weight loss program (WLP) (Knuth et al, 2014; Schwartz et al, 2012). However, studies examining the RMR response between responders and non-responders, classified those individuals by body weight loss and not by body composition (BC) changes (Herrmann et al, 2015; Tremblay et al, 2015), ignoring the effect that muscle mass can have over RMR (Müller et al, 2002). Therefore, the aim of this study was to investigate the RMR response between responders and non-responders regarding BC changes after a WLP. **Methods** One hundred and sixty-nine (82 males) overweight (W) and obese (O) participants (body mass index 25-34.9 kg/m<sup>2</sup>), aged 18-50 years, underwent a WLP during 24 weeks. Subjects were randomized into three training groups (strength train-

ing, endurance training or a combination of strength and endurance; training frequency 3 times/week) or a physical activity recommendations group. All in combination with a 25-30 % caloric restriction diet. RMR was measured by indirect calorimetry and the mean of the last 10 min in a lying position was used for analysis. BC changes were measured with DXA. Participants were classified as responders when they decrease their initial body weight by  $\geq 10\%$  and increase lean body mass by  $\geq 10\%$ , and non-responders if these conditions were not satisfied. A one-way ANOVA with repeated measures was conducted. Results RMR decreased after the intervention ( $1706.15 \pm 36.38$  vs  $1600.39 \pm 31.33$  kcal;  $p < 0.001$ ) within the whole group, without differences between individuals who lost more ( $-105.82 \pm 44.19$  kcal;  $p = 0.018$ ) and less ( $-110.73 \pm 31.11$  kcal;  $p < 0.001$ ) than 10% of their initial body weight. However, responders did not change their RMR ( $-98.98 \pm 50.42$  kcal;  $p = 0.051$ ) while non-responders significantly decreased it ( $-112.56 \pm 29.45$  kcal;  $p < 0.001$ ). Discussion The causes for the metabolic adaptation to weight loss are still unclear and some studies indicated that only FFM maintenance prevents the slowing of metabolic rate during active weight loss (Johansen et al, 2012; Knuth et al, 2014). A lean body mass increase could be necessary to maintain RMR and our results reinforce this hypothesis. References Herrmann SD, et al (2015). Obesity (Silver Spring), 23(8):1539-49. Johansen DL, et al. (2012). J Clin Endocrinol Metab, 97(7):2489-96. Knuth ND, et al. (2014). Obesity (Silver Spring), 22(12):2563-9. Müller MJ, et al. (2002). Obes Rev, 3(2):113-22. Sherwood NE, et al. (2016). Contemp Clin Trials, 47:209-216. Schwartz A, et al. (2012). Obesity (Silver Spring), 20(11):2307-10. Tremblay A, et al. (2015). Clin Obes, 5(3):145-53. Funding: DEP2008-06354-C04-01 Contact elianeaparecidacastro@gmail.com

## ADOLESCENTS ATHLETES AND NON-ATHLETES: DO THEY DIFFER IN HEIGHT, WEIGHT AND BMI?

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Introduction Adolescence is considered as a risk factor for inactivity (Rowland, 1999). Owing to the high risk of overweight adolescents becoming obese adults, the engagement of adolescents in sports is a fundamental goal of obesity prevention (Hills et al., 2015). The aim of this study was to analyze differences in early adolescents, athletes, and non-athletes, in terms of anthropometric parameters: body height, body weight, and BMI. Methods The study was conducted on the sample of 214 male 5th-grade students of elementary schools in Novi Sad (Serbia), between 11-13-years of age, divided into 4 groups: 61 non-athletes, 72 soccer players, 46 basketball players, and 35 martial arts athletes (judo, karate, kickboxing, taekwondo, and aikido). The adolescent athletes were involved in sports not less than 2 years. The groups were compared in 3 different anthropometrical variables: height, weight, and BMI. Differences between groups were analyzed by one-way ANOVA (Post Hoc), Kruskal-Wallis, Mann-Whitney, and Chi-square test. Results Students who were engaged in basketball, on average, were the tallest, the heaviest and had the highest BMI. Students who played soccer were, on average, the shortest, of the lowest weight and had the lowest BMI. The greatest similarity exists between martial arts athletes and non-athletes. A statistically significant difference in average height was identified only between soccer and the basketball players ( $p = 0.024$ ). As regards weight and BMI, there were significant differences among all groups, except between martial arts and non-athletes groups. Percentage of overweight early adolescents (obesity included) ranged from 8.3% in football players to 41.3% in basketball players. In martial art athletes and non-athletes, this percentage reached 22.9% and 24.6%, respectively. Discussion Early adolescence is a delicate developmental phase and individual differences in maturation might affect the results (Beunen et al., 1988). A permanent engagement in selected sports can affect the nutritional status as well as other biological parameters in youth. Sports selection (natural and intentional), might also be a factor of influence: tall children are selected to basketball, soccer require fast and agile players. Some sample issues (mixed martial arts group, a number of participants) might also affect the results obtained. References Beunen G, Malina RM, Van't Hof MA, Simons J, Ostyn M, Renson R, Van Gerven D (1988). Champaign, IL: Human Kinetics. Hills AP, Anderesen LB, Byrne NM. (2015). Br J Sports Med, 45:866-870. Rowland TW. (1999). The President's Council on Physical Fitness and Sports Research Digest, Series 3, 6, 1-9. Contact markoviclidija169@gmail.com Do not insert authors here

## TENNIS PLAYING LIMITS UPPER EXTREMITY SUBCUTANEOUS FAT ACCUMULATION IN PREADOLESCENTS: A VOLUME METRIC STUDY USING MRI

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Research Institute of Biomedical and Health Sciences (IUIBS), Las Palmas de Gran Canaria, Canary Islands, Spain. Introduction. Tennis submits the arm that holds the racket (dominant arm) to a great amount of exercise compared to the contralateral. Nowadays, little is known about the effects of tennis on the fat mass in preadolescents (1). Subcutaneous adipose tissue (SAT) is a component of the fat mass with a great interest for health (2) that can be measured with great reproducibility in children using magnetic resonance imaging (MRI) (3). The main aim of the present study was to determine if playing tennis at pre-pubertal ages is associated with lower upper extremity SAT accumulation compared to non-active boys. Methods. MRI was used to determine SAT in 17 male preadolescents ( $11.0 \pm 0.8$  years, Tanner 1-2), not obese and healthy. Seven were tennis players (playing frequency 5 d/w, at least 2 y; TP) and 10 were physically non-active controls (CG). Contiguous MRI images were used to calculate the volume of SAT of each arm independently (from the axilla to the head of the radius) (4). Differences between groups were established using ANCOVA, with height as covariate, and Bonferroni-Holm post hoc test (5). Side-to-side differences were assessed using Student's paired t-tests. Significant differences were assumed when  $P < 0.05$ . Results TP and CG had similar age, height, weight and pubertal status ( $P = NS$ ). Body mass index was lower in TP than in CG ( $17.2 \pm 1.4$  vs.  $19.6 \pm 2.3$ , respectively,  $P < 0.05$ ). The TP had lower SAT than the CG in the dominant and non-dominant upper extremity ( $P < 0.05$ ), also after adjusting for height as covariate (dominant:  $379.25 \pm 54.26$  vs.  $596.98 \pm 47.82$  cm<sup>3</sup>,  $P < 0.05$ ; non-dominant:  $381.01 \pm 49.29$  vs.  $586.43 \pm 43.44$  cm<sup>3</sup>,  $P < 0.01$ ). The dominant and non-dominant arm had a similar volume of SAT in the TP ( $386.50 \pm 104.53$  vs  $387.32 \pm 97.67$  cm<sup>3</sup>, respectively,  $P = 0.89$ ) and in the CG ( $591.34 \pm 182.49$  vs  $581.52 \pm 162.91$  cm<sup>3</sup>, respectively,  $P = 0.27$ ). Discussion This study shows that tennis playing 5 days per week is associated with lower SAT accumulation in the upper extremities of male preadolescents compared to sedentary controls. Interestingly, this difference (35%) is lower than the observed in the trunk of the same children (54%, unpublished data). Another finding is that in the TP and in the CG the volume of SAT is similar in both arms. References 1. Sanchis-Moysi J, et al. J Sports Med Phys Fitness. 2011;51(3):409-16. 2. Wajchenberg BL. Endocr Rev. 2000;21(6):697-738. 3. Pietrobello A, et al. The invisible fat. Acta Paediatr. 2007;96(454):35-8. 4. Kostek MA, et al. Med Sci Sports Exerc. 2007;39(7):1177-85. 5. Atkinson G, Batterham AM. Int J Sports Med. 2012;33(7):505-6.

## TRUNK SUBCUTANEOUS FAT IN PREPUBESCENT TENNIS PLAYERS AND SEDENTARY CONTROLS: A VOLUMETRIC STUDY USING MRI

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**Introduction.** Childhood obesity is an important public health issue worldwide (1). Tennis may help to reduce fat mass accumulation in children (2). Subcutaneous adipose tissue (SAT) is a component of the fat mass that has a great interest for health (3). Magnetic resonance imaging (MRI) is the gold standard method to determine SAT in children (4). The main aim of this study was to determine if playing tennis at pre-pubertal ages is associated with lower trunk SAT compared to non-active boys. **Methods.** MRI was used to determine SAT in 17 male preadolescents (11.0±0.8 years, Tanner 1–2), not obese and healthy. Seven were tennis players (playing frequency 5 d/w, at least 2 y; TP) and 10 were physically non-active controls (CG). Contiguous MRI images from T3-T4 intervertebral disc to pubic symphysis were used to calculate the volume of trunk SAT (5). Differences between groups were established using ANCOVA, with height as covariate, and Bonferroni-Holm post hoc test. SAT differences between abdominal (L1-L2 intervertebral disc to pubic symphysis) and thoracic sub-regions (T3-T4 to L1-L2 intervertebral discs) were assessed using Student's paired t-tests. Significant differences were assumed when  $P < 0.05$ . **Results** TP and CG had similar age, height, weight and pubertal status ( $P = \text{NS}$ ). Body mass index was lower in TP than in CG ( $17.2 \pm 1.4$  vs.  $19.6 \pm 2.3$ , respectively,  $P < 0.05$ ). TP had lower total trunk, thoracic and abdominal SAT than CG ( $P < 0.05$ ), also after adjusting for height as covariate (Total:  $2046.2 \pm 607.4$  vs.  $4088.0 \pm 508.0$  cm<sup>3</sup>,  $P < 0.05$ ; Abdominal:  $1759.41 \pm 508.30$  vs.  $3419.11 \pm 425.10$  cm<sup>3</sup>,  $P < 0.05$ ; Thoracic:  $286.8 \pm 109.7$  vs.  $668.9 \pm 91.7$  cm<sup>3</sup>,  $P < 0.05$ ). In both groups the abdominal sub-region accumulated more SAT than the thoracic ( $P < 0.05$ ) displaying a similar distribution (86 vs. 14% in TP and 84 vs. 16% in CG, respectively;  $P = \text{NS}$ ). **Discussion** Tennis playing 5 days per week is associated with lower trunk SAT accumulation in male preadolescents compared to sedentary controls, due to lower abdominal (49%) and thoracic SAT (58%). The distribution of SAT between the abdominal and the thoracic sub-region is similar in TP and control children (84-86% greater SAT in the abdominal region). This information could help to promote policies aiming at reducing the prevalence of obesity in children and prevent the associated risks for health. **References** 1. Keke LM, et al. *Rev Epidemiol Sante Publique*. 2015;63(3):173-82. 2. Sanchis-Moysi J, et al. *J Sports Med Phys Fitness*. 2011;51(3):409-16. 3. Winsley RJ, et al. *Acta Paediatr*. 2006;95(11):1435-8. 4. Pietrobelli A, et al. *Acta Paediatr*. 2007;96(454):35-8. 5. Owens S, et al. *Med Sci Sports Exerc*. 1999;31(1):143-8.

## DIFFERENCES IN ANTHROPOMETRIC CHARACTERISTICS BETWEEN CHILDREN SOCCER PLAYERS: TODAY AND EIGHT-TEEN YEARS AGO

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**Introduction** The aim of this study was to determine significant differences in some anthropometric characteristics between children soccer players aged 7-10. Over the last two decades, percentage of overweight and obese children is rapidly growing (Podstawski and Boryslawski, 2012), which made many researchers, doctors and sociologists to feel the need of exploring the various possibilities of preventing this negative tendency, by collecting and analyzing a specific bit of information that aids in understanding growth and maturation. **Methods** This study was conducted on the entity of 150 male subjects aged 7-10 divided into two groups: 90 soccer players measured at present and 60 soccer players measured 18 years ago. A t-test was used for comparison of 9 anthropometric variables: height, weight, BMI, knee diameter, circumference and skin folds of upper and lower leg. **Results** Based on compared data, significant differences ( $p < .01$ ) were found in 8 variables where the group that was measured at 1997 had significantly lower values than group measured at 2015. The only variable that had no significant differences was: lower leg skin fold. **Discussion** It appears that, at present, children spend less time practicing sports or physical activities, while they devote more time to activities such as watching television and playing video games (Vicente-Rodriguez et al., 2003). Sedentary lifestyle and badly programmed diet combined with physical exercise will result in changes of bodily composition (Prskalo et al., 2015.), which will mostly reflect on the quality of life of an individual. The importance of similar research topics (secular, longitudinal studies) has great interests for the global community, all in a cause of understanding variations of population's growth and maturation through time. It is yet to find out if synergy of factors such as nutrition, a specific type of physical activity or sociology-cultural factors has a predictive influence on referent dynamics of growth and maturation. Secular trend in height has stopped in many developed countries while weight has continued to increase (Malina, 2014) resulting in increase in overweight and obese. **References** Malina RM. (2004). *Anthropological Review*, 67, 3-31 Podstawski R, Boryslawski K. (2012). *Clinical Kinesiology*, 66(4), 82-90 Prskalo I, Badric M, Kunjesic M. (2015). *Coll. Anthropol*, 39 Suppl. 1, 21-28 Vicente-Rodriguez G, Jimenez-Ramirez J, Ara I, Serrano-Sanchez JA, Dorado C, Calbet JAL (2003). *Bone*, 33(5), 853-859 Contact gusicmarko@yahoo.com

## EFFECT OF EXPIRATORY MUSCLE STRENGTH TRAINING INTERVENTION ON THE MAXIMUM EXPIRATORY PRESSURE OF PARKINSON DISEASE PATIENTS

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**Introduction** A study asserted that the maximum peak expiratory flow of patients with Parkinson disease(PD) decreased with their decreasing maximum maximum expiratory pressure(PEmax)[1]. A recent study asserted that administering expiratory muscle training (EMST) to patients with PD noticeably improves their swallowing and coughing functions and PEmax [2]. The literature [3] administered a 20-week 75% PEmax intervention to 54 year-old patients with idiopathic PD (Hoehn & Yahr stage 2.5)[4] and confirmed that after 4 weeks and 20 weeks of intervention, the PEmax scores of the patients were improved by 50% and 158%, respectively. Through interventions of various training frequencies, this study investigated the effect of EMST on the expiratory muscular strength of these patients. **Methods** The participants were categorized into Experimental Group A/5DE(5 days/Week, training strength= 75%PEmax, n=4), Experimental Group B/3DE(3 days/week, training strength= 75% PEmax, n=5), and the control group/3DC(3 days/week, training strength= 0% PEmax, n=4). The EMST intervention mainly involved using an expiratory muscle strength trainer. The PEmax measurement method was conducted according to the ATS/ERS (2002). **Results** The PEmax of the 5DE group was significantly higher than that of the 3DC group ( $\eta^2 = 0.64$ ;  $P < .05$ ). Moreover, the posttest PEmax values of the 5DE group and 3DE group were significantly higher than their pretest values (5DE:  $168 \pm 73.48$  cmH<sub>2</sub>O vs  $89.25 \pm 46.67$  cmH<sub>2</sub>O,  $\eta^2 = 0.91$ ; 3DE:  $121 \pm 56.16$  cmH<sub>2</sub>O vs  $75.25 \pm 29.09$  cmH<sub>2</sub>O,  $\eta^2 = 0.73$ ;  $P < .05$ ). However, the pretest and posttest PEmax values of the 3DC group differed nonsignificantly ( $P > .05$ ). **Discussion** The PEmax values of Group A were significantly higher than those of the control group. Moreover, the PEmax values of Group A and Group B significantly increased by 88% and 61%, respectively, indicating that engaging in EMST 5 d/week or 3 d/week facilitates increasing the PEmax value. This result accords



with those of study [5], their results confirmed that the PEmax values of the two groups improved significantly. Several study that administering EMST 5 d/week to healthy but sedentary elderly adults, and patients with spinal injury facilitated improving their expiratory muscular strengths[6]. The study participants with an average Hoehn and Yahr stage of 2.89 and age of 72.78 years[7], which are higher than those of our study. The training strength was set to 5 days per week or 3 days per week, and the training period spanned 4 weeks. The results revealed that the expiratory muscular strength of the patients was significantly improved. References 1.Herer B., et al. (2001) Chest, 119(2), 387-393. 2.Silverman EP., et al. (2006) NeuroRehabilitation, 21(1), 71-79. 3.Saleem AF., et al. (2005) NeuroRehabilitation, 20(4), 323-333. 4.Hoehn MM., Yahr M. (1967) Neurology, 17, 427-442. 5.Anand S., et al. (2012) Am J Speech Lang Pathol, 21, 380-386. 6.Roth EJ., et al. (2010) Arch Phys Med Rehabil, 91(6), 857-861. 7.Pitts T., et al. (2009) Chest, 135(5), 1301-1308. Contact Kuo, Y. C. [yuchi.kuo@gmail.com]

## ARTIFICIAL CO<sub>2</sub>-WATER BATHING IMPROVED MUSCLE FLEXIBILITY AND HARDNESS IN MALE COLLEGE STUDENTS

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**Introduction** Facilitation of the blood supply to the muscle and of oxygen consumption in the muscle by a local immersion of the extremities into high concentration carbon dioxide water (CO<sub>2</sub>-water, CO<sub>2</sub>>1000ppm) (Yamamoto, 2007), suggests an improvement of muscle performance and joints flexibility. In the present study, we investigated the effect of artificially made CO<sub>2</sub>-water immersion on both the flexibility and hardness of the muscles in healthy volunteers. **Methods** Five male healthy students (18-19 yrs, 169.7±2.6cm, 64.5±8.0kg, 15.7±2.9%fat) participated in this study. The subject equipped with probes and electrodes for measurements of the following parameters were immersed up to the xiphoid into CO<sub>2</sub>-water (35 °C, 15 min) or control tap-water (CO<sub>2</sub><20 ppm), or seated in same position in bathtub without water (Air). Blood flow in the immersed skin (BF), external ear cavity temperature (ETemp) and electrocardiogram (ECG) were recorded continuously throughout the experiment. Cardiac autonomic nerve activity was evaluated by power spectrum analysis (PSA) of R-R interval fluctuation in ECG. Muscles hardness (MH, left gastrocnemius dominant), range of motion at left ankle joint (Ankle ROM), sitting trunk flexion (flexibility) were measured before and after three different treatments. **Results** At 15 min of immersion, CO<sub>2</sub>-water decreased heart rate (HR) whereas the other 2 treatments did not. BF was significantly larger in CO<sub>2</sub>-water immersion throughout the recording period compared to the other 2 treatments. Ankle ROM was significantly increased by water immersion irrespective of CO<sub>2</sub>-concentration, whereas Air was not. Improvement of flexibility and decrement of MH were observed only by CO<sub>2</sub>-water treatment. A power ratio, LF(0.04-0.15Hz)/HF(0.2-0.4Hz), in PSA was smaller in CO<sub>2</sub>-water treatment than in tap-water treatment, while HF-power did not change. **Discussion** Our present result supports the previous study showing that LF/HF ratio, an indicator of cardiac sympathetic nerve activity, was smaller in CO<sub>2</sub>-water immersion than in tap-water immersion (Sato, 2009). HR decrease in CO<sub>2</sub>-water immersion also suggests a suppression of sympathetic nervous system. We reported previously that the muscle blood flow in the immersed part was larger in CO<sub>2</sub>-water than tap-water of a same temperature. Muscular sympathetic activity might not be inhibited. Though the underlying mechanism is still unknown, considering effects of CO<sub>2</sub>-water bath on those parameters, i.e. MH and trunk and ankle flexibilities, this water treatment may be useful to preconditioning of muscle and also to recovery from fatigue. **References** Sato, M., et al. (2009). Int J Biometeorol, 53, 25-30. Yamamoto, N., Hashimoto, M. (2007). J Physiol Sci, 57(suppl), S188. Contact yama@rchokkaido-cn.ac.jp

## THE INFLUENCE OF GROUP STAY ACTIVITY ON MORNING BODY TEMPERATURE AND ABILITY TO GET UP AFTER SLEEP IN ELEMENTARY SCHOOL 5TH GRADERS

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**Introduction** Disorder in children's living habits such as 'the child who stays up late' and 'the child who cannot get up in the morning' are concerns in Japan. Under such circumstances, Japanese elementary schools, aiming to rebuild children's lifestyle, have carried out collective accommodation activities such as natural classrooms and open-air schools. Musashino-shi, Tokyo, has been providing population accommodation activities for about one week with a faculty discount rate. While the children are feeling the benefits of these activities, verification of their effects is an issue there. Therefore, the group stay activity in this city does affect the morning body temperature of the child according to this research. **Methods** The target was 532 fifth-year students enrolled in public elementary schools in Musashino-shi, Tokyo. The survey, a self-completed health questionnaire, covered accommodation activity over the previous five days, body temperature at waking up following accommodation activities for seven days, bed time, and a record of factors such as wake time. In the five days before the accommodation activities, children less than 36 degrees C was more than three days were classified as 'hypothermia trend group', children less than 36 degrees C was less than two days were classified as 'standard body temperature group'. And the mean of morning body temperature, bed time and wake-time during all 12 days were calculated. **Results** Morning body temperature, bed time, wake-time 'body temperature group factor,' and changes in the period of time 'period factor' were confirmed through two-way analysis of variance. Significant interactions were observed in all factors. Further, changes in morning body temperature during periods, compared to the standard group body group, the hypothermia trends factor, how will significantly elevated from further Specialty activities Day 3 was confirmed. In addition, the bedtime of the prior hypothermia trend group, wake-time was found to be a late sleep late happened trend as compared to the standard body temperature group. **Discussion** According to Noi et al. (2003), the waking axillary temperature of a hypothermia trend group is less than is 36 degrees C compared to 36 degrees C in the standard body temperature group; it has been reported to peak at a later time. And, Shibata et al. (2011) found the average time of waking up at night with a minimum skin temperature in the low body temperature group to be significantly delayed in the morning compared to the control group. Therefore, it is possible to guess the phase of the preliminary body temperature rhythm to which I was retreating when getting up by the hypothermia tendency group in this research, after the phase of the preliminary body temperature rhythm to which I was retreating moved to a background of a change's in the body temperature being remarkable with stay activity. **References** Noi S et al. (2003) International Journal of Sport and Health Science, 1, 182-187 Shibata M et al.(2011) Japanese Journal of School Health,53,411-418 (in Japanese)

## QUALITY OF LIFE IN THE SUBJECTIVE EVALUATION OF THE ELDERLY IN POLAND

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**Introduction:** Quality of life is a multidimensional concept. Its self-assessment depends on the degree of fulfillment of life goals, health condition, leisure activities, the efficiency of performing daily routines, family and social relationships. All of these factors are influenced by independent variables such as age and gender. The aim of the study was to determine which of the areas of quality of life (somatic,

psychological, social, environmental) has the greatest impact on quality of life self-assessment made by men and women after 50 years of age. Material and methods: The quality of life survey was conducted among 1314 elderly people ( $\geq 50$  years) living in the cities and towns of the region of Lower Silesia (Poland) in 2010-2015. The groups of women ( $n = 988$ ) and men ( $n = 326$ ) were divided into age subgroups: younger (50-65 yrs) and older (65-80 yrs). Quality of life was tested by the short version of WHOQOL. Results: Women estimated their quality of life higher than men. Taking age into consideration, the self-assessment was higher among women of the younger subgroup, while among men the members of the older subgroup rated their quality of life higher. According to the surveyed persons, the factors with significant effect on the quality of life were personal relationships (social domain  $F=8,324$ ,  $p=0,003978$ ), the availability of information in day-to-day life and the acceptance of own physical appearance.

### **MARCHING IN THE RIGHT DIRECTION: REPORTING ON THE BENEFITS OF A HOLISTIC HEALTHY LIFESTYLE INTERVENTION FOR EMIRATI NATIONAL SERVICE RECRUITS.**

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**Introduction** Recent evidence suggests that the rapid rate of urbanisation within the United Arab Emirates (UAE) in recent years has contributed to a less physically active Emirati society, compared to previous generations, and nutrition transitions that are in stark contrast to Bedouin traditions (Ng et al., 2011). This has resulted in increased health related diseases associated with higher overweight and obesity prevalence. Recognising the potential economic cost of supporting a nation that is getting unhealthier and evermore exposed to preventable communicable and non-communicable diseases, the UAE Government has invested heavily into preventative health services that are readily available for UAE Nationals. This study reports initial results of healthy lifestyle interventions carried out as part of the UAE's National Service military training. Methods National Service Recruits (age:  $20.63 \pm 4.57$  yrs, body mass index (BMI):  $28.71 \pm 8.47$  kg•m<sup>-2</sup>,  $n=2846$ ), attending a residential military training camp, participated in a range of health interventions over the course of a 12 week basic training period. These included a calorie controlled menu, individual and group dietetic and weight management clinics, a health education curriculum and ability-specific physical training programmes. Quantitative data were collected at the start (T1) and end (T2) of Phase 1 of National Service Training. Results During the 12 week training period the percentage of recruits with a BMI  $>25.00$  kg•m<sup>-2</sup> ( $n=1764$ ) decreased (T1 61.98 %, T2 50.98%), with weight loss (T1  $100.14 \pm 19.93$ , T2  $88.49 \pm 16.91$  kg;  $t=100.91$ ,  $P<.001$ ) and waist circumference reductions (T1  $105.61 \pm 14.95$ , T2  $92.97 \pm 13.52$  cm;  $t=71.25$ ,  $P<.001$ ). Health knowledge improved ( $53.05\% \pm 1.06$ ;  $t=56.48$ ,  $P<.001$ ). Overall, physical fitness improved: one mile run time decreased (T1  $11:53 \pm 03:13$ , T2  $10:45 \pm 02:27$  min:ss;  $P<.001$ ); push-ups increased (T1  $17.34 \pm 11.78$ , T2  $23.35 \pm 12.37$  reps•min;  $P<.001$ ); sit ups increased (T1  $24.47 \pm 9.70$ , T2  $28.66 \pm 9.55$  reps•min;  $P<.001$ ); and squats (T1  $31.11 \pm 13.25$ , T2  $37.71 \pm 12.98$  reps•min;  $t=26.55$ ,  $P<.001$ ). In addition, overall physical fitness of obese (BMI  $>30.00$  kg•m<sup>-2</sup>;  $n=368$ ) recruits improved: predicted VO<sub>2</sub> increased (T1  $26.50 \pm 9.40$ , T2  $34.38 \pm 10.15$  mL/kg•min;  $P<.001$ ); push-ups increased (T1  $6.45 \pm 6.43$ , T2  $9.22 \pm 7.99$ ;  $P<.001$ ); sit ups increased (T1  $16.29 \pm 7.61$ , T2  $18.56 \pm 7.76$ ;  $P<.001$ ); and squats increased (T1  $21.75 \pm 10.38$ , T2  $26.21 \pm 11.47$ ;  $P<.001$ ). Conclusion Significant health knowledge improvements were reported over the intervention period, coinciding with favourable changes in fitness and body measures. A limitation was the relatively short duration of the healthy lifestyle intervention. For longer-lasting improvements, ongoing research is needed in order to follow-up the recruits' health and fitness status to determine whether lifestyle changes are being maintained. References Ng, Shu Wen, et al. 'Nutrition transition in the United Arab Emirates.' European journal of clinical nutrition 65.12 (2011): 1328-1337. Contact ramzy.ross@3ds.ae

### **DESCRIPTIVE EPIDEMIOLOGY OF PHYSICAL ACTIVITY, BODY COMPOSITION AND QUALITY OF LIFE AMONG BRAZILIAN MILITARY POLICE OFFICERS**

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**Introduction** Policing has been recognized as a hazardous occupation associated with intense physical and psychological demands. Obesity and physical inactivity rates are rising among police officers, however little is known about their association with quality of life in this population. Objectives: We aim to evaluate the association between physical activity level (PAL) and body composition (BC) with the quality of life (QOL) among Brazilian military police officers. Methods We conducted a cross-sectional study among 418 volunteers (88.3% men), recruited from 12 out of 14 police departments of a northern state of Brazil. PAL was evaluated by the IPAQ-questionnaire, categorizing volunteers as active (AT:  $\geq 150$  min/w) or insufficiently active (IA:  $<150$  min/w), and by the total accumulated METs per week. BC was estimated by BMI and obesity was defined as BMI  $\geq 30$  kg/m<sup>2</sup>. QOL was evaluated by the WHOQOL questionnaire in a scale of 0 (worst) to 100 (best) score, among 4 domains: physical (PHD), psychological (PSD), social relationships (SRD) and environment (EVD). Descriptive statistics were calculated and t-test was used for group comparison, at the 5% level of significance. Results Mean age and BMI were  $38.6 \pm 6.6$  yrs and  $26.5 \pm 3.4$  kg/m<sup>2</sup>. 44.3% of police officers were IA and 16.3% were obese. Obese officers had only about one half of the physical activity performed by the non-obese ones ( $867 \pm 820$  vs  $1582 \pm 1221$  METs/w;  $p<.001$ ). Mean QOL was  $67 \pm 16$  for PHD,  $72 \pm 13$  for PSD,  $74 \pm 15$  for SRD and  $59 \pm 14$  for EVD. IA officers showed lower QOL for PHD (-8.6%), PSD (-5.4%) and EVD (-6.7%) ( $p<.02$ ), as compared to the active ones. QOL among men was lower for PHD (-9.5%) and EVD (-8.0%), as compared to women ( $p<.001$ ). There were no differences on QOL between obese and non-obese. Discussion Even though prevalence of obesity was similar to the general population in the same region and year (16.3% vs 16.8%), the proportion of IA officers was lower (44.3% vs 51.1%) (Brazil, 2013), as were the QOL of the IA subgroup and the male officers. Future research is needed to investigate determinants of QOL among male and IA officers and on specific strategies to promote physical activity in obese police officers. References Brazil. Vigitel 2013. Risk Factors Surveillance and Chronic Disease Protection through Phone Survey (VIGITEL). Available at [http://bvsms.saude.gov.br/bvs/publicacoes/vigitel\\_brasil\\_2013](http://bvsms.saude.gov.br/bvs/publicacoes/vigitel_brasil_2013) Contact welere@gmail.com

### **STAIR DESCENDING EXERCISE INDUCED PHYSIOLOGICAL BUT NOT BIOCHEMICAL ADAPTATIONS IN ELDERLY MALES WITH CHRONIC CORONARY ARTERY DISEASE**

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**Introduction** Mean life expectancy has increased dramatically during the twentieth century, and it is expected that it will continue to increase. What will be the quality of these additional years of life? Today, older individuals can gain a lot by keeping their muscle strength

and functional performance through physical activity. Thus, is more urgent than ever the development of new methods and training regimes. It is important for modern exercise types to be easier to be performed than traditional exercise modes and more importantly to exert favorable effects on human health and performance. Methods Participants were allocated into: a stair descending group ( $n = 10$ , age  $67.5 \pm 1.3$  yr, mean  $\pm$  SEM) and a stair ascending group ( $n = 10$ , age  $65.6 \pm 2.2$  yr). Participants performed an acute bout of stair descending or stair ascending exercise (bout 1) on an automatic escalator (4 sets of 3 min each, speed was set at 45 steps·min<sup>-1</sup>, in total 540 steps for both groups). Before and at day 2 post exercise, physiologic measurements were performed and blood samples were collected for the measurement of blood lipids. Then, participants carried out eight weeks of stair descending or ascending training consisting of three exercise sessions per week. Afterward, they repeated the acute stair descending or ascending protocol (bout 2), as carried out at the beginning of the study, and the same physiologic and biochemical measurements were performed. A three-factor ANOVA (group  $\times$  bout of exercise  $\times$  time) was used to analyse muscle function and blood lipids profile. Results On the basis of the evidence derived from the present study, stair descending exercise markedly increased muscle strength and performance after eight weeks of stair descending exercise. Moreover, it was found that the first bout of stair descending exercise caused muscle damage, insulin resistance and affected positively TG and TC concentration; however, after the second bout the alterations in all parameters were diminished. Discussion Although we failed to find any effect of 8 weeks of stair descending exercise on blood lipids, stairs descending exercise increased muscle strength. Maintaining muscle strength in the elderly is of great importance so that individuals can function more readily in daily life activities. Furthermore, the fairly light intensity and metabolic cost of stair descending exercise and the short duration of each exercise session, are potentially important practical advantages of this type of exercise. Particularly, in individuals with restricted physical ability such as elderly and CAD patients where high metabolic demand of exercise is not desired.

### IMPROVEMENT OF ANIOXIDANT CAPACITY IN PRE-DIABETIC MEN AFTER ECCENTRIC HYPOXIC EXERCISE TRAINING

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**Introduction** Oxidative stress might be linked to the development of diabetes mellitus (DM) (Rani et al., 2016). Eccentric exercise training was shown to decrease insulin resistance (Paschalis et al., 2011) and enhance anti-oxidative capacity (Child et al., 1999). Additionally, hypoxia increases reactive oxygen species and might also lead to specific redox adaptations (Bailey et al., 2001a). Thus, we aimed to investigate the effects of 3 weeks of eccentric hypoxic exercise on oxidative stress and antioxidant levels in pre-diabetic men. **Methods** Six pre-diabetic men (age: 51-67 years) not habituated to eccentric exercise and without altitude exposure ( $> 1500$  meters) for 2 months prior to the start of the study were included. Participants performed 3 weekly downhill walking sessions down from an altitude of 2500 m to 2000 m for 3 weeks. Blood samples were taken before the first exercise session, immediately after the first session, during the third training week and 24 hours after the last training session. From the blood samples the reactive oxidative metabolites (dROMs) and the biological antioxidant activity of plasma (BAP) were determined using the Free Carpe Diem device (FREE® Carpe Diem; Diacron International, Italy). Results dROMs after the first training session were significantly higher compared to pre-exercise (9.73%,  $p = 0.027$ ). BAP levels were significantly increased after the first training session, during the third training week, and 24 hours after the last training session compared to pre-training (55.64%, 72.77%, and 81.76%). **Discussion** The demonstrated increases in the antioxidant capacity may have developed under conditions of higher oxidative stress (Savu et al., 2012). Since oxidative stress was elevated even after the first training session, the higher antioxidant capacity after 3 weeks of downhill in hypoxia might be considered as specific adaptation to repeated increases in oxidative stress levels (Dillard et al., 1978; Askew, 2002). Therefore, eccentric hypoxic exercise training might have preventive effects in patients suffering from pre-diabetes. **References** Askew EW. (2002). *Toxicology*, 180, 107-19. Bailey DM, Davies B, Young IS. (2001a). *Clin Sci*, 101, 465-475. Child R, Brown S, Day S, Donnelly A, Roper H, Saxton J. (1999). *Clin Sci*, 96, 105-15. Dillard CJ, Litov RE, Savin WM, Dumelin EE, Tappel AL. (1978). *J Appl Physiol Respir Environ Exerc Physiol*, 45, 927-32. Paschalis V, Nikolaidis MG, Theodorou AA, Panayiotou G, Fatouros IG, Koutedakis Y, Jamurtas AZ. (2011). *Med Sci Sports Exerc*, 43, 64-73. Rani V, Deep G, Singh RK, Palte K, Yadav UC. (2016). *Life Sci. Savu O, Ionescu-Tirgoviste C, Atanasiu V, Gaman L, Papacoea R, Stoian I. (2012). J Int Med Res*, 40, 709-16. Contact Kultida.Klarod@student.uibk.ac.at

### THE EFFECT OF SLEEP ON RECOVERY FROM CENTRAL FATIGUE

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**Introduction** For all athletes, sleep is crucial for recovery from peripheral and central fatigue. Although there have been many reports on the effect of sleep on recovery from fatigue, it is unclear that the precise relationships between sleep and recovery from central fatigue resulting muscle contraction. Furthermore, it remains uncertain whether the quality of nocturnal sleep promotes recovery from central fatigue. The interpolated twitch technique (ITT) is widely used to assess voluntary activation (VA) of skeletal muscles (Merton, 1954). In addition, the reduction of VA in maximal efforts is the sign of central fatigue (Gandevia, 2001). The purpose of this study, therefore, is to investigate the effect of nocturnal sleep on recovery from central fatigue, using ITT and polysomnogram (PSG). **Methods** Healthy young adults who did not have sleep problem were recruited. They participated in three experimental conditions in random order: sleep (0%), partial sleep deprivation (50%) and total sleep deprivation (100%) conditions. They performed isometric maximum voluntary contraction of elbow flexor muscles for assessing VA using ITT before and after each condition. PSG including electroencephalogram, electro-oculogram, electromyogram, and heart rate were recorded during the nocturnal sleep. In addition to ITT and PSG, subjective fatigue and sleep index were measured using visual analogue scale (VAS) and Stanford Sleepiness Scale (SSS). **Results and Discussion** There were certain differences in VA, VAS and SSS between conditions. Furthermore, the results show that there were positive relationship between sleep variables and fatigue index. In conclusion, the present study revealed that nocturnal sleep plays an important role in the recovery from central fatigue for assessing ITT. **References** Merton PA. (1954). Voluntary strength and fatigue. *J Physiol*, 123, pp. 553-564. Gandevia SC. (2001). Spinal and supraspinal factors in human muscle fatigue. *Physiol Rev*, 81(4), pp. 1725-1789.

### A POSSIBILITY TO PROMOTE THE PHYSICAL RECOVERY BY SLEEP AFTER CO<sub>2</sub>-WATER BATHING IN ATHLETES

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**Introduction** The bathing and sleep processes in physical recovery play an important role in human. Sleep is homeostatically controlled and, after a prolonged period of stress, we recognize importance of the sleep. Exercise load and sleep deprivation (SD) results in an increase in sleep, indicating that sleep is tightly maintained at a restricted level (Borbely and Achermann, 1999). It has recently been reported that SD induces the expression of heat shock protein (HSP) family members (Terao et al., 2003). HSPs are an important family of endogenous protective proteins that are induced in response to a wide variety of stresses, such as heat shock, hypoxia, hydrogen peroxide, inflammation, ischemia (Jaattela, 1999) and exercise load. The purpose of this study is to examine the physical recovery by sleep after CO<sub>2</sub>-water bathing in athletes. **Methods** Eight healthy college athletes participated in this study. The subjects were taken two different types of bathing; tap-water bathing and CO<sub>2</sub>-water bathing. The water temperature of both bathing was 38 degrees Celsius. The subjects were attached to surface electrodes on their forehead to record an EEG. To measure the sleep-wake cycle, accelerometers (Lifecorder GS, SUZUKEN, Japan) was used. The sleep - wake data were analyzed by circadian rhythm analysis software (SleepSign Act, KISSEI COMTEC, Japan). SpO<sub>2</sub> and body movement and pulse were measured by means of near-infrared spectroscopy (PulseWatch PMP-200, Pacific Medico, Japan). Sleep variables analyzed time in bed (TIB), sleep period time (SPT), total sleep time (TST), wake time after sleep onset (WASO), sleep efficiency (SE), sleep latency (SL), time of sleep onset, time of wake onset, and bed out latency (BOL). **Results and discussion** SL was significantly shorter ( $p < 0.05$ ) in CO<sub>2</sub>-water bathing than that in tap-water bathing. SE was significantly higher ( $p < 0.05$ ) in CO<sub>2</sub>-water bathing than that in tap-water bathing. During sleep of the single night, the delta wave incidence of EEG appeared more in the sleep after CO<sub>2</sub>-water bathing. Therefore, these results suggest that as CO<sub>2</sub>-water bathing could raise body core temperature enough, this hyperthermia may cause a deep sleep. **Conclusions** Sleep is homeostatically controlled, and indeed, an increase in the NREM sleep is typically observed after CO<sub>2</sub>-water bathing in comparison to tap-water bathing. The sleep after the CO<sub>2</sub>-water bathing seems to be extremely useful in the physical recovery from fatigue. **References** Borbely AA, Achermann P. (1999). *J Biol Rhythms*, 14, 557-568. Terao A, et al. (2003). *Neuroscience*, 116, 187-200. Jaattela M. (1999). *Ann Med*, 31, 261-271. Contact twada@kokushikan.ac.jp

### THE USE EMG AND MRI TO EVALUATE CORE STRENGTHENING PROGRAM

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**THE USE EMG AND MRI TO EVALUATE CORE STRENGTHENING PROGRAM** **Introduction** The curl - up exercise is advised both in prevention and treatment of the LBP. Compared to other core stability exercises, curl-up provides lower compressive loads for a given muscle challenge (Axler and McGill, 1997). The main aim, of the presented study, was the evaluation of the curl-up exercise based training on the electrical activity, surface, circumference and thickness of the spine stabilization muscles. The question that we aim to answer is this: does the curl-up based training, with own body mass load, improves local muscle strength or local muscle endurance? **Methods** The exercises were performed during 4 weeks. The experiment participant was training 3 times per week (Monday, Wednesday, Friday), under a personal trainer's supervision. In the first week, the training comprised of 10 repetitions, in the second 20, in the third 30 and finally, in the 4 week 40 repetitions during one series. Before and after each training session, an MVC measurement, of the following muscles, was taken: rectus abdominus (RA), external oblique (OIE) and erector spinae (ES). In order to evaluate training effectiveness MRI was used too. The following geometric parameters were measured and calculated: cross sectional area - CSA, muscle thickness of the right and left sides of the following muscles: rectus abdominus (RA), anterolateral abdominal (LABD), psoas major (PS), quadratus lumborum (QL), lumbar erector spinae (ES), multifidus (MF) **Results** A statistically significant increase in the amplitude of the EMG was found only for the upper part of the m.RA. The effects training program on the morphology of muscles was assessment using MRI method. Cross sectional area of all the muscles, except QL changed significantly. Training has also changed the surface RA (right side), IABD and ES (left side). The thickness of the muscle OAE and OAI increased after training on both sides of the body and TA only on the left side. All MRI parameters had shown symmetry. The EMG activity asymmetry, of the ES muscle, persisted after 4 weeks of training; however it was not statistically important. On the other hand, the statistically unimportant asymmetry of the lower RA, after 4 weeks of training, became statistically significant. **Discussion** Our studies show that the own load curl up exercise increases muscle endurance not the local muscle strength. Enhancing lumbar stability by increasing local muscle endurance instead of local muscle strength is the safest and most justifiable approach. Therefore, this exercise is suitable for both the healthy patients and those suffering from LBP. Exercise curl-up can be performed either by people with LBP and healthy people because it can be modified so that it may be small, medium and large load on the muscles stabilizing the spine (Rutkowska-Kucharska and Szpala, 2015). **References** Axler CT, McGill SM. (1997) *Med Sci Sport Exer*, 26, 804-811. Rutkowska-Kucharska A, (2015) *Biomed Hum Kinetics*, 7, 16-22 Do not insert authors here

### CONFIRMATION REGARDING RELATIONAL CONSTRUCTION OF BODY COMPOSITION AND BMI IN PRESCHOOL CHILDREN.

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**CONFIRMATION REGARDING RELATIONAL CONSTRUCTION OF BODY COMPOSITION AND BMI IN PRESCHOOL CHILDREN.** Sakai, T.1, Fujii, K.2, Watanabe, T.3, Tanaka, H.4 1: College of Life and Health Sciences, Chubu University, Aichi, Japan 2: AIT (Graduate School of Business administration and Computer Science, Aichi Institute of Technology, Toyota, Japan) 3: Junior College Division, The University of Aizu, Fukushima, Japan 4: Faculty of Sociology, Ryutsu Keizai University, Ibaraki, Japan **Introduction** Obesity is a state wherein body fat accumulates to an abnormal degree, and detailed information about body composition is necessary to inspect the problems of obesity in children. In the present study, we measure body composition with machinery which can measure lean body mass in addition to a quantity of fat based on the multi-frequency BI (bioelectrical impedance analysis) method. This examines differences in body composition for preschool children, including differences according to sex, and correlates them within the measured values of BMI. **Methods** The subjects were 533 preschool children, comprising 260 boys and 273 girls. Body composition was measured using the body composition analyzer (MC-190EM, Tanita Corp., Japan). Statistical values for physique and body composition were calculated according to gender and age. In each age group of boys and girls, a regression analysis of %Fat for BMI was performed, after drawing regression polynomials from the first to the third order, a regression polynomial of a proper order was determined. With a similar method to that of measuring fat per-



centage, a regression polynomial of a proper order for muscle percentage was determined for each age group of boys and girls. Results There were no significant gender differences among each of the age groups in weight, however, significant differences were found in height within the 4-year-old age group (boys > girls). The fat percentages for girls were higher than boys, and the muscle percentages were the opposite. These results show that there were differences according to sex. We made our evaluations based on a regression analysis of fat percentages for BMI and muscle percentages. As a result, a high correlation was found between BMI and fat percentages in boys and girls. The relation of BMI and muscle percentages was the opposite of the relation of BMI to fat percentages, and we found a high negative relation between boys and girls. Discussion A significant regression tendency was confirmed from the present results of the regression analysis of fat and muscle percentages for BMI for preschool children. This suggests that BMI can also be used to evaluate the fatness or thinness of a preschool child. In short, BMI can be regarded as the index that can evaluate fat and muscle percentages from early childhood. References Fujii K and Sakai T (2009) Consideration of the canalization effect based on physical factors of mothers and their children. - Physical factors of mothers related to physical growth in young children. Sport Sciences for Health 5: 1-7 Contact : sakai@hgu.ac.jp

## REGULATION OF EXERCISE INTENSITY BASED UPON HEART RATE IN ENDURANCE SPORTS – EVALUATION OF TRAINING PRESCRIPTIONS BY THE AMERICAN COLLEGE OF SPORTS MEDICINE

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Physical inactivity and a sedentary lifestyle are becoming more and more important as risk factors for metabolic and civilization diseases. When it comes to prevent or counteract accompanying adverse effects, advice on the amount of time spent with physical activity and sport per week are highly dependent on the chosen training intensity. Numerous studies tried to deduce intensity recommendations for the use in cardiorespiratory endurance training in the general population. In this respect, the American College of Sports Medicine (ACSM) recommends the use of 60-80% heart rate reserve as optimal training intensity for healthy adult recreational athletes. Since these recommendations are based on findings derived from incremental test protocols, the purpose of this study was to evaluate the prescribed intensities in continuous endurance tests. Therefore, 7 non-endurance athletes without previous cardiovascular or pulmonary disease (2 male and 5 female; age:  $49.4 \pm 5.1$  years; body mass:  $71.0 \pm 11.2$  kg; height:  $1.71 \pm 0.08$  m; BMI:  $24.2 \pm 2.4$  kg/m<sup>2</sup>; HRR<sub>rest</sub>:  $64.1 \pm 5.2$  bpm) participated in three continuous endurance tests on a cycle ergometer at 50%HRR, 60%HRR and 70%HRR for 35 minutes and an incremental test to determine the individual anaerobic threshold (iAnT) of each subject. During the continuous protocols heart rate was held constant after a 15minute warm-up throughout the whole test by regulating resistance. Peripheral blood lactate was collected from the earlobe to determine submaximal load. Starting load and extent of increase every 3 minutes in the incremental protocol were based on the anticipated iAnT. The individual HRR was calculated using a modified Karvonen-formula. The watt-values as well as the lactate-values detected in the continuous tests were compared to those elicited by the incremental protocol. Mean values in the continuous tests were  $74.3 \pm 33.6$  watt (50%HRR),  $90.5 \pm 31.5$  watt (60%HRR) and  $97.9 \pm 35.1$  watt (70%HRR) for performance output, respectively. Mean lactate values were  $1.39 \pm 0.6$  mmol/l,  $1.96 \pm 0.83$  mmol/l and  $2.53 \pm 0.87$  mmol/l, respectively. Mean values in the incremental tests were  $1.49 \pm 0.33$  mmol/l for lactate at the individual aerobic threshold (iAeT),  $2.99 \pm 0.33$  mmol/l for lactate at iAnT,  $88.6 \pm 29.8$  watt at iAeT and  $125.8 \pm 32.6$  watt at iAnT. The results support the recommendations of the ACSM, whereat exercising at 60%HRR seems to be a light endurance training at the iAeT whereas training at 70%HRR leads to a moderate strain. For high intensity endurance training, adult recreational athletes should consider loads that elicit a HRR far beyond 70%. Further studies are needed that fortify these findings in larger cohorts.

## PHYSICAL ACTIVITY DID NOT ALTER WEIGHT LOSS AND BODY COMPOSITION OF WOMEN AFTER 6 MONTHS OF BARIATRIC SURGERY

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PHYSICAL ACTIVITY DID NOT ALTER WEIGHT LOSS AND BODY COMPOSITION OF WOMEN AFTER 6 MONTHS OF BARIATRIC SURGERY Simões, R.A.1, Pessotti, E.R.1, Ravelli, M.N.2, Crisp, A.H.2, Rasera-Jr, I.1, Oliveira, M.R.M.3 1: Bariatric Clinic of Piracicaba, 2: FCFAR-UNESP, 3: IBB-UNESP Introduction Bariatric Surgery is most effective long term treatment for severe obesity. Exercises after surgery may improve physical fitness and additional metabolic benefits. However, there is a lack of consensus on performing physical activity (PA) in the postoperative and its effects on weight loss process and body composition. Methods Forty one women were divided into 2 groups: Exercise (EX; n=22); 113,9Kg(11,6); 161cm(4,9); 34,2y(6,7); Sedentary (ST; n=19); 111,1Kg(11,5); 160cm (4,7); 35,5y(8,6). All patients underwent gastric bypass Y-Roux (BGYR) without silastic band and made anthropometric measurements by bioimpedance analysis (Biospace, InBody 230®) before (T0) and 6 months after BGYR (T6), following the instructions established by the manufacturer. Were accessed: body weight (BW), body fat, lean mass and body water. At T6 were calculated for EX and ST in absolute and relative to the initial BW: weight loss; body fat loss, lean mass loss, body water loss. Patients were instructed to follow a postoperative diet and 2 months after BGYR EX were encouraged to do PA. EX and ST returned to the clinic monthly for nutritional monitoring and to respond to the questionnaires of PA. Normal distribution of the data was checked and the comparison between the variables used Student's t-test. Results EX performed aerobic PA (60min/ 3x wk). Any significant difference (p>0,05) between EX and ST at T0 and T6 was found. All anthropometrics measurements decreased significantly T0 and T6 for both groups. Discussion There are two key issues regarding PA after BGYR and anthropometric changes: the possibility to accelerate or increase weight loss (Egberts et al, 2012) and extending the loss of muscle mass due to greater energy expenditure under severe caloric restriction (Auclair et al, 2016). The data presented here do not support none of the hypotheses showing any anthropometric difference between women engaged in PA and sedentary 6 months after surgery. One possible explanation is that the effects of bariatric surgery on weight loss and lean mass loss are quite relevant and the practice of PA is not enough to change or deepen this situation (Coen; Goodpaster, 2015). References Egberts K, Brown WA, Brennan, L, O'Brien PE (2012). Does Exercise Improve Weight Loss after Bariatric Surgery? A Systematic Review. OBES SURG 22:335-341. Auclair A et al. (2016). Impact of a 12-Weeks Supervised Physical Activity Program After Bariatric Surgery on Body Composition and on Abdominal and Mid-Thigh Body Fat Distribution Changes; a Randomized Study. Circulation 131: AMP94 Coen PM, Goodpaster BH (2015). A role for exercise after bariatric surgery? Diabetes Obes Metab 18(1):16-23 Contact: aspone@hotmail.com

## ADAPTATIONS IN MUSCLE MASS AND MOTOR FUNCTION DURING RESISTANCE TRAINING WITH ELASTIC BANDS AT DIFFERENT INTENSITIES IN OLDER ADULTS

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1: University of Valencia (Valencia, Spain), 2: Clinical Analysis, University Hospital Dr. Peset, (Valencia, Spain), 3: Physiology Department, University of Valencia (Valencia, Spain). Introduction Resistance training (RT) is an intervention frequently used to improve muscle strength and body composition in older adults (OA) (Chodzko-Zajko et al., 2009). Despite this, there is a lack of knowledge on how elastic resistance training (ERT) affects the muscle mass (MM) and motor function (MF) in this population. The purpose of this study was to determine the effects of ERT at different intensities on MM and MF in OA. Methods 121 OA (70.07 ± 5.12 years) were randomized into three groups: Control Group (CG) (n=45); High Intensity Group (HIG) (n=39); and Moderate Intensity Group (MIG) (n=37). A 16 weeks (WK) elastic resistance training (ERT) (TheraBand) program twice a WK was applied with 6 exercises. HIG were performed with 6 repetitions (REP) while MIG with 15 REP and both at intensity of 6-7 on the OMNI-RES perceived exertion for the first 4 WK and 8-9 the next 12. Total, upper, lower limbs MM and isometric strength (IS) were measured. Nonparametric tests were performed. Results The results showed significant improved in HIG and MIG respectively, comparing pre and post-training in total MM (+1.73 and +1.55%), upper limbs MM (+6.35 and +4.75%) and lower limbs MM (+2.99 and 2.64%). Regarding IS, HIG and MIG had significant improvements in vertical rowing (+38.71 and +46.19%, respectively) and horizontal leg press (+52.82 and 73.07%, respectively). Analysis between groups showed no significant effects. Discussion Our results could indicate that variables of prescription applied are not enough stimuli to provoke significant effects between intensities in OA and agree with previous studies (Borde R, Hortobágyi T, Granacher U, 2015; Martins et al., 2015). ERT are an effective method for improving MM and MF in OA but more research is necessary to identify the effect of different intensities in middle and long programs. References Borde R, Hortobágyi T, Granacher U. (2015). Dose-Response Relationships of Resistance Training in Healthy Old Adults: A Systematic Review and Meta-Analysis, *Sport Med*, 45(12), 1693-1720. Chodzko-Zajko WJ, Proctor DN, Fiatarone Singh MA, Minson CT, Nigg CR, Salem GJ, Skinner JS. (2009). American College of Sports Medicine position stand. Exercise and physical activity for older adults. *Med Sci Sports Exerc*, 41(7),1510-1530. Martins WR, Safons MP, Bottaro M, Blasczyk JC, Diniz LR, Fonseca RM, Bonini-Rocha AC, Oliveira RJ. (2015). Effects of short term elastic resistance training on muscle mass and strength in untrained older adults: a randomized clinical trial. *BMC Geriatrics*, 12, 15-99. Contact: pedro11gb@gmail.com

## THE RELATIONSHIP BETWEEN AMOUNT OF PHYSICAL ACTIVITY AND SLEEP HABITS IN UNIVERSITY STUDENTS

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Introduction It has been reported that people having some sleep problems is about 13% in Japan (Ministry of Health, Labour and Welfare, Japan, 2011). In addition, people who feel daytime sleepiness were 37.7% in male and 43.0% in female (Ministry of Health, Labour and Welfare, Japan, 2013). However, it has been reported that increased amount of physical activity improved sleep quality (King et al., 1997). On the other hand, it has also been reported that Japanese students had shorter sleep hours than the other countries (Steptoe A et al., 2006). The purpose of this study is to examine the relationship between amount of physical activity and sleep habits in university students. Methods Subjects in this study were 1,741 university students with a mean age of 19.9±1.4 (±SD). We carried out a questionnaire from November to December 2011 and 2012. The questionnaire was composed of personal profiles, Life-style, including physical activity and sleep habits. In this study, it was classified people performing habitual physical activity into three levels by physical activity minutes per week; under 120 minutes (under 120), under 600 minutes (under 600) and over 600 minutes (over 600). Sleep quality was assessed by Japanese version of Pittsburgh Sleep Quality Index (PSQI-J). Lower sleep quality was assessed by using a cutoff total score point of >5.5. Daytime sleepiness also was assessed by Japanese version of Epworth Sleepiness Scale (JESS). Statistical analysis used SPSS ver.21.0. Statistical analysis used by analysis of variance,  $\chi^2$  test, Mann-Whitney U-test and correlative analysis and multiple. Results The amount of physical activity divided into four categories, those were non-habitual, under 120, under 600 and over 600 minutes per week. We compared with those four categories for male and female respectively. Compared with four categories, ratio of non-habitual students increased according to grade year rises in male and female. In male, there were significant differences in weight, BMI and points of JESS. The under 120 was lower than the other categories in the points of JESS. The under 120 group had a tendency to later the time of getting up than the other categories. In female, the over 600 was significantly shorter than the other categories in hours to fall asleep. Discussion It became clear that there were differences of male and female in the relationship between amount of physical activity and sleep habits. In female, increased amount of physical activity improved sleep latency, but not improved in male. In male, increased amount of physical activity increased daytime sleepiness because of earlier getting up time in the morning. It was suggested that the amount of physical activity was not necessarily related to sleep quality in university students. Acknowledgment This study was supported by grant from Grants-in Aid for Scientific Research (C), (JSPS KAKENHI Grant Number 23601021), 2011-2013. Contact Please contact to SASAKI Hiroko lhiros22@hokusho-u.ac.jp

## EFFECTS OF GROUP EXERCISE CLASS FOR REGIONAL ELDER PEOPLE HELD AT THE UNIVERSITY ON FUNCTIONAL FITNESS AND HEALTH-RELATED QUALITY OF LIFE

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Purpose The purpose of this study was to investigate the effect of regional elder people on functional fitness and health-related quality of life (HRQOL) in group exercise classes held at the university. Methods Twenty-nine healthy people (age; 69.0±3.4 years, men; n=13, age; 70.2±2.6, female; n=16, age; 68.0±3.6 years) volunteered to participate in this study. Subjects participated in 8-week group exercise class (90min./d, 2times/week, total 16 sessions). This exercise program consisted of 15 min. of warm-up and stretching, 20 min. of resistance exercise, 10 min. of step exercise, 20 min. of endurance-type exercise (walking), 20 min. of ball exercise (recreation), and 5 min. of cooling down. All exercise session was led by trained fitness instructors and supervised by the researchers. After the every exercise session, subjects were recorded Borg scale. Before (pre-) and after (post-) the group exercise classes, the following physical performances were measured; hand grip strength (HG), chair stand (CS), arm curl (AC), sit-up (SU), timed up & go (TUG), sit & reach (SR), back scratch (BS), functional reach (FR), 10-m walking (10-mWK), 10-m obstacle walking (10-mOWK) and 6-min walking (6-MW). In addition, blood pressure, brachial-ankle pulse wave velocity (baPWV), body composition, blood property, and 36-Item Short Form Survey (SF-36) were measured before and after the course. Results Participation rate of the group exercise class was 88.3±8.9%. Borg scale in the exercise class was

11.7±0.3. Although there were not significantly changed in body weight, %fat, fat, and lean body mass, waist circumference significantly decreased from pre to post exercise class ( $p<0.05$ ). Total cholesterol ( $p<0.001$ ), low-density lipoprotein cholesterol ( $p<0.01$ ), and triglyceride ( $p<0.001$ ) were significantly decreased after the exercise. Systolic blood pressure and baPWV was significantly decreased after the exercise ( $p<0.05$ ). Additionally, HG, CS, AC, SU, SR, BS, and 6-MW were significantly increased after exercise class. Time of TUG, 10-mWK, and 10-mOWK were significantly decreased after exercise class. On the other hand, FR was not significantly changed from pre to post exercise class. Physical functioning, vitality, and mental health in SF-36 were also significantly increased after the course. Conclusion In conclusion, this study demonstrated that group exercise classes for elder people living in that region provides improvement of functional fitness and HRQOL. References 1) Helbostad, J. L., Sletvold, O., Moe-Nilssen, R., Effects of home exercises and group training on functional abilities in home-dwelling older persons with mobility and balance problems. A randomized study. *Aging Clinical and Experimental Research*, 16(2) : 113-121, 2004 2) Olivares, P. R., Gusi, N., Prieto, J., Hernandez-Mocholi, M. A., Fitness and health-related quality of life dimensions in community-dwelling middle aged and older adults. *Health Qual Life Outcomes*, 9 : 117, 2011

### COULD CURIOSITY TRIGGER WELL-BEING THROUGH SPORT EVENT?

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**Introduction** While most studies have examined the factors to motivate or influence fans behavior relate to sport, only a few research has investigated what antecedents initially attract people to consume sport and further shift a nonfan to a loyal fan (Park, Mahony, & Kim., 2011). Accordingly, This study focus on sport fan curiosity as the antecedent of satisfaction with event and psychological well-being. **Methods** Data was collected from spectators participating in a quasi-professional volleyball game held in Taiwan. During the first wave of survey, 204 completed questionnaires were returned with a response rate of 85%. After game was over, a follow-up online questionnaire with the satisfaction-with-event and psychological well-being measures was delivered to the participants at first-wave by e-mail. The final respondent consisted of 172 spectators (97 female) with a mean age of 21.85 years ( $SD = 5.30$ ). **Results** As the result presented, SPFECS had a significant association with SWE (a path;  $B = .17$ ,  $SE = .08$ ,  $t = 2.22$ ,  $p < .05$ ), supporting Hypothesis 1. In Hypothesis 2, we suggest that SWE positively associates with the change in PEAQ. Result showed that SWE had a significant relation with the change in PEAQ. (b path;  $B = .43$ ,  $SE = .06$ ,  $t = 7.21$ ,  $p < .01$ ). Thus, the Hypothesis 2 was supported. Finally, we propose the positive relation between SFECS and the change in PEAQ would be mediated by SWE. Supporting Hypothesis 3, we found that SFECS had a significant and positive indirect effect on the change in PEAQ (c path;  $B = .14$ ,  $SE = .07$ ,  $t = 2.14$ ,  $p < .05$ ). **Discussion** Supporting the proposed model, results of the study showed that sport fan curiosity has a positive association with satisfaction with event, which in turn enhanced psychological well-being. The study provided reliable evidence to contribute our knowledge about how sport fan curiosity has an influence on psychological well-being. Overall, the current findings further provided practical implications for fans' behavior in sport context. Reference Park, S. H., Mahony, D. F., & Greenwell, T. C. (2010). The measurement of sport fan exploratory curiosity. *Journal of Sport Management*, 24(4), 434-455.

### INVESTIGATING THE FACTORS OF BAD POSTURE.

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**【Introduction】** Children having bad posture has been concerned for the last several years. Several in elderly people studies have been conducted on the relationship between backward curvature and muscle strength1), or the relationship between balance ability and muscle mass2). The child who has a bad posture infers that their skeletal muscle mass and/or muscle strength to support a body are not enough. Thus, the purpose of this study was to clarify the effect of muscle strength, skeletal muscle mass and physical activity level on creating posture in children. **【Methods】** Ten healthy Japanese girls (age:14.1±0.9 yr, height:157.4±5.0 cm, weight:52.5±6.6 kg ) voluntarily participated in this study. Pictures in a natural standing posture were taken from the front and the right side. Anatomical landmarks were digitized by using image analyzing system. The position of the center of gravity and foot pressure for 30 seconds were measured. Skeletal muscle mass was estimated by body composition analyzer by using bio-electrical impedance. Muscle strength in trunk and physical activity level of daily living were measured. **【Results & Discussion】** It was indicated that the center of gravity inclined toward the back when there was less muscle mass of the leg ( $r = -0.791$ ,  $p = 0.006$ ). In addition, the smallness of leg muscle mass is associated in some way with the degree of the forward head posture ( $r = 0.662$ ,  $p = 0.037$ ). Then, the subjects were divided into a good posture group and a bad posture group. The foot pressure, the skeletal muscle mass, the muscle strength and the physical activity level had no significant differences between the two groups. These results suggested the possibility that the correctness of posture is affected by trunk and leg muscle mass, but not by the physical activity level. **【References】** 1) Aida et al. (2005). Japanese journal of applied physiology, 35, 289-296. 2) Kozaki et al. (2003). Japanese Journal of Physical Fitness and Sports Medicine, 52, 157-166. **【Contact】** Megumi Ohta [m-ohta@lets.chukyo-u.ac.jp]

### EXERCISE COMBINED WITH MILK INTAKES SUPPRESSES MORBIDITY AND SYMPTOMS FOR UPPER RESPIRATORY TRACT INFLAMMATION DURING WINTER IN ELDERLY INDIVIDUALS

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**INTRODUCTION:** Regular moderate physical exercise causes a reduction in morbidity rates for upper respiratory tract inflammation (URTI) among athletes. A daily intake of milk has shown to increase in immune function among elderly individuals. A combined effect of regular physical activity with daily milk intakes on URTI is, however, unclear. This study aims at evaluating the combined effects of bowling exercise and milk intakes on salivary immunoglobulin A (sIgA) concentrations and the morbidity rate and symptom of URTI during winter in elderly individuals. **METHODS:** The number of 36 healthy individuals (15 males and 21 females, 54-74 yr) were participated, and 13 subjects (4 males and 9 females; 56-69 yr) completed. The subjects performed 2-hour bowling games once a week for 12 months from April to March of the following year. The subjects were randomly divided into two groups, (1) MILK ( $n = 5$ ); those who took a 500 mL-milk during 3-game bowling, (2) SPORT ( $n = 8$ ); those who took a 500 mL-sport drink during 3-game bowling. The sIgA concentrations were determined 3 times during pre-winter (April-September) and winter (October-March). The amounts of physical activities and daily milk intakes were assessed by the IPAQ-SV and questionnaire, respectively. Averages of determined variables for each season were calculated and used for the analysis. The rate of morbidity and the level of symptoms for URTI were recorded once a week for 6 months, and an average

during winter was calculated. Non-parametric evaluation of statistical analysis was used, and a level of 5% was considered to be significant. RESULTS: The sIgA concentration decreased significantly from the pre-winter to the winter in the SPORT, ( $205.27 \pm 43.66 \mu\text{g/ml}$  to  $126.42 \pm 24.54 \mu\text{g/ml}$ , mean  $\pm$  SEM)( $z = 2.75$ ,  $p < 0.01$ ); however, no such decline was detected in the MILK ( $137.06 \pm 33.10 \mu\text{g/ml}$  to  $121.38 \pm 20.56 \mu\text{g/ml}$ )( $z = 0.85$ ,  $p = 0.40$ ). Neither the amount of physical activity nor that of daily milk intakes differed between the groups as well as the seasons. The morbidity rates of URTI were significantly lower in the Milk than the SPORT (0.4 times vs. 1.5 times)( $z = 2.41$ ,  $p = 0.02$ ), and the total points for symptom levels were also significantly lower in the MILK than the SPORT (9 points vs 19 points)( $z = 2.81$ ,  $p < 0.01$ ). DISCUSSION: This study may provide an evidence to suggest that regular mild sports activities lasting for 2 hours combined with a 500 ml milk intake reduce morbidity rates and symptoms for upper respiratory tract inflammation during winter in elderly individuals. CONTACT h.murata@edu.hokudai.ac.jp

### CHILDREN'S GUIDED ACTIVE PLAY: A NOVEL APPROACH USING SELF-PACED GAMES TO ESTABLISH PHYSICAL ACTIVITY PROGRAM TARGETS

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INTRODUCTION: It is well recognized that children's physical activity (PA) participation is below recommended guidelines. Furthermore the rates of PA participation decline from childhood to adolescence, with girls having greater declines than boys. It has been suggested that active play, compared to PA with sport-specific skills, might be an effective format to engage children in being physically active. To achieve health and fitness benefits from active play programs, they must be of sufficient intensity and prescriptive in nature. The purpose of this study was to investigate the potential of using children's self-paced games in determining the 'dose' of physical activity for children when participating in an active play program. METHODS: Study one - Children ( $n=34$ ; 8-12yrs) participated in one-hour active play sessions ( $n=5$ ) that included age-appropriate cooperative games (33). Each of the cooperative games was classified by ACC outputs (vectors (v)), as well as estimates of metabolic equivalents (MET) and percent time at moderate-vigorous activity (%MVPA), into light, moderate and vigorous games ( $p<0.05$ ). Study 2 - the cooperative games were used to prescribe physical activity intensity levels during an eight-week children's active play program (1h/d; 5d/wk). Children's (8-12yrs;  $n=25$ ) PA participation was measured in wk-1 (i.e., baseline (PA-BL)). Weekly PA targets (i.e., 10-30% percent above PA-BL) were randomly assigned for wk-2 to wk-8. RESULTS: Calibrated accelerometers (ActiGraph GT3X+) assessed the suitability of prescribing children's self-paced games during active play program on achieving PA targets. PA for children's self-paced games (study one) averaged  $3600 \pm 385$  cnts/min and  $4.1 \pm 0.6$  MET for all games ( $n=33$ ) (range 1142-5169 cnts/min ( $p<0.05$ ); and 2.5 to 6.5 MET ( $P<0.05$ )). Heart rates ranged from 115-158 bpm ( $p<0.05$ ); mean of  $138 \pm 17$  bpm (66%HRmax). For study two the PA-BL averaged 140,327 cnts/session over wk-1. PA participation ranged from 159,795 to 185,087 cnts/session from wk-2 to wk-8 ( $p<0.05$ ); mean of  $169,669 \pm 13,556$  cnts/session. PA targets for wk-2 (i.e.  $>20\%$  of PA-BL), wk-3 (i.e., between 10-20% PA-BL) and wk-4 (i.e.,  $<10\%$  of PA-BL) were on average 2%, 1.5%, and 1% of prescribed PA levels ( $p>0.05$ ). For wk-6 to wk-8 achieving PA targets (of  $>20\%$ ;  $<10\%$ ; 20-30% above PA-BL) were -31%, -0.5% and -18% when compared to PA-BL ( $p<0.05$ ). CONCLUSION: Children's self-paced games can be used to prescribe the 'dose' of PA during active play programs. Funding: Faculty of Health, York University - Grants-in-Aid

### IRISIN LEVELS IN THE BLOOD OF WOMEN OF DIFFERENT BODY MASS UNDER FASTING CONDITIONS AND AFTER A 10-MINUTE EXERCISE

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Irisin is called an effort hormone. It is a product of proteolytic cleavage of FNDC5 (fibronectin type III domain containing protein 5). It takes part in the body's metabolism regulation and intensifies oxidation of glucose and fatty acids. In adipose tissue it increases the expression of UPC-1 with PGC-1 alpha and takes part in the conversion of white adipocytes into brown ones (browning). It is a myokine secreted by muscles during physical exercise and an adipokine released by white adipose tissue. An increase in the expression of FNDC5 was also noticed in the hippocampus of mice subjected to endurance exercise and it was concluded that PGC-1alpha and FNDC5 regulate the expression of BDNF in the brain, a substance that participates in neuroplasticity. In the prevention of age-related diseases (e.g. dementia) or ones caused by obesity, e.g. diabetes mellitus type II or cancers and in treatments which make use of physical activity, it is important to determine irisin levels and their changes due to physical effort in the blood of obese people. Despite our knowledge of molecular mechanisms of irisin, changes in its levels in the blood after exercise are not clear or sufficiently documented. The aim of the study was to assess changes in irisin levels in the blood of women of different age and body mass, under fasting conditions and after physical exercise. The women were subjected to a 10-minute single exercise on a cycloergometer with a workload of 100W and 70-80 rpm.  $\text{VO}_{2\text{max}}$  was determined with the Astrand-Ryhming test. Before exercise (under fasting conditions) and 15 minutes after its completion the subjects had their blood taken from the basilica vein in order to assay their irisin levels. Body mass and composition were also analyzed. Irisin levels were correlated with age, body mass and body composition. On the basis of the obtained results it was stated that irisin levels are correlated with body mass, %fat in the body and they also depend on the subjects' age. While regulating the expression of BDNF, irisin can affect cognition, which is suggested by its correlation with age and body composition parameters observed in our studies. Taking into account prevention of obesity and diseases within the diseasome of physical inactivity which correlate with age, but which are at the same time a result of low level of physical activity, it is a vital piece of information not only in terms of research but also its practical application. Contact e-mail: eugenia.murawska-cialowicz@awf.wroc.pl

### THE ATTITUDE OF STUDENTS TOWARDS THEIR HEALTH: MODERN TENDENCIES AND BEHAVIOURAL RISKS

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Introduction In recent years, the problem of studying the health of students and their attitudes towards their health to pay close attention of many researchers. The urgency of this problem is determined by the fact that the students are of great importance in formation the social, labor and reproductive capacity of our countries. The purpose of research - to perform analysis the indicators that characterize attitude of students towards their health in context of behavioural risks. Methods Research was carried out within the framework of the research project «Physical Activity and Health of Students» in 2010-2014. The study involved students the following educational institutes: Ural State University of Physical Education, South Ural State University (Chelyabinsk, Russia), Kostanay State Pedagogical Institute (Kosta-



may, Republic Kazakhstan). In total in research have taken part 840 person. Results It was found that upon reaching the age of 15, many students have tried smoking (at least once smoked cigarettes) – 54.2% of boys and 36.1% girls. By 15 years of age the vast majority of students at least once in his life tasted alcohol. 15.3% of boys and 4.9% of girls said they had at least once in their life have tried drugs. Students have relatively low level of physical activity. Only 15.3% of boys and 13.1% of girls are engaged in physical exercise a daily. Discussion / Conclusion Unstable social, economic and socio-cultural situation, which is typical of modern society exacerbates this tendency leads to the fact that about 70% of students in a state of prolonged psycho-emotional and social stress. Negative external factors contribute to the depletion of the body's adaptive capabilities lead to a breakdown of the mechanisms responsible for the preservation of health. References 1. Health of Students: the sociological analysis / Ed. I.V. Zhuravleva. – Moscow: Publishing House of the Institute of Sociology, Russian Academy of Science, 2012. – 252 p. 2. Fyodorov A.I. The Attitude of Students towards Their Health / A.I. Fyodorov. – Chelyabinsk: Ural State University of Physical Education, 2013. – 72 p. Contact Fyodorov Alexander: sportscience@mail.ru; <http://www.sportconference.jimdo.com>

## PHYSICAL TRAINING AND THE BLOOD PRESSURE OF UNMEDICATED HYPERTENSIVE WORKERS

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**INTRODUCTION** The employees' health is the concern of large corporations. A Brazilian company has been promoting a fitness program for eleven years oriented by the School of Physical Education at Universidade Federal do Rio de Janeiro, Brazil. As part of the risk factors control for non-transmissible chronic diseases, physical exercises are recommended for the prevention, treatment and control of blood pressure (BP). The aim of this study was to investigate the BP behavior after four months of training in unmedicated hypertensive subjects. **METHODS** Sixty-four sedentary subjects participated in the program (time  $\geq 1$  year), divided into a training group (TG) and a control group (CG). All were physically assessed and the TG had three sessions per week, totaling 48 sessions, each lasting 60 minutes. They performed a 25-minute aerobic training between 50 to 70% of heart rate reserve, a strength training in two series ranging from 8 to 12 repetitions, and a flexibility training applying the static stretching method. BP was measured by auscultation at pre- and post training and data were processed by two-way ANOVA using the Scheffé post hoc when needed ( $p < 0.05$ ) for intragroup and intergroup comparison. **RESULTS** The intragroup outcome for the TG showed an 11.4% reduction in systolic BP (SBP) ( $P < 0.05$ ) and 5.3% in diastolic BP (DBP) ( $P > 0.05$ ). The CG showed no changes in BP ( $P > 0.05$ ). Comparing CG and GT, there was a significant difference in SBP in post-training situation, but this did not occur in other measurements. **DISCUSSION** Studies confirm the hypotensive effect after aerobic work (Pescatello et al., 2004), but few have investigated the post-exercise strength hypotension. Martins et al. (2004) followed medicated hypertensives subjected to strength, aerobic and flexibility sessions and after eight weeks they found no significant differences regarding the resting values in both groups; however the BP in the TG showed a tendency to reduction. Despite the methodological differences between our experiment and Martins and co-workers', we found higher reductions in BP, probably because our sample was not medicated and training lasted 16 weeks. With measurements taken 48 hours after the last session aiming to decrease the acute hypotensive effect immediately after exertion, we found a clinically significant reduction in BP at rest. **REFERENCES** Martins ACS, Nogueira BRML, Couto FVP, Nicolau MSB, Pontes FL, Simão R, Polito MD. Comportamento da pressão arterial 12 horas após uma sessão de exercícios em hipertensos treinados. Rev Bras Fisiol Exerc 2004; 3,199-207. Pescatello LS, Franklin BA, Fagard R, Farquhar WB, Kelley GA, Ray CA. ACSM Position Stand: Exercise and hypertension. Med Sci Sports Exer 2004; 36, 533-53.

## RELATIONSHIPS BETWEEN SERUM ADIPONECTIN LEVELS AND MUSCULAR FITNESS IN PORTUGUESE ADOLESCENTS: LABMED PHYSICAL ACTIVITY STUDY

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**Do Introduction:** Paradoxically, recent investigations have showed that adiponectin levels are inversely associated with muscle strength. However, to date, there is a lack of knowledge on the relationship between muscular fitness (MF) and adiponectin levels in adolescents. We aimed to examine the independent associations of MF and adiponectin levels in adolescents, controlling for several potential confounders. **Methods and Results:** This is a cross-sectional analysis with 529 Portuguese adolescents aged 12-18 years. A MF score was computed as the mean of the handgrip strength and standing long jump standardized values by age and gender. We measured fasting glucose, insulin, HDL-cholesterol, C-reactive protein and adiponectin. Linear regression analysis showed a significant inverse association between adiponectin (Z-score by age and sex) and MF score, after adjustments for age, sex, pubertal stage, socioeconomic status, adherence to the Mediterranean diet, body mass index, HOMA-IR, HDL-cholesterol, C-reactive protein and cardiorespiratory fitness (unstandardized  $\beta = -0.176$ ;  $p < 0.005$ ). Analysis of covariance showed a significant difference between the Low MF/Non-overweight group and the High MF/Non-overweight Group ( $p < 0.05$ ) and between the Low MF/Non-overweight and High MF/Overweight Group ( $p < 0.05$ ) ( $F(5, 523) = 2.262$ ,  $p = 0.047$ ). **Conclusion:** Adiponectin circulating levels are inversely and independently associated with MF

## RELATIONSHIP BETWEEN DAILY PHYSICAL ACTIVITY, PHYSICAL FITNESS AND LIFESTYLE HABITS IN ELEMENTARY SCHOOL CHILDREN

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**Introduction:** In Japanese children, although their physical fitness has been getting better gradually in the last decade, it is still lower than their parents' physical fitness. It is worth surveying the background of physical fitness in the children in order to solve this problem. The purpose of this study was to assess the daily physical activity in Japanese elementary school children and to analyze the relationship between daily physical activities and physical fitness or lifestyle habits. **Methods:** Subjects were 164 elementary school children (3rd grade; 68, 5th grade; 96) in Tokyo. Daily physical activities (steps, amount of physical activity, activity time, total energy consumption, exercise strength) were assessed in eight successive days using a uniaxial accelerometer (Lifecorder EX; Suzuken Co., Japan). The subjects performed a physical fitness test including grip strength, one-leg balancing, 20m shuttle-run, sit-ups, side-to-side jump, forward standing jump, hamstring and lower back flexibility softball throw, and 50m run. The lifestyle was assessed using questionnaires. **Results:** The total energy consumption, amount of physical activity and steps per day showed significantly higher values in boys than girls for both grades ( $p < 0.01$ ). The steps per day were significantly higher in 3rd grade than 5th grade for boys and girls ( $p < 0.01$ ). The steps per day of the children who belong to sports clubs were 1500 steps more compared to the children who don't belong to sports clubs ( $p < 0.01$ ). Tele-

vision view time and breakfast intake did not show significant correlation with the physical activities. 20m shuttle-run was correlated positively with steps per day in the 5th grade boys ( $p < 0.05$ ). Discussion: Daily physical activities such as steps per day tend to decrease with grade, which is remarkable for girls. The children who participated in sports club showed significant greater steps per day. Therefore, for the elementary school children in this study, participating in sports clubs may contribute to increase physical active mass in weekdays. Contact: [muraoka@ge.meisei-u.ac.jp](mailto:muraoka@ge.meisei-u.ac.jp)

#### **BREAKS IN SEDENTARY TIME AND MUSCULAR FITNESS IN PORTUGUESE ADOLESCENTS: A LONGITUDINAL ANALYSIS FROM THE LABMED STUDY.**

SANTOS, R.1,2, LOPES, L.1,3, MOREIRA, C.2, ABREU, S.1, OLIVEIRA-SANTOS, J.1, AGOSTINIS, C.1, OLIVEIRA, A.1, ROSÁRIO, R.4, PÓVOAS, S.5, SILVA, P.1, MOTA, J.2

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Introduction Low levels of muscular fitness (MF) seem to be associated with an adverse metabolic and inflammatory profile in children and adolescents. It has been reported that cardiorespiratory fitness is independently associated with physical activity and sedentary time in adolescents; however, the information about the associations of MF is scarce. This study aimed to verify if the associations between changes in breaks of sedentary time and MF changes are independent of physical activity levels, over a 2-year period, in Portuguese adolescents. The sample comprised of 225 children (56.9% girls) aged  $13.59 \pm 1.46$  at baseline, from the LabMed study (2011-2014). Sedentary time and physical activity were measured with accelerometry and MF with the Long Jump and Handgrip tests. Accelerometer counts, lasting at least 1 min, above 101 counts per min were define as a break in sedentary time. A MF score was created from the sum of age and sex adjusted z-scores from the average Handgrip and Long Jump tests. Linear regression models were fitted to assess  $\beta$  and 95%CI predicting MF changes, adjustments included age, sex, accelerometer wear time at baseline and follow up, MF score at baseline, changes in total moderate-to-vigorous physical activity, changes on total sedentary time, changes in maturation status and changes in BMI. Results Results showed that, over a 2 year period, breaks in sedentary time decreased from on average from  $20.6 \pm 8.6$ /day to  $17.7 \pm 9.3$ /day ( $p \leq 0.001$ ); however, changes in sedentary time breaks were positively related with changes in muscular fitness, after adjustments for the above-mentioned confounders  $\beta = 0.020$  (95%CI: 0.002-0.037);  $p = 0.029$ . Discussion This study suggests that increasing breaking sedentary time is positively related with increases in MF during adolescence, regardless of changes in total sedentary time, moderate-to-vigorous physical activity and other potential confounders. Contact [rutes@uow.edu.au](mailto:rutes@uow.edu.au)

#### **OBJECTIVELY MEASURE SEDENTARY TIME AND ACADEMIC ACHIEVEMENT IN SCHOOLCHILDREN**

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Introduction A healthy lifestyle is essential for students to achieve their full academic potential, mental growth, lifelong needs, health and well-being. The deleterious health effect of sedentary behaviour on cognitive outcomes in children and adolescents has been explored, but results are inconsistent and the factors underlying these associations are not fully understood. This study aimed to evaluate the relationship between objectively measured total sedentary time and academic achievement in Portuguese children. Methods The sample comprised of 213 children (51.6% girls) aged 9-10 ( $9.46 \pm 0.43$ ) years, from the north of Portugal. Sedentary time was measured with accelerometry and academic achievement was assessed using the Portuguese Language and Mathematics National Exams results. Multilevel Poisson Regression models were fitted to assess rate ratios predicting academic achievement, adjustments included accelerometer wear time, age, gender, body mass index, socioeconomic status, mother education level, moderate-to-vigorous physical activity, cardiorespiratory fitness and motor coordination. Results Results showed that the relationship between academic achievement and sedentary behavior was curvilinear with an inverted U shape, although not statistically significant [Rate Ratio: 1.006 (95% CI: 0.967-1.046);  $p = 0.960$ ]. Discussion To perform academically, children may need a certain amount of sedentary time (probably spent on school-related pursuits such as homework, reading or studying), but additional sedentary time may be detrimental to academic success. This study suggests that objectively measured total sedentary time was not associated with academic achievement, after adjusting for potential confounders. Contact: [luis.iec.um@hotmail.com](mailto:luis.iec.um@hotmail.com)

#### **PHYSICAL FITNESS AND COGNITIVE FUNCTION OF COMMUNITY-DWELLING ELDERLY FEMALE PARTICIPATING IN A SQUARE-STEPPING EXERCISE CLUB- COMPARISON ACCORDING TO NUMBER OF YEARS OF PARTICIPATION –**

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Introduction With the aging of the population in recent years, there are high hopes for activation of local communities focusing on resident-led exercise activity. The authors have fostered an autonomous club for practicing Square-Stepping Exercise (SSE) at least twice per month from the viewpoint of care prevention. Many previous studies on the effects of autonomous exercise clubs have investigated levels of satisfaction with questionnaires or used surveys to investigate subjective healthiness. In contrast, few studies have conducted cross-sectional or longitudinal investigation of Physical fitness and cognitive function. Therefore, the purpose of this study was to cross-sectionally compare whether community-dwelling elderly female participating in a SSE club exhibited different effects on physical fitness and cognitive function depending on the number of years they had been participating in the club. Methods The subjects in this study were elderly females who could conduct their lifestyles independently and were continuously participating in an SSE club. The SSE club in this study was a group that conducted SSE and was operated autonomously by local residents. Physical fitness was evaluated according to the five items of grip strength, standing on one leg with eyes open, sitting down and standing up for 30 seconds, walking in a figure of eight and moving beans with chopsticks. Physical fitness age was calculated using formula created by Nakagaichi et al. Cognitive function was evaluated using the Five-Cog Test developed by Yatomi et al. Results No significant differences were noted in the items for physical fitness. However, physical fitness age was significantly younger in the 5 years group compared to the 1 year group. On the other hand, there was no significant difference in cognitive function testing among each group. Conclusion To participate in the SSE club on the long-term has been suggested that improve physical fitness for elderly female. However, it was not obvious for the improvement of cognitive function.

## History

### CHRONOLOGICAL TABLE ABOUT ELEMENTS FOR PARALLEL BAR PERFORMANCE IN MEN'S ARTISTIC GYMNASTICS "ANALYSIS FROM JAPANESE JOURNALS"

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**Introduction** Currently, more than 100 elements on the Parallel Bar (PB) have been recorded in the Gymnastics Code of Points. However, we wonder by whom, when or where these various elements are performed. The purpose of this study was to collate data elements on the PB in men's artistic gymnastics and to suggest new elements in the future. **Methods** The method of study was undertaken by bibliographic analysis. This article refers mainly to journals that were published by the Japan Gymnastic Association, and a list that was made regarding the occurrence of new elements on PB in men's artistic gymnastics. **Results** From the analysis, the author gathered data regarding various elements that were performed. For example, the Swing forward with 1/1 turn to uprise arm hang was performed by CARMINUCCI G (ITA) in the 1971 World Championships. Moy piked with straddle backward to handstand was performed by TIPPELT S (GDR) in the 1989 World Cup and Moy piked with straddle backward to handstand was performed by TIPPELT S (GDR) in the 1989 World Cup and Swing forward, straddle cut backward, and regasp with straight body at horizontal was performed by BHAVSAR R (USA) in the 2009 World Cup. These elements are performed by many top male gymnasts. Bent arm swing forward to hop 1/2 turn to support was performed by KATO S (JPN) in the 1976 Olympics and Forward uprise to Kato hop to support was performed by WATANABE M (JPN) in the 1983 World Championships. Double salto forward piked dismount was performed by BELYAVSKIY D (RUS) in the 2011 World Championships. Basket with 5/4 turn to handstand was performed by ZHOU S (CHN) in the 2012 Asian Cup. **Discussion** In conclusion, directions of new occurring elements on the PB may add twists or salto to the existing elements. Developments of PB elements are greatly influenced by rules of the era, change of the apparatus height level, and improved skills of men's gymnastics. Future, we will make it clear directions of new elements to pay attention to changes to the Men's Code of Points. **References** Japan gymnastics association (1986) Japan gymnastics association Study of information, 70. Japan gymnastics association (2009) Japan gymnastics association Study of information, 100. Contact My email address nakasone@bss.ac.jp

## Molecular Biology and Biochemistry

### CHANGES IN HGF LEVELS AFTER A PROGRESSIVE TEST BEFORE AND AFTER A TABATA HIIT PROGRAM

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**Introduction:** HGF (hepatocyte growth factor) is a growth factor of mesenchymal origin which activates satellite cells participating in the regeneration of damaged muscle fibres. It fulfils many biological functions, it is a mitogenic (stimulates cell division), motogenic (enables cell migration), morphogenic (facilitates cell differentiation), and angiogenic factor (stimulates formation of blood vessels). It acts in an auto-, para – and endocrine manner. Due to its participation in regeneration of different cell structures, HGF is being tested for use as a medicine administered in medical conditions accompanied by organ damage. HGF can be of systemic origin (secreted by the lungs, liver, kidneys), or of muscle origin – secreted by fibroblasts in the muscles. Although a lot of research has been done into HGF and the role it plays in muscle regeneration and angiogenesis, little is known of changes in HGF levels in athletes in response to different types of effort. **Aim:** The aim of the study was to assess the changes in HGF levels after a progressive test on a treadmill before and after an 8-week Tabata HIIT program (high intensity interval training) done twice a week. Each training unit consisted of 7 sets of 4-minute-long workouts following the pattern of 20sek work/10sek passive break and 1min break between the sets. A group of women (n=8) and men (n=10) were involved in the study. HGF levels were assayed by the ELISA method. **Results:** HGF level measured 15 minutes after a progressive test increased in comparison to its resting values before and after an 8-week training program. Before the training, higher values of HGF were noted in women, after the training there were no differences. HGF at rest and after effort correlated with the parameters of acid-base balance – pH, BE and lactate level (LA) **Discussion:** A 2-month HIIT program did not cause an increase in HGF levels in the subjects' blood. However, an increase in its levels after a progressive test and correlation with pH and LA suggest that muscle acidosis could be one of the factors initiating the activation and increase in HGF levels in the blood. Wahl et al. (2014) also noticed an increase in HGF levels after a single HIT workout.

### REGULAR MODERATE EXERCISE IMPROVES NON-ALCOHOLIC FATTY LIVER DISEASE INDUCED BY HIGH-FAT DIET VIA MONOACYLGLYCEROL O-ACYLTRANSFERASE 1 PATHWAY SUPPRESSION

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**Introduction:** Non-alcoholic fatty liver disease (NAFLD) has been known to be dangerous as much as alcoholic fatty liver disease. NAFLD has a risk of developing steatohepatitis, fibrosis, cirrhosis and then eventually hepatocellular carcinoma, and therefore, this risk is increased with obesity. Recently, monoacylglycerol O-acyltransferase 1 (MGAT1) has been reported to play a key role in development of diet-induced NAFLD. Thus, this study was to investigate the effect of exercise on suppression of MGAT1 pathway in liver tissue of high-fat diet induced obese rats. **Methods:** The experiment was composed of 2 parts. In part 1 phase, 35 rats divided into 2 groups, normal diet group (ND, n=7) and high-fat diet group (HFD, n=28) to study the effects of high-fat diet on MGAT1 expression in liver tissue. In part 2 phase, the HFD group (n=21) was divided into control group (HFD-con, n=7), exercise group (HFD-exe, n=7) and diet shift from high-fat diet to normal-diet group (HFD-shift, n=7), to study the effects of exercise on MGAT1 suppression in NAFLD. Total experimental period was 12 weeks (6 weeks for each part). All the high-fat feeding rats were fed a high-fat diet (45% of total calories from fat). The treadmill exercise consisted of a 6-weeks accommodation phase with increasing exercise intensity (first, second, and third week: 15 m/min for 30, 45 and 60 minutes, respectively; fourth, fifth and six weeks: 20 m/min for 30 and 45 minutes, respectively), followed by a 5-weeks constant training period (20 m/min for 60 minutes). All running rats had a 5-minute warm-up phase with slowly increasing speed, before each training session (5 times a week between 5:00 and 6:00 pm). Lipid accumulation in liver tissue was determined by Oil Red O staining method. mRNA expressions of MGAT1 and liver fat synthesis related gene (PPAR $\gamma$ , chREBP, SREBP1c) were measured by real-time PCR

(qPCR) and protein expressions were measured by Western blotting. Results The MGAT1 expression significantly increased by high-fat diet feeding (part 1). However, HFD-exe reduced mRNA expression of MGAT1. Both HFD-exe and HFD-shift also reduced protein expression of MGAT1. Notably, lipid accumulation in the liver reduced in both HFD-exe and HFD-shift group. Conclusions: These results suggest that the MGAT1 pathway suppression by regular moderate exercise is critically important in the treatment of NAFLD in diet-induced obesity.

### HIGH INTENSITY RESISTANCE TRAINING REDUCES BODY WEIGHT AND MUSCLE MASS LOSS INDUCED BY ACUTE SLEEP DEPRIVATION

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**Introduction** Sleep deprivation (SD) increase hypothalamus-pituitary-adrenal axis activity, which results in negative energy balance, weight loss and muscle atrophy in rats (Mônico-Neto et al, 2015). Previous resistance training could minimize the catabolic effect induced by SD and preserve the body mass and muscle trophism. Thus, aim of this study is observe if trained rats by high intensity resistance training could minimize the deleterious effects on muscle mass and weight loss when submitted to SD. **Methods** Forty male Wistar were allocated into 1 of 4 groups: control (CTL), resistance training (RT), sleep deprivation for 96 hours (SD96), and RT followed by SD for 96 hours (RT+SD96). The protocol of exercise was performed during 8 weeks, 5 times/week. Forty-eight hours after last session of exercise, the RT group were euthanized and the RT+SD96 and SD96 groups were submitted to SD for 96 hours by modified multiple platform method (Suchecki and Tufik, 2000). Immediately after SD, were analyzed the corticosterone concentration, muscle trophism, and molecular markers of protein synthesis and degradation in muscle. **Results** The sleep deprivation induced body mass and muscle loss, increased corticosterone concentration and markers of protein degradation in muscle, as LC3, SQSTM1/p62, ubiquitinated proteins. In other hand, RT+SD96 minimized these changes and increased activity of protein synthesis pathway, as mTOR and p70S6k. **Discussion** High-intensity RT performed before SD contained muscle loss induced by SD. Moreover, increased activity of synthesis protein pathway and minimized the abundance of protein degradation pathway, minimizing the body's weight loss. These changes indicate that trained rats had better assimilation of stress induced by SD. **References** Suchecki D, Tufik S (2000). Social stability attenuates the stress in the modified multiple platform method for paradoxical sleep deprivation in the rat. *Physiol Behav.* Jan;68(3):309-16. Mônico-Neto M, Giampà SQ, Lee KS, de Melo CM, Souza Hde S, Dáttilo M, Minali PA, Santos Prado PH, Tufik S, de Mello MT, Antunes HK (2015). Negative energy balance induced by paradoxical sleep deprivation causes multicompartmental changes in adipose tissue and skeletal muscle. *Int J Endocrinol*; 2015:908159. **Acknowledgements** Fapesp (#2011/15962-7, #2013/00152-5), CEPID/SONO-FAPESP (#98/14303-3), CNPq, CAPES. Contact marcosmoniconeto@gmail.com

### THE IMPACT OF MODERATE-INTENSITY CONTINUOUS AND HIGH-INTENSITY INTERVAL TRAINING ON PLASMA MIRNA PROFILE OF HYPERGLYCAEMIC PATIENTS

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**AFFILIATIONS** 1. Victoria University, Australia 2. University of WA, Australia 3. University of Queensland, Australia **INTRODUCTION** Exercise is highly beneficial in patients with type-2 diabetes (T2DM) for improving clinical risk factors like obesity and insulin resistance. However, the exact biological mechanisms that result in the improved clinical outcomes are not fully understood. Identifying potential biomarkers that are differentially regulated by exercise in T2DM, such as circulating microRNAs (miRNAs), and associating these responses with improved insulin resistance and other clinical risk factors, may offer new insights to optimise exercise prescription in individuals with T2DM. **METHODS** 26 men and 7 women with elevated fasting glucose ( $\geq 6.1$  mM) with and without T2DM completed 16wks of the following exercise programs: i) moderate-intensity continuous training (MICT, n=7, 30mins at 60-70% peak heart rate (PHR), 5x/wk); ii) high-volume high-intensity interval training (4HIIT, n=13, 4x4min intervals at 85-95% PHR, interspersed by 3mins active recovery, 3x/wk); iii) low-volume HIIT (1HIIT, n=13, 1x4min interval at 85-95% PHR). miRNA was extracted from resting blood samples taken before and after the 16wks intervention. Pre-selected miRNAs were detected by qPCR using Exiqon Kits and data were analysed with GenEx software. **RESULTS** Plasma abundance of mir-28-3p, mir-126-3p, mir-146a-5p, mir-27a-3p and mir-223-3p was decreased ( $p < 0.05$ ) in hyperglycaemic patients following MICT intervention. Only mir-34a-5p expression levels significantly increased ( $p < 0.05$ ) after 4HIIT, while no changes in plasma miRNA expression were observed after 1HIIT. **DISCUSSION** MICT caused a greater impact on the plasma miRNA expression profile than HIIT, significantly reducing the abundance of mir-28-3p, mir-146a-5p and mir-27a-3p, previously shown to be increased in T2DM patients [1]. MICT further reduced the expression of mir-223-3p and mir-126-3p, already found to be downregulated in the setting of T2DM [1] and that may play a role in glucose uptake and insulin resistance in peripheral tissues [2, 3]. Following 4HIIT, only mir-34-5p expression was increased, which has been associated to hypertriglyceridemia [4] and may suggest a negative effect of this intervention. Together, these data indicate that HIIT and MICT differentially alter the plasma miRNA expression profile in hyperglycaemic patients, which may mediate the different training-induced changes on the metabolism. Further studies considering healthy individuals will be addressed. **REFERENCES** 1. Zampetaki et al. *Circulation Research*. 2010;107:810-817 2. Ryu HS et al. *PLOS One*. 2011;6(3):e17343 3. Lu et al. *Cardiovascular Research*. 2010;86:410-420 4. Kong et al. *Acta Diabetologica*. 2011;48: 61-69 Contact: alba.moreno@vu.edu.au

### RESPONSES OF SKELETAL MUSCLE HYPERTROPHY IN WISTAR RATS TO DIFFERENT RESISTANCE EXERCISE MODELS

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**Introduction** Intense interest in the downstream molecular events by which mTOR signaling promotes cell growth have been emerged, however, the pathway of upstream mechanisms regulating mTOR needs more investigation, mainly molecules that directly modulated the mTOR. Thus, the aim of the present investigation was evaluated the effects of three different models of progressive resistance exercise based on climbing a ladder on the phosphorylation of mTOR and the upstream signaling. **Methods** Wistar rats (n=6 per group) were used as follow: untrained (C), endurance resistance training (ERT), strength resistance training (SRT), and hypertrophy resistance training (HRT). All animals were exercised in climbing a ladder (1.1 x 0.18 m, 30 2-cm-high steps, 80° slope). Forty-eight hours after the last training session, the animals were killed by decapitation and quadriceps muscle was collected for Western Blot and histology analysis. **Results** We observed a significant increase in the fiber cross-sectional area of all the exercised groups compared to sedentary. The exercised



groups increased mTOR phosphorylation and of the molecules that activate mTOR (i.e. PKB, 14-3-3, ERK, P38MAPK phosphorylation) when compared to untrained group. In addition, the increase of SRT was higher compared to ERT group, and the increase of HRT was higher mTOR phosphorylation compared to ERT. On the other hand, the protein levels of tuberlin, REDD1 and SESN2, and the phosphorylation of AMPK (molecules that inhibit mTOR) were lower compared to the untrained group. Interestingly, these reductions were higher in the SRT compared to ERT, and in HRT compared to the other groups. Discussion The results showed that quadriceps weight and cross-sectional areas were higher in the exercised groups compared to untrained rats. However, the hypertrophy resistance training group presented better results compared to the other experimental groups. This same pattern was observed for mTOR phosphorylation and for the most pivotal molecules involved in the upstream control of mTOR (increased of PKB, 14-3-3, ERK, P38MAPK, 4EBP1 phosphorylation and reduction of Tuberlin, Sestrin 2, REDD1 and p-AMPK). Our data demonstrated that the higher training intensity led to higher activation of the mTOR/PKB intracellular signaling and proteins that positively regulates this pathway while occur the inhibition of proteins that negatively modulate this pathway. Moreover, the HRT showed the higher increase on muscle hypertrophy as well as intracellular signaling activity. Contact [ctsouza@unesec.net](mailto:ctsouza@unesec.net)

### **SOCS3 ABLATION IN LEPTIN RECEPTOR-EXPRESSING CELLS INHIBITS GLUCONEOGENESIS AND PREDISPOSES MICE TO HYPOGLYCEMIA AFTER PROLONGED FASTING**

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**Introduction** Leptin plays an important role in the regulation of glucose homeostasis during obesity. For example, inactivation of SOCS3 in leptin receptor-expressing cells protects mice from diet-induced insulin resistance (Pedroso, 2014). However, it is unclear whether leptin modulates glucose homeostasis during caloric restriction, which is condition in which gluconeogenesis is critical to support life. **Methods** Mice lacking SOCS3 protein specifically in leptin receptor (LepR)-expressing cells (LepR SOCS3 KO mice) were studied during fasting. To assess hepatic glucose production, a pyruvate tolerance test (PTT) was performed in LepR SOCS3 KO and control mice, either in fed and fasting (24 and 48h) conditions. To investigate the mechanisms involved in glucose homeostasis, we assessed the serum levels of hormones involved in the regulation of glucose homeostasis or used drugs to block the autonomic nervous system during the PTT. In order to inhibit the parasympathetic nervous system, we administered of 3 mg / kg of atropine (Sigma). Phenolamine (Sigma) (3mg / kg) and propranolol (Sigma) (0.5mg / kg) were co-administered to block the sympathetic nervous system. Results Fasting caused a reduction in serum glucose levels; however, control mice were able to sustain glycemia above 60 mg/dL avoiding hypoglycemia. On the other hand, LepR SOCS3 KO mice exhibited hypoglycemia after 48 h fasting. PTT results showed that LepR SOCS3 KO mice had suppressed gluconeogenesis, especially during prolonged fasting periods. No changes in serum levels of insulin, glucagon, growth hormone and corticosterone were found between groups during fed and fasting conditions. Additionally, hepatic glucose production remained lower in LepR SOCS3 KO mice even with the blockage of parasympathetic nervous system. However, after blocking the sympathetic nervous system, the differences between groups in the gluconeogenesis were no longer observed. **Discussion** Our results reveal that leptin modulates glucose homeostasis even during periods of caloric restriction. This regulation depends on the sympathetic nervous system. Although putative SOCS3 inhibitors can be beneficial for the treatment of obesity and diabetes, these drugs can produce undesired effects such as increase the risk of hypoglycemia during prolonged caloric restriction. These findings contribute to the understanding of possible side effects of drugs intended to increase leptin sensitivity for weight loss treatment. Financial Support Fundação de Amparo à Pesquisa do Estado de São Paulo (FAPESP 2010/18086-0 and 2013/25032-2) References Pedroso JA, et al. (2014). *Mol Metab* 3(6), 608-18. Contact [joao.pedroso@usp.br](mailto:joao.pedroso@usp.br)

### **COMBINED EFFECTS OF 17-BETA-ESTRADIOL AND EXERCISE TRAINING PROTECTS AGAINST CARDIAC APOPTOSIS IN OVARECTOMIZED RATS**

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**Introduction.** Menopause-related estrogen-deficiency has been linked to the rapid increase in cardiovascular disease. 17 $\beta$ -estradiol provides protection against cardiovascular disease. Moreover, exercise training is well known to prevention and treatment of cardiovascular disease. The purpose of this study was to evaluate the combined effects of 17 $\beta$ -estradiol and exercise training on cardiac anti-apoptotic and pro-survival effects in ovariectomized rats. **Methods.** Fifty-six female Sprague-Dawley rats were divided into sham-operated group (Sham), and bilateral ovariectomized group (OVX), and OVX injected intraperitoneally with 17 $\beta$ -estradiol (OVX-E2; 10 mg/kg/day), and OVX treated with 17 $\beta$ -estradiol and exercise (OVX-E2-EX). 10 weeks after intervention, the excised left ventricle from rats were measured by histopathological analysis, TUNEL assays and Western Blotting. **Results.** The OVX group exhibited abnormal myocardial architecture, interstitial fibrosis and more cardiac TUNEL-positive apoptotic cells relative to Sham group. This situation became better after 17 $\beta$ -estradiol alone or combination interventions. The OVX group exhibited decreased ER- $\alpha$ , ER- $\beta$ , IGF-1, IGF-1R, p-PI3K, p-Akt, Bcl-2, Bcl-xL and p-Bad compared with Sham group. All of these changes were increased after 17 $\beta$ -estradiol alone or combination interventions. The OVX group exhibited increased TNF- $\alpha$ , Fas ligand, Fas receptors, FADD, t-Bid, Bad, Bax, Cytochrome c, caspase-8, -9, and -3 compared with Sham group and this increase could be reversed by either 17 $\beta$ -estradiol alone or combination interventions. Moreover, there are a partly additive effect on the upregulation of ER- $\beta$ , IGF-1, IGF-1R, Bcl-2 and Bcl-xL as well as the downregulation of Fas, FADD, Cytochrome c, activated caspase-9 and activated caspase-3 in the OVX-EX-E2 group compared with the OVX-E2 group. **Discussion.** Our results indicated that combined therapies with 17 $\beta$ -estradiol and exercise training could have an additive or synergistic effect in protecting against cardiac apoptosis through modulation of cardiac estrogen receptor related pro-survival and anti-apoptosis pathways in ovariectomized rats. It suggested that combination of 17 $\beta$ -estradiol plus exercise training would ameliorate parts of cardiac function in the population of postmenopause. **Refrance.** Atsma F, Bartelink ML, Grobbee DE, and van der Schouw YT. (2006). *Menopause* 13, 265-279. Had-dock BL, Marshak HP, Mason JJ, Blix G. (2000). *Sports Med*, 29(1), 39-49. Contact. Email: [charlet8116@gmail.com](mailto:charlet8116@gmail.com)

## CHRONIC RAPAMYCIN ADMINISTRATION FURTHER STRENGTHEN EXERCISE-INDUCED MRNA EXPRESSION OF PROTEIN INVOLVED IN ENERGY METABOLISM IN RATS FED A HIGH-FAT DIET

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**Objective** The mammalian target of rapamycin(mTOR) pathway is a critical signaling component in the development of obesity-related insulin resistance, but the precise mechanisms linking exercise-induced improvement of the insulin resistance and mitochondria oxidative metabolism in high-fat diet(HFD) rats remain unclear. Our aim was to investigate the role of the rapamycin (inhibitor of mTOR) on exercise-induced improvement of skeletal muscle gene involved in energy metabolism in HFD rats. **Method** 24 male SPF rats were fed with HFD for 6 weeks. After one week exercise adaptation, the rats were randomized to 4 groups (n=6):HFD+sedentary group(H group),HFD+exercise group(HE group),HFD+rapamycin (HR group), HFD+ exercise+rapamycin(HER group).The rats in HE group and HER group were performed exercise training for 4 weeks from the 8th week on and those in HR group and HER group received the intraperitoneal injection of rapamycin with the dose of 2 mg/kg/day for 2 weeks from the 10th week on. At the 11th week, the glucose tolerance and insulin tolerance tests were performed two days before the sacrifice of the animals. Finally, the rats were sacrificed after 12-16 hour fast. The soleus (SOL) and extensor digitorum longus(EDL) were harvested for analysis of activity of mitochondria oxidative enzyme and gene expression involved in energy metabolism. **Result** The exercises and rapamycin reduced the body weight and relative body fat ( $P < 0.05$ ). Moreover, the exercises improved the glucose tolerance and insulin tolerance while the rapamycin aggravated these variables. Further analysis indicated that the exercise significantly improved the activities of succinate dehydrogenase and cytochrome C oxidase (COX) in EDL of HFD rats, and significantly up-regulated the expression level of UCP2, PPAR $\alpha$  and COX4 mRNAs in EDL of HFD rats, but the rapamycin did not inhibit the expression of these genes. On contrary, rapamycin up-regulated the PGC-1 $\alpha$  and UCP2 mRNAs in EDL. **Discussion** Consistent with previous researches[Samuel et al, 2012 ;Houde et al, 2010],the exercises improves insulin tolerance, mitochondrial oxidative capability and mRNA level of genes involved in energy metabolism, and chronic rapamycin administration aggravates insulin resistance induced by HFD.Researches have shown that mTOR pathway promotes skeletal muscle mitochondrial oxidative metabolism.In the present study,rapamycin did not inhibit but strengthen exercise-induced up-regulation of skeletal muscle genes involved in energy metabolism in HFD rats. **Reference** [1] Samuel VT, Shulman GI.Mechanisms for insulin resistance: common threads and missing links. *Cell*,2012,148(5):852-871. [2] Houde VP, Br   S, Festuccia WT, et al. A chronic rapamycin treatment causes glucose intolerance and hyperlipidemia by upregulating hepatic gluconeogenesis and impairing lipid deposition in adipose tissue. *Diabetes*, 2010, 59 (6): 1338-1348.

## Motor Learning

### VISUAL BIOFEEDBACK REDUCES FOREARM MUSCULAR ACTIVITY DURING PIANO OCTAVE STROKE

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**Introduction** Piano keystrokes are mainly performed with the muscles of the upper extremities. The octave keystroke (OKS), in which as the hand is spread widely, requires more muscular activity (MA) in the hand, especially in individuals with small hands. Real time viewing of electrical myogram (EMG) can be used to see MA during keystrokes. The aim of this study was to examine how MA during piano OKS was reduced by viewing real time EMG (RTEMG). **Methods** The subjects were five graduate students majoring in piano. The piano used for this experiment was a grand piano. The experimental task was to play fortissimo 8th OKS on each side. Surface EMG was used to measure and present the MA of subjects' upper body muscles (neck, shoulder, upper arms and forearms). EMG was sampled with 5-500 Hz band pass filters and 1000 Hz. The root mean squares of measured EMG was taken and integrated (IEMG) during the 500 ms of the before keystroke (pre and during keystroke: PDKS) and after keystroke (AKS) at the time of peak sound pressure. The biofeedback (BF) task was to consciously reduce the MA of the forearm by looking at the RTEMG. The effect of BF was evaluated by the ratio of IEMG when looking to that when not looking at RTEMG. **Results** In PDKS, the MA of the trapezius (range from -31.1 % to -5.0 %), biceps (range from -28.4 % to -2.2 %) and all forearm muscles (range from -31.5 % to -14.8 %) on both sides were reduced. However, the MA of both the deltoid and triceps were increased (range from +12.4 % to +41.4 %). In AKS, the MA of the right trapezius (-16.5 %) and all forearm muscles (range from -19.1 % to -4.8 %) was continuously reduced but that of the deltoid (+22.6 %) and triceps (+40.7 %) and triceps (+26.4 %) was increased. In contrast, the MA of all left muscles was increased (range from 2.8 % to 32.1 %). **Discussion** The results of PDKS indicate that BF was effective in the neck and forearm muscles. Conversely, BF led to more work in the deltoid and triceps. It was assumed that the subjects concentrated on decreasing MA in the forearm muscles rather than in the shoulder and upper arm muscles. We could not clearly elucidate the differences in the AKS results between the right and left. The left keys are heavier than the right ones. It is possible that this had an effect on MA after keystrokes.

### ACUTE EFFECTS OF CONTEXTUAL INTERFERENCE, GRADUAL DIFFERENTIAL, CHAOTIC DIFFERENTIAL, AND REPETITIVE BADMINTON SERVE TRAINING ON EEG BRAIN ACTIVITY

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**Introduction** Several studies have demonstrated increased learning rates in variable over repetitive practice. More specifically, this has been demonstrated for the contextual interference (CI) approach (e.g. Brady, 2008) and the differential learning (DL) approach (e.g. Sch  llhorn, Hegen, & Davids, 2012) which are representatives of variable practice. To date, little is known on the post-training effects on brain activity comparing CI and DL that possibly contribute to the beneficial effect of variable over repetitive practice. In the present study, we compared post-training effects of repetitive training, CI, gradual DL and chaotic DL on EEG brain activation patterns. **Methods** Twenty-two semi-professional badminton players performed repetitive, CI, and two DL (gradual, chaotic) badminton serves in a randomized within-subjects design. Electroencephalographic activity was recorded from nineteen electrodes according to the 10-20 system before, and immediately after each 20-minute exercise. **Results** Analyses of variance revealed a significant effect for training for the theta,  $F(4,84) = 2.98$ ,  $p < .02$ ,  $\eta^2 = .17$ , alpha,  $F(4,84) = 3.06$ ,  $p < .02$ ,  $\eta^2 = .19$ , beta,  $F(4,84) = 2.78$ ,  $p < .04$ ,  $\eta^2 = .06$ , and gamma band,  $F(4,84) = 3.07$ ,  $p < .02$ ,  $\eta^2 = .21$ . Post-hoc tests revealed increased theta activity in contralateral occipito-parietal regions in gradual DL and chaotic DL compared to CI,  $p < .02$ , and repetitive training,  $p < .02$ , with increased alpha activity compared to CI,  $p < .02$ , and repetitive train-

ing,  $p < .03$ . After CI training, beta and gamma activity was increased in anterior areas compared to the remaining conditions,  $p < .05$  each. Occipital alpha activity was increased in repetitive training compared to the remaining conditions,  $p < .05$  each. Discussion Results indicate different underlying neuronal processes in repetitive training, CI, and DL with a higher involvement of central and parietal areas in gradual DL and chaotic DL, anterior areas in CI, and occipital areas in repetitive training. Our results suggest that DL stimulates the somatosensory system more extensively, whereas CI activates specifically executive controlled processing in anterior brain areas. Repetitive training seems to rely on a rather visually guided processing. Comparing the different variable practice schedules of CI and DL, results show that the variable training schedule per se (CI, DL), not the degree of structure causes the difference in EEG brain activation patterns. References Brady, F. (2008). The contextual interference effect and sport skills. *Perceptual and Motor Skills*, 106, 461–472. Schöllhorn, W.I., Hegen, P., & Davids, K. (2012). The Nonlinear Nature of Learning - A Differential Learning Approach. *The Open Sport Science Journal*, 5, 100–112. Contact henz@uni-mainz.de

## THE PHENOMENOLOGICAL STUDY OF DIFFERENCES ABOUT A MOVEMENT UNDERSTANDING BETWEEN LEARNER AND LEADER

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In motor learning, it is important that how does the leader understand a target movement. In this understanding, it is clear that the target movement is performing in front of the leader. However, leaders must pay attention to the movement, which shows a phenomenon of the historical one-time. In other words, leader should consider the target movement not as a movement of each case, but as a way of the movement (Bewegungsweise) in the sense of Strauss. This way of the movement has the anti-logic characteristic such as differentiation and identification. And we understand this way of the movement based on sense to guarantee this identity in the form of 'as ~'. For this reason, in order to understand a way of the movement of learners, we must be the subject of discussion consciousness experience with a focus on Kinaesthesia (in the sense of Husserl) of learners. In addition, communication between leaders and learners will play a very important role as a way for understanding this consciousness experience. In order to be corresponded with this communication between leader and learner, they must be dialogue towards the same target. However, the match of this communication target is not an easy work. Therefore, this study, as a first step to identify communication target, leaders understanding structure based on the movement observation and learners self-understanding structure based on an execution of the movement are clarified by using empirical illustration. Through that result, furthermore this study intends to define the target for communication in motor learning. Understanding of the leaders accumulates as some of the failure type through the experience of findings of various failures. In addition, the more abundant teaching experience of leader is, the more this failure example is symbolized. Moreover, this symbol is not an outside shape, but this will differentiate further into multiple sensory images. This process is not due to only an empirical knowledge increased by a simple observation and then it will differentiate through communication with a variety of learners. On the other hand, in understanding of the learner, sensuous difference occurs first through the repeated practice. In addition, learners continue to explore the sense to bring a success of the movement from various differentiated sensory image. Through this explore, learners finally identify the feeling that matches a success of the movement. Finally, it was clarified that an understanding of the learner and the leader is progressing exactly in the opposite direction. However, what is common to both relates to sensory images. By close-up this image, leaders and learners could be corresponded a communication on the same target.

## POSTURAL CONTROL IN CHILDREN FROM 6-12 YEARS OLD

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**INTRODUCTION** One of the most important function of postural control is to maintain the equilibrium during quiet stance and movement. The development of this postural control during the childhood and adolescence has not been well determined and more studies about this topic are necessary (Cuisinier et al., 2011). The objective of this study was to establish differences in postural control in children of different ages. **METHODS** A cross-sectional study was carried out in which 208 children participated. The subjects were divided in 6 groups of age: 6, 7, 8, 9, 10 and 11 years old. The sample size of each group was between 22 and 39 subject of both sex. All subjects performed two bipedal trials under two different randomized conditions: i. eyes open and ii., eyes closed. The subjects were instructed in order to maintain the same posture during the four trials. Each trial had a duration of 30 seconds and the subjects were instructed to stand as still as possible. Centre of pressures displacement was acquired using a Wii Balance Board (Wikstrom, 2012) with a sample frequency of 50 Hz. After data acquisition, the signals were digitally processed to obtain the mean velocity in antero-posterior and medio-lateral directions (MVAP and MVML respectively) and ellipse area (EA). Due to normality distribution were not meet, Kruskal-Wallis test was performed to determine the effect of age in the postural control variables. Pairwise comparisons with Bonferroni correction were requested when significant effects were found. The level of significance was set at  $p = 0.05$ . **RESULTS** There was an effect of age in MVAP with eyes open ( $H_5 = 29.46$ ;  $p < 0.001$ ), with eyes closed ( $H_5 = 11.65$ ;  $p = 0.04$ ), and MVML with eyes open ( $H_5 = 16.55$ ;  $p = 0.005$ ) and eyes closed ( $H_5 = 13.71$ ;  $p = 0.02$ ). Children of 6 years old showed a higher MVAP than children of 9, 10 and 11 years ( $p < 0.05$ ) in eyes open condition. Moreover, the group of 7 years showed higher MVAP than those of 10 years old ( $p < 0.05$ ). On the other hand, children of 6 years showed a higher MVML than children of 8, 9 and 10 years old in eyes open condition. Regarding eyes closed condition, MVML was lower in children of 8 years than in children of 6. There were not differences in EA variable. **DISCUSSION** It is important to point out that postural control improves from 6 to 9-10 years old, but there is an involution between 10 and 11 years old. This fact could be due to a higher increase of height or weight of the subjects (Hue et al., 2007). In conclusion, when children growing up, their postural control improve but not their postural stability. Moreover, this trend was found only during eyes open condition. **REFERENCES** Cuisinier, R., Olivier, I., Vaugoyeau, M., Nougier, V., & Assaiante, C. (2011). *PLoS ONE*, 6(5). Hue, O., Simoneau, M., Marcotte, J., Berrigan, F., Doré, J., Marceau, P., ... Teasdale, N. (2007). *Gait & Posture*, 26(1), 32-38. Wikstrom, E. A. (2012). *Journal of Athletic Training*, 47(3), 306-313.

## INFLUENCE OF ASCENDING OR DESCENDING FORCE OUTPUT ON THE ACCURACY TO THE TARGET FORCE

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**Introduction** In the motor learning or physical training, the accuracy of force modulation is an important factor because it produces the early efficiency. During the force modulation, we select several strategies of force output in order to match the target force. The strategies

involve ascending or descending force output. The previous studies reported the differences that the excitability of primary motor cortex and the threshold of motor unit recruitment between ascending and descending the force output. Therefore, it is considered that these mechanisms have relationships to the difficulty of force modulation. The purpose of this study was to investigate the influence of those strategies on the accuracy to the target force. Methods Twelve subjects were participated in the experiment. Experiment was conducted in accordance with the Declaration of Helsinki. First of all, maximum voluntary contraction (max) of palmar/dorsiflexion force was evaluated in each subject. At the beginning of the experiment, subjects reach their wrist muscle strength to the initial force themselves by means of visual feedback. Then, they were instructed to ascend/descend their force to match the target force (ascend force /descend force: AF/DF) with blind. Finally, the values that they perceived to reach the target force were recorded. The target forces were set 3 levels (30%, 50%, 70%MVC). The initial forces were set to the 15% less than the target force in the AF task, and 15% more than the target force in the DF task. The Constant Error (CE) was calculated as indices the errors between the target force and the actual force. Two-way ANOVA by means of force modulation factor and target force was conducted in each muscle contraction. Post hoc comparisons were made using Bonferroni; the threshold for statistical significance was set at  $p < 0.05$ . Results In the target force was 30%MVC, the CE of AF condition showed significant higher than DF condition ( $p < 0.05$ ). On the other hand, the CE of AF condition showed significant lower than DF condition in the 70%MVC ( $p < 0.05$ ). There was no significant difference between AF and DF in the 50%MVC ( $p > 0.05$ ). Discussion CE of 50%MVC showed less error in both condition. It was similar to the previous study that force sense was most precise during force reproduction. CE of 30%MVC suggested that the ascending force output was more difficult than the descending force output in low intensity force modulation. CE of 70%MVC suggested that the descending force output was more difficult than the ascending force output in high intensity force modulation. Contact: hayamit@shinshu-u.ac.jp

### COMPARISON OF MOTOR SKILL LEVELS BETWEEN EXPERTS AND NON-EXPERTS ACCORDING TO THE EFFECT OF INTERNAL TIMING TRAINING WITH NON-INVASIVE BRAIN STIMULATION ON THE EXTERNAL TIMING TASK

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Introduction Neurological studies suggest that timing in motor learning is affected differently according to the types (anode, cathode, sham) of tDCS on the brain and this type of stimulation effects individuals differently based on the level of their motor skills. Therefore, the purpose of this study is to investigate and compare the motor skill levels between expert and non-experts according to the effect of internal timing training with non-invasive brain stimulation (tDCS) on the external timing task. Methods The following experiment examined fourteen university students (14 male; age range 20-30, mean = 24, sd = 4.5) and fourteen baseball players (14 male; age range 20-25, mean = 21, sd = 4). All participants had no history of neurological disease and were right-handed as verified by the modified Edinburgh Handedness Scale (Oldfield, 1971). The twenty-eight participants were divided into four groups of seven persons each which included; expert (Anode), expert (Sham), non-expert (Anode), non-expert (Sham). Group A and C received 15 minutes of tDCS over the cerebellum while participants trained internal timing task. Group B and D received 5 seconds of tDCS on the same area but the tDCS was then switched off without the participants knowledge. The experiment took place over a period of three days. On the first day of the experiment, all participants were tested their external timing task and 2 weeks later, they were tested on their internal timing training with the tDCS applied for two sessions during that day. At the end of the second day, participants were tested their external timing task again to compare the reaction time to results before and after the treatment. Based on the data from these measurements, the independent variable is accuracy and the variable of external timing task, as well as the accuracy of the internal timing task. Results The results of this study were drawn as follows, the type of tDCS (anode, sham) between expert and non-expert had different effectiveness according to the level of motor skills, but not the type of tDCS applied (anode vs sham). Depending on the groups (expert, non-expert) motor skill levels were shown significant improvement of the accuracy and variable in internal timing with tDCS (anode) and its non-expert had bigger improvements than expert in external timing task ( $p = 0.023$ ). In addition, accuracy of internal timing training. Discussion Although anodal tDCS has impact on external timing, the impact is no significant. While in an internal timing training, the experts with more stability tended to be less variable in performance whereas non-experts had a significantly difference on their performance. These results show that the timing training is more effective on non-experts compare to the experts. References Oldfield R C. (1971). The assessment and analysis of handedness: The Edinburgh inventory. *Neuropsychologia*. 9(1), 97-113. Contact [sls418@sun.ac.kr]

### BRAIN INFORMATION PROCESSING OF FOOTBALL PLAYERS DURING DECISION MAKING

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Introduction In soccer, there are many situations in which decision making for instantaneous judgments is required. The main research method in this area has been measuring the Reaction Time (RT) and visual search behavior (Ando et al., 2001; Montes-Mico et al., 2000). It has been argued that RT is an elapsed time from the perceived stimulus to the action, and visual search behavior involves cognitive behavior. For that reason, only analyzing these two indicators, will not produce adequate considerations for how soccer players process information during decision making. The purpose of this study, therefore, was to clarify the differences in information processing process of football players with different performance level. Methods Participant were college football players who were winners of the all Japan university top level ( $n = 5$ ; Expert) and 5 graduate students with no football experience ( $n = 5$ ; Novices). They used a decision making task (Soccer version). Electroencephalography (0.5–100 Hz) was recorded with Ag/AgCl electrodes from 5 scalp locations: Fz, Cz, Pz, C3, C4. Trials with eye blinks, eye movements and response errors were excluded from analysis ( $\pm 80$  mV). EMG-RT is the time from stimulus onset to the appearance of the electromyogram (EMG). EMG-RT is a valid indicator of programming time. the electrode is mounted the surface of the gastrocnemius lateral head. Results P300 was identified at the latency and from the polarity to induced latent, latency and amplitude were also measured. In all of the participants of the experiments and the tasks, P300 has been confirmed. EMG-RT has appeared before the P300 latency in all participants. Expert had a significantly shorter RT and EMG-RT than Novices in the task. Discussion The result of this study identified the trend that EMG-RT has appeared before the P300. The human brain always predicts the future and it changes the behavior by calculating the consistency of the results. Rather than to predict and evaluate by a command from the brain, it can be evaluated from the receiving sensation (Seth, A. K., 2013). This is called the interoceptive inference, and it has attracted attentions in recent years. The results of this study, did not agree with the results of previous studies on the ERP and EMG. For that reason, it can be considered that it is likely to be associated with the interoceptive inference. In future studies, number of participants need to be increased for more reinforced considerations. References Ando, S., Kida, N., and Oda, S. (2001) Perceptual and Motor Skills, 92, 786-794. Montes-Mico R., Bueno I., Candel J., and Pons AM. (2000). Journal of American Optometric Association.



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## DEFENDER'S PURSUIT STRATEGY AGAINST AN ATTACKER IN INTERPERSONAL COMPETITION TASK

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**Introduction** In ball sports, such as basketball or Association football, a defender should approach an attacker to constraint his/her action. Previous studies were to focus on the lateral position or velocity of the player (Brault et al., 2012; Fujii et al., 2014). In lateral direction, a defender is required to react and follow an attacker (i.e. lead-lag phase relation (Duarte et al., 2012)), suggesting that defender have no choices of pursuit strategies, so the expertise of defender's movement could be hidden in the front and rear direction. Therefore, the aim of this study was to examine defender's movement of the front and rear direction on performance outcomes of 1-on-1 penetrating task. **Methods** Six amateur football players (mean age  $18.6 \pm 0.5$  years; training experience:  $10.8 \pm 2.8$  years), and six novices (mean age  $23.5 \pm 1.2$  years) took part in the experiment. Paired participants performed a 1-on-1 duel task in an 11x11m outdoor court, playing a role of either attacker or defender. The attacker was asked to cross the end line behind the defender without being caught by the defender. The defender was told to catch the attacker by touching the attacker with both hands. Participants' movement were recorded by two digital video cameras and their head positions were calculated by 3D direct linear transformation method. Mean and SD of peak velocities of the front (negative values) and rear (positive values) direction were then used to quantify the defender's movement over trials. Results No differences in mean of defender's movement were identified between successful outcomes of attackers (18 trials) and defenders (42 trials) (mean $\pm$ SD =  $-0.11 \pm 0.85$  m/s and  $-0.13 \pm 0.65$  m/s,  $p > 0.05$ ). However, variabilities of defender's movement in attackers succeeded were higher than defender's success ( $0.81 \pm 0.30$  m/s and  $0.60 \pm 0.24$  m/s,  $p < 0.01$ ). **Discussion** The purpose of this study was to investigate the influence of pursuit strategies on the performance outcomes of interpersonal competition task. This study revealed that smaller variability of defender's movement in front and rear direction was related to defender's success, indicating that different defending strategy influence the final outcome of play. Our results suggest that successful defense was achieved through not sink-or-swim but steady and gradual pursuit strategy. **References** Brault, S., B. Bideau, R. Kulpa, and C. M. Craig (2012). Plos One, 7, 13. Duarte, R., D. Araujo, K. Davids, B. Travassos, V. Gazimba, and J. Sampaio (2012). J Sport Sci, 30, 871-877. Fujii, K., D. Yamashita, S. Yoshioka, T. Isaka, and M. Kouzaki (2014). Sport Biomech, 13, 204-214. Contact k.tsutsui6@gmail.com

## EFFECTS OF BLUE LIGHT TREATMENT ON AGILITY IN BADMINTON PLAYERS

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Blue light has been shown to be comparatively effective to regulation of the human circadian clock contrast to bright light ( $\sim 10,000$ lux). Therefore, it is possible for blue light to be effective to physical function of badminton players who work out indoor. The purpose of this study is to exam the effects of blue light treatment on physical performance, especially agility, of highly skilled badminton players. Thirty-seven international badminton players were tested on three separate occasions with the crossover counterbalanced design. In session 1, they tested agility test without any treatment as adaptation of the agility test. Session 2 served as placebo treatment by low white light ( $\sim 200$ lux) for 30min and session 3 served as blue light treatment by lighting blue light (HF3431) to players for 30 minutes before agility test. As results, placebo treatment ( $\sim 200$ lux low white light) improved agility time significantly [ $46.8(3.3)$  vs.  $43.0(3.3)$ ,  $p < .05$ ]. However, Blue light treatment showed more improvement significantly than low light treatment (placebo treatment) [ $43.0(3.3)$  vs.  $42.1(3.1)$ ,  $p < .05$ ]. These findings indicated that blue light treatment can improve physical performance for elite athletic players who have risks for lack of sunlight.

## TEMPORAL AND SPATIAL OCCLUSION OF ADVANCED VISUAL INFORMATION CONSTRAIN COORDINATION TENDENCIES IN ONE-HANDED CATCHING BEHAVIOURS

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**Introduction** Dynamic interceptive actions, like catching, are performed under severe spatial and temporal constraints. Here, we used novel, integrated technology in a spatial and temporal occlusion design, which provided insights on participant behavioural regulation when pre-release visual information of an actor's throwing action was manipulated. **Methods** An integrated video and ball projection machine was used to create four temporal occlusion and five spatial occlusion conditions of an actor throwing a ball towards participants standing 7m away. Hand kinematics and gaze behaviours of 12 participants were recorded while attempting to catch a projected ball at 13.9 m/s that was synchronised with the video footage showing advanced kinematic information from the actor. **Results** Analyses of the temporal occlusion manipulations revealed that when footage was occluded at earlier time points, catching performance decreased. Movement onset of the catching hand and initiation of visual tracking on the ball emerged earlier when footage of the thrower was occluded closer to ball release. The spatial occlusion manipulation did not affect catching success, although movement onset emerged later when a greater proportion of the actor was occluded. Later movement onset in both temporal and spatial occlusion conditions was countered by greater maximum velocity of the catching hand when moving it into a catching position. The final stages of the action (e.g., grasping) remained unchanged across both spatial and temporal conditions, highlighting their sensitivity and suggesting that the later phases of the action were organised using ball flight information. **Discussion** Findings revealed how catching behaviours were continuously (re)organised and adapted as information became available in task performance, first by using kinematic information from images of a thrower's actions, and then with ball flight information. Results highlighted the importance of maintaining information-movement coupling during performance of interceptive actions, with these behavioural adaptations having important implications for research that assesses interceptive skills based solely on pre-ball flight information, as in many studies using current video-based simulation paradigms. Contact Joseph.stone@shu.ac.uk

## Neuromuscular Physiology

### INFLUENCE OF ELECTROMAGNETIC STIMULATION ON MUSCLE STRENGTH

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**INTRODUCTION** The purpose - development and testing of muscle strength building strategy by means of magnetic stimulation of muscles against the background of their voluntary contractions. **METHODS** 18 participants, male athletes, aged 19-28, were teamed up into a control (CG) and experimental (EG) groups. All the subjects performed planter foot flexion with an 80% effort of the maximal rotary momentum (MRM) during 15 trainings on the «Biodex» complex. Each training included 10 five-second contractions with a 50-second break in between. During muscle contractions 5Hz - magnetic stimulation, 50% of «Magstim Rapid-2» stimulator maximal power, was applied to the EG subjects' muscle gastrocnemius. Prior, in 5 and 15 days of the training both MRM and EMG of shin muscles were simultaneously registered. The same days H-reflex and M-response of gastrocnemius and muscle soleus were registered as well. **RESULTS AND DISCUSSION** As a result of 15 trainings, MRM increased in both groups – higher in the EG than in the CG by 15,4% after 5 trainings and by 19,4% after 15 trainings. The analyses of EMG parameters, H- and M-responses prove the more significant gain of power potential in the EG to have been achieved by increase of a descending nerve drive to the spinal motoneurons and increase of gastrocnemius motor-neuron pool reflex excitability. **CONCLUSION** Magnetic stimulation of muscles, against the background of their voluntary contraction, can be used as an extra method of muscle strength building strategy. **CONTACT** gorodnichev@vlgaf.ru, shlyakhtov@inbox.ru

### ADAPTIVE CHANGES OF MOTONEURON PROPERTIES IN RESPONSE TO STRENGTH TRAINING

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**Introduction** Different forms of an increased or a decreased muscular activity induce adaptations in electrophysiological properties of motoneurons (MNs). Long-lasting strength training, with repeated short-term and high-intensity exercises, is responsible for an increase of muscle mass and force, however particular types of motor units respond differently to this kind of training. The aim of this study was to determine whether the strength training induces adaptations in electrophysiological properties of motoneurons innervating the trained muscles. **Methods** The study was performed on adult Wistar rats, randomly assigned to the training or the control groups. Animals from the training group were nutritionally conditioned in order to make weightlifting put on their shoulders, in a special apparatus, with progressively increasing load, for 5 weeks. Intracellular recordings from spinal MNs were made in deeply anaesthetized rats from both groups. Passive and threshold membrane properties were measured, and rhythmic firing of MNs was analyzed. **Results** It was demonstrated that 5-week strength training evoked adaptive changes in motoneurons of both fast and slow types. A shortening of the rise time of action potentials, an increase of input resistance, an increase of the maximum frequencies of rhythmic firing, and an increase in the slope of the frequency-current relationship were observed. Moreover, an increase in the input resistance and a decrease in the minimum currents required to evoke rhythmic firing were noticed in fast-type motoneurons only. **Discussion** Effects of the 5-week strength training were: 1) higher excitability of fast-type motoneurons, 2) higher susceptibility of either fast or slow-type motoneurons to an increased or decreased intensity of stimulation. Higher maximum firing rates of MNs as well as higher discharge frequencies evoked at the same level of membrane depolarization imply higher levels of tetanic forces of motor units after the strength training. Modifications of a motoneuronal firing rate by small changes in intensity of depolarization current (i.e., strength of synaptic input) appear to be more effective in MNs after the strength training. Supported by the National Science Center grant 2013/11/B/NZ7/01518. Contact krutki@awf.poznan.pl

### PLASTICITY OF MOTOR UNITS CONTRACTILE PROPERTIES WITHIN 8 WEEKS OF THE ENDURANCE TRAINING ON A TREADMILL IN RAT HINDLIMB MUSCLE

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**INTRODUCTION** Several tested forms of changed activity, as spinal cord injury, muscle overload, vibration or locomotor training evoke changes of motor unit (MU) properties, including transformation of their physiological types. The study investigated unknown changes in the contractile properties of the three types of MUs in the medial gastrocnemius (MG) muscle of rat resulting from the treadmill endurance exercise. **METHODS** Rats were assigned to 4 groups, untrained – control (C) and trained, 5 days weekly either for 2 weeks (2W), 4 weeks (4W) or 8 weeks (8W). The intensity of locomotion progressively increased. Finally, rats of the 2W group covered average distance of 5.5 km, 4W – 21 km, 8W – 56 km. Subsequently, functionally isolated MUs were investigated in MG in electrophysiological experiments. **RESULTS** The mean body mass of trained rats was lower compared to C group. Proportion of fast fatigable (FF) MUs was lower whereas of fast resistant (FR) higher in all trained groups. Slow MUs proportion increased only in 8W when compared to C group. Changes of contractile properties concerned mainly FR MUs and included: shortening of twitch time parameters, decrease in twitch-to-tetanus ratio, increase in stimulation frequencies at the steep part of the force-frequency relationship. For all trained groups of FR MUs the fatigue resistance increased and MUs considerably increased the ability to potentiate the force of unfused tetani within the fatigue test. For FF MUs of the 2W lower twitch and tetanus forces were noted. **CONCLUSION** An adaptive changes in MU contractile properties in the endurance training appeared early, after 2 weeks of training, evoked physiological transformation within fast MUs and modified mainly properties of FR MUs. Supported by National Science Center grant 2013/09/B/NZ7/02555

### TRANSCRIPTOMIC STUDY OF LUMBAR SPINAL CORD AFTER QUADRICIPITAL ECCENTRIC EXERCISE

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**Introduction** Intense eccentric muscle contractions induce more "Delayed Onset Muscle Soreness" (DOMS) than concentric and/or isometric muscle contractions. We previously showed that eccentric exercise is followed by modifications in muscle fiber typology with a decrease of glycolytic fibers number in a favor of an increase of oxidative fibers (Hody, 2013). The only systematic intervention that provides a muscle protection against DOMS is to do submaximal eccentric contractions with a progressively increased intensity. This protective

mechanism, called the "Repeated Bout Effect" (RBE), is not well understood so far. However, it is likely explained by cellular, mechanical and neural theories (McHugh, 2003). Regarding the hypothesis of a neural theory, the existence of a protective contralateral effect of a unilateral eccentric exercise emphasizes the implication of neural adaptations (Starbuck, 2012). The objective of this study is to better understand which neural signal would be elicited in the lumbar spinal cord after eccentric contractions, and would bring protection through RBE. Methods Male adult mice (C57BL6) were randomly divided into three groups: (1) downhill running with quadriceps eccentrically-biased contractions, (2) uphill running with quadriceps concentrically-biased contractions and (3) untrained control group. Running groups performed an exercise on an inclined treadmill at a velocity of 20cm/s. This latter consisted of running 18 bouts of 5 minutes interspersed with a 2 minutes rest. Lumbar spinal cord was dissected 24h after the running exercise. Total RNA were extracted and analyzed by RNA Seq. Results & Discussion By this approach, we want to identify modifications in gene expressions that would be specifically triggered by eccentric exercise. RNA Seq identified 117 genes over expressed in eccentric group in comparison with concentric and control groups. Two genes obtain high level of expression: PTGDS (1471,35 in eccentric and 749,856 in concentric with a fold change ( $\log_2$ ) of -0,97) and APOD (800,224 in eccentric and 463,647 in concentric with a fold change ( $\log_2$ ) of -0.79). Other genes were significantly more upregulated like LCN2, PLAUR, MAFF, TNFSF8 but APOD and PTGDS are more interesting to explain the possible mechanisms which influence the muscle fibers typology by modulating motoneuron signaling coming from lumbar spinal cord. References Hody, S., Lacrosse, Z., Leprince, P., Collodoro, M., Croisier, J. L., & Rogister, B. (2013). Medical Science and Sports Exercise, 45(8), 1460-1468. doi: 10.1249/MSS.0b013e3182894a33 McHugh, M. P. (2003). Scandinavian Journal of Medicine and Science in Sports, 13(2), 88-97. doi: 10.1034/j.1600-0838.2003.02477 Starbuck, C., & Eston, R. G. (2012). European Journal of Applied Physiology, 112(3), 1005-1013. doi: 10.1007/s00421-011-2053-6

### CONTRACTILE PROPERTIES OF FAST AND SLOW MOTOR UNITS IN RAT SKELETAL MUSCLE AFTER BETA-ALANINE SUPPLEMENTATION

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**Introduction** The concentration of carnosine, a dipeptide synthesised from beta-alanine and L-histidine, is almost twice as high in fast than in slow human muscle fibres (Harris et al., 1998), suggesting its important role mainly in fast muscle physiology. It was shown that supplementation with beta-alanine increased muscle carnosine concentration and improved performance (Hill et al., 2007, Baguet et al., 2010). However, the role of carnosine and its analogue anserine – histidyl dipeptides (HDPs) in contractile function of various types of muscle fibres in vivo is poorly understood. This study determined contractile properties and fatigability of fast and slow motor units (MUs) in rat medial gastrocnemius muscle in vivo after 10-week supplementation with beta-alanine. **Methods** Ten rats were randomly assigned to beta-alanine (supplemented with ~640 mg/kg BW/day beta-alanine) and control (non-supplemented) group. Contractions of 258 medial gastrocnemius MUs were evoked by electrical stimulation of ventral root filaments in deeply anaesthetised animals. Twitch and tetanus force parameters were compared in fast fatigable (FF), fast resistant to fatigue (FR), and slow (S) MUs. The fatigue resistance was tested with a standard 40 Hz fatigue protocol followed by a second fatigue protocol at 40 Hz in fast and 20 Hz in slow MUs. Results In supplemented rats HDPs concentration increased by 25% in red and carnosine by 94% in white portion of medial gastrocnemius muscle in comparison to control rats. Twitch force of FF MUs and maximum tetanic force of FR MUs increased and half-relaxation time was prolonged in slow MUs of supplemented animals. FF MUs fatigued less during first 10 s and FR MUs between 10th and 60th s. In slow MUs forces declined less during first 60 s of 20 Hz test. **Discussion** This study shows that beta-alanine induced muscle carnosine and anserine loading improves twitch force in FF MUs composed of glycolytic type IIB and maximum tetanic force in FR MUs composed of oxidative-glycolytic type IIA fibres. It also improves resistance to fatigue during first 60 s in fast MUs and reduces force decline during repeated low-frequency stimulation in slow MUs composed of oxidative type I fibres. Our data demonstrate an important function of HDPs not only in fast but also in slow MUs. NCN grant 2013/09/B/NZ7/02554. References Baguet A, Bourgeois J, Vanhee L, Achten E, Derave W (2010). J Appl Physiol, 109, 1096–1101. C. Harris R, Dunnett M, Greenhaff PL (1998). J Sports Sci, 16, 639–643. Hill CA, Harris RC, Kim HJ, Harris BD, Sale C, Boobis LH, Kim CK, Wise JA (2007). Amino Acids, 32, 225–233. Contact pawlak@awf.poznan.pl

### FASCICLE BEHAVIOR IN RESPONSE TO VARYING LENGTHENING CONTRACTION VELOCITIES

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**Introduction** The pennate muscle is generally described as a parallelogram model, but the fascicle contracts nonlinearly. The pennation angle (PA) substantially increases as the fascicle approaches the deep aponeurosis under various conditions. Pressure generated by rapid contraction of the synergist muscles may explain this phenomenon observed using an ultrasound probe tightly fixed to the skin. In these cases, fascicle curvature should not be observed during the lengthening contraction. Therefore, this study was designed to clarify whether the pressure of the synergist muscles influences the fascicle behavior of the agonist muscle by analyzing this behavior during lengthening contraction. **Methods** Nine male subjects performed two passive ankle dorsiflexion movements under relaxed (Relaxed), voluntary (VOL), and electrical (ELEC) conditions. Under the VOL and ELEC conditions, the calf muscle was lengthened while the subjects exerted 20% of the maximal isometric ankle plantarflexion torque at 90 voluntarily and electrically. The ankle joint was rotated from 110 to 70 at four velocities (5/s, 45/s, 95/s, and 110/s) and returned to the initial position at 5/s. Longitudinal sectional images of the gastrocnemius medialis muscle were obtained at 36 Hz. For each ultrasonic image, the following points were digitized: point P where a fascicle arises from the deep aponeurosis; 5 points (F5, F10, F15, F20, and F25) on the fascicle; and 5 points (D5, D10, D15, D20, and D25) on the deep aponeurosis 5, 10, 20, and 25 mm horizontally from P, respectively. The interior angles  $\angle F5 P D5$  (PA5),  $\angle F10 P D10$ ,  $\angle F15 P D15$ ,  $\angle F20 P D20$ , and  $\angle F25 P D25$  were calculated as five types of PAs. **Results** When the velocity of ankle dorsiflexion was slow, the PA decreased in similar patterns during lengthening under each condition. At the highest velocity, PA5 significantly remained greater than the other PAs under the VOL and ELEC conditions, and tended to be smaller under the Relaxed condition. As dorsiflexion velocity increased, P tended to move to toward the distal direction under the VOL and ELEC condition to a greater degree than under the Relaxed condition. **Discussion** When dorsiflexion was performed at the highest velocity under VOL and ELEC, P moved in the distal direction, while the PA nearest to the deep aponeurosis remained greater than the other PAs. If pressure caused by contraction of the synergist muscles had influenced this fascicle behavior, it would not be observed during fascicle lengthening because the pressure would also be decreasing. Therefore, greater PAs near the deep aponeurosis during rapid contractions may be caused by factors other than pressure due to the synergist muscles.

## BACKGROUND MUSCLE ACTIVITY INFLUENCES FASCICLE BEHAVIOR DURING REPEATED MAXIMUM MUSCLE CONTRACTIONS

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**Introduction** A parallelogram model is generally used to describe the pennate muscle. However, the pennation angle (PA) is larger near the deep aponeurosis during maximum voluntary contraction (MVC) under various conditions and that the behavior of the muscle-tendon complex is influenced by fatigue. Background muscle activity and prediction of the subsequent movement may also affect fascicle behavior. Therefore, this study was designed to examine the effects of background muscle activity, prediction of MVC timing, and fatigue on fascicle behavior during MVC while shortening (SHO), lengthening (LEN), and isometric contractions (ISO) were passively repeated. **Methods** Fifteen male subjects performed 100 isokinetic knee extension-flexion movements (90/s) with 50 performed at MVC cued by a light at 60 knee angle. MVC was repeated during passively SHO and LEN in every second trial (C1), while the 50 MVC trials were randomly interspersed (C2). Only in the C1 trials were subjects informed beforehand of the light cue timing. MVC was repeated 50 times also during ISO at 60 knee angle every 4 s (C1) or at 5 random times per 20 s (C2). Longitudinal sectional images of the vastus lateralis muscle were recorded at 36 Hz. On each ultrasound image, the following were digitized: point P, where a fascicle arises from the deep aponeurosis; three points (F5, F10, and F15) on the fascicle; and three points (D5, D10, and D15) on the deep aponeurosis 5, 10, and 15 mm horizontally from P. The interior angles  $\angle F5 P D5$  (PA5),  $\angle F10 P D10$ , and  $\angle F15 P D15$  were calculated as three types of PAs. Results Increases in PAs ( $\Delta PA$ ) decreased significantly with MVC repetitions while increases in P movement distance ( $\Delta P$ ) remained unchanged in every contraction type.  $\Delta P$  at MVC during CON were significantly larger in C1 trials than in C2 trials. On the other hand, there were no significant differences between them during ISO. PA5 increased to a significantly greater extent compared with the other PAs at MVC during ISO and ECC.  $\Delta PA$  and  $\Delta P$  were significantly smaller in ECC than in the other contraction types. MVC torque was largest in ECC and smallest in CON. C1 trials produced MVC torque larger than that in C2 trials during ECC and CON. **Discussion** Unlike CON, ISO showed no significant differences in fascicle behavior between the C1 and C2 trials. Similar results were observed for MVC torque, suggesting that ISO is a better condition than CON for performing MVC. ECC and ISO significantly increased PA near the deep aponeurosis and produced larger MVC torque. This indicates that larger PA near the deep aponeurosis may contribute to large force production. However, large differences in MVC torque between the C1 and C2 trials during ECC show the high difficulty of performing MVC during ECC.

## TENSIOMYOGRAPHY OF SELECTED LOWER LIMB MUSCLES IN SPRINTERS AND LONG DISTANCE RUNNERS.

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**Introduction** It is well known that sprinter has exceeded fast twitch fibers. Thus, the contraction velocity of lower limb muscles shorter than long distance runners. However, mechanical properties of the belly in selected lower limb muscles are not clear by TMG method. Therefore, the aim of this study was to clarify the mechanical properties of thigh and leg muscles in sprinters and long distance runners. **Methods** Fifty-five male collegiate athletes from sprinters (SP; n=27; mean  $\pm$  SD age, height and weight were 20.1 $\pm$ 1.5years; 172.7 $\pm$ 3.8cm and 64.2 $\pm$ 4.0kg) and long distance runners (LDR; n=28; mean  $\pm$  SD age, height and weight were 19.5 $\pm$ 1.0years; 170.9 $\pm$ 5.7cm and 55.7 $\pm$ 4.2kg). The mechanical properties of rectus femoris (RF), vastus medialis (VM), vastus lateralis (VL) and biceps femoris (BF) in thigh, and tibialis anterior (TA), gastrocnemius medialis (GM) and gastrocnemius lateralis (GL) in leg were assessed by TMG method. Mechanical properties of delay time (Td), contraction time (Tc) and maximal displacement of the muscle belly (Dm) were analyzed in both groups. Results Td and Tc of RF (Td; 23.4 $\pm$ 0.5ms, Tc; 25.2 $\pm$ 0.9) were showed in among the muscle groups in SP. Tc of BF (37.8 $\pm$ 1.6ms) in LDR was observed long contraction time. Whereas, Td for RF (23.4 $\pm$ 0.5ms) and BF (21.3 $\pm$ 0.4ms) in SP were significant shorter reaction times than LDR. Tc of BF (25.2 $\pm$ 0.9ms) in SP was significantly shorter contraction time than that of LDR (27.8 $\pm$ 0.8ms). And also, same tendency were observed for RF (21.1 $\pm$ 0.8ms), VL (22.1 $\pm$ 0.5ms) and GL (23.1 $\pm$ 1.1ms). Dm of BF in SP showed significant lower values than LDR. **Discussion** In this study, contraction times for rectus femoris, vastus lateralis, biceps femoris and gastrocnemius lateralis in sprinter were significantly differed to the long distance runners. Furthermore, mechanical properties of delay time, contraction time and maximal displacement of biceps femoris were extremely differed between sprinter and long distance runners. From these results, it was considered that mechanical properties on thigh and leg muscles measured by TMG method may reflect to the muscle fiber composition. Reference Dahmane R, Djordjevic S, Smerdu V. (2006). Med Bio Eng Comput, 44(11), 999-1006. Dahmane R, Valen i V, Knez N, Er en I. (2001). Med Bio Eng Comput, 39(1):51-5. Valencic V, Knez N. (1997). Artificial Organs, 21(3), 204-242.

## A STUDY TO EVALUATE THE EFFECTS OF A NEUROMUSCULAR INJURY PREVENTION PROGRAMME IN ADOLESCENT MALES PARTICIPATING IN HURLING

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**INTRODUCTION:** Adolescents involvement in organised sport has never been more popular with nearly 90% of post primary school students in Ireland participating in sport, however, this increased level of activity has reportedly caused concern regarding the potential risk and severity of sporting injuries (2). Previous research into adolescent injury incidence in a variety of multidirectional field sports, including rugby, soccer, and basketball have established a decline in injury rates following the implementation of injury prevention programmes (1). Former investigations into injury incidences and rates within the Gaelic Athletic Association (GAA) has primarily focused on elite adult players, with a lack of data on the adolescent cohort. Adolescents are at risk in terms of overload and growth related injuries in sport, and the GAA is no exception to this (3). **METHODOLOGY:** Over 800 male subjects aged 13 – 18.5 years were recruited from fourteen post primary schools, seven schools participated in the intervention group and seven in the control group. The intervention group implemented an injury prevention programme namely the GAA 15 before training and matches. The control group adopted their normal warm-up behaviour prior to matches and training. At the commencement of the experimental phase each player underwent a screening process to assess their baseline record of their neuromuscular function and physical performance measures. These performance tests consisted of a 20 meter sprint, counter movement jump and the y-balance assessment. The assessments were then repeated when the players exited their competitive season, but no less than six weeks from commencement. Player wellness, activity exposure and injury incidence will be recorded daily by a players mobile phone web application. **RESULTS:** Preliminary results are expected in May 2016 and available for conference presentation. It is hypothesised that the use of an injury prevention programme will have a positive effect on non-contact lower limb injury incidence along with neuromuscular performance elements. **DISCUSSION:** It is predicted that the results of this investiga-



tion will show that the implementation of an neuromuscular injury prevention programme can reduce non-contact sporting injuries in adolescent males participating in GAA field sport. The findings of this research will help to contribute to a knowledge base regarding injury prevention strategies in adolescent males participating in sport. REFERENCES: 1. Ekegren, C.L., Gabbe, B.J. & Finch, C.F., (2015). Sports Medicine, (October). 2. Lunn, P., Kelly, E., & Fitzpathrick, N. (2013) Dublin: ESRI and the Irish Sports Council. 3. Kang, J. et al., (2013). International journal of injury control and safety promotion, 20(1), pp.19–26. CONTACT: sean.kelly@itcarlow.ie

## **A STUDY TO INVESTIGATE THE EPIDEMIOLOGY AND MODIFIABLE RISK FACTORS FOR INJURY IN ADOLESCENT GAELIC FOOTBALL**

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**Aim:** To determine the influence of various modifiable risk factors on injury risk in adolescent Gaelic football players. **Introduction:** The 2014 Annual report by the GAA claims there are 6,969 Gaelic football players between the age of 13 and 17 in talent academies. Recent research suggests that 32% of adolescent Gaelic football players will suffer an injury in a given year; equating to over 2,200 injuries to talent identified youths alone(1). O'Connor (2015) also found that 64% of the injuries were non-contact in nature and may be preventable. There are a number of factors related to an increased risk of injury in this cohort such as overtraining, poor balance and strength(2) and lack of sleep(3). However, to-date, no research has been carried out to quantify the influence of these risk factors on adolescent injury rates in Ireland. The objective of the present study is to establish the potential factors for increased risk of injury and, in-turn, identify potential strategies to decrease injury risk. **Methodology:** 498 male Gaelic football players aged between 13 and 18 years were recruited from 14 post-primary (second level) schools across Leinster. All subjects completed a daily questionnaire via the smartabase smartphone/tablet application. The questionnaire obtained information on daily training loads (RPE x Duration), sleep quantity (Hours) and self reported injuries. Subjects were tested for performance of strength, power, balance and flexibility at the beginning and end of the trial period. Qualitative analysis will also be carried out via semi-structured interviews. These will be done with one coach and one player from each team towards the end of the study to gain a practical insight into this method of athlete monitoring. **Results:** Preliminary results for this study are expected in May 2016 and will be reported at the conference. It is expected that the project will identify risk factors or groups of risk factors which have the greatest impact on injury rates. A regression analysis will be utilised to determine the influence of each risk factor injury. The qualitative analysis will provide an insight into the practicalities of implementing self-monitoring for adolescent athletes. **Discussion:** This study will contribute to a growing body of literature regarding injuries and injury prevention among adolescent athletes. It is the first study of its kind to be carried out in Ireland and also the first study executed with the intent of establishing the influence of individual risk factors or groups of risk factors on injury incidence in this cohort. **References:** 1. O' Connor, S., McCaffrey, N., Whyte, E.F. and Moran, K.A. (2015) Journal of Science and Medicine in Sport 2. Griffin, L.Y. (2006) American Journal of Sports Medicine, 34(9), pp. 1512–1532. 3. Milewski, M.D., Skaggs, D.L., Bishop, G.A., Pace, J.L., Ibrahim, D.A., Wren, T.A.L. and Barzdukas, A. (2014), Journal of Pediatric Orthopaedics, 34(2), pp. 129–133.

## **DAILY INTEGRATED MUSCLE PROTEIN SYNTHESIS RESPONSES WITH RESISTANCE TRAINING USING DEUTERIUM OXIDE.**

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**Introduction** Labeled amino acid infusion trials have been used in the literature to measure myofibrillar muscle protein synthesis (MPS). For instance, it is known that MPS can be elevated for at least 24–48h after resistance-training (RT) and this pattern can vary depending on RT status (i.e., trained and untrained). However, several aspects of this method could preclude a greater applicability of MPS in aligning with phenotypic outcomes, such as the short durations (hours), cannulation, high cost of sterile infusions, with a high demand of control (lab environment enclosure), restricting normal daily activities and feeding patterns. An interesting method that overcomes most of the issues above is the use of deuterium-oxide (D<sub>2</sub>O) ingestion, as it does not require infusions nor does it interfere with daily activities, being ideal to measure MPS in a RT period (Wilkinson et al., 2014). In addition, using an integrative approach to measure MPS allows an 'acute' but longer (days-weeks) precise estimation on the physiological increase in MPS after an RT bout. Therefore, to capture a more integrated scenario of the MPS response throughout a RT period, we assessed day-to-day integrated MPS using D<sub>2</sub>O at different training-phases. **Methods** Ten young men (27±3 y; 69.4±8.8 kg; 172±6 cm) performed 10wk RT (45° leg-press and leg extension exercises, 3 sets of 9–12 RM). Day-to-day integrated MPS analysis was conducted at an untrained basal state (Pre) and 24h and 48h after the first RT bout (W0), third week of RT (W3) and last week (W10) of RT by D<sub>2</sub>O ingestion (100ml bolus, 72h before first biopsy), muscle biopsies (Pre-, 24h and 48h-post RT bout - [-24h only at W0]) and saliva measurements (from 72h before first biopsy until 48h after the RT bout). **Results** Integrated MPS increased after 24h (P < 0.001) and 48h (P = 0.008) at W0, but only after 24h at W3 (P = 0.015) and at W10 (P = 0.05) compared with W1. MPS were greater at W0 compared to W3 and W10 (no difference between W3 and W10) and 24h values were higher than 48h independent of the week of evaluation. **Discussion** Early on RT (W3), the rise in MPS is already down regulated, but is maintained until, at least, at W10 of RT. Independent of training-phase, the increase in MPS in the first 24h after exercise is always greater than 48h. Integrated MPS measured on a day-to-day basis after RT allowed a higher understanding in estimating how MPS is modulated acutely at different training-phases. **References** Wilkinson et al. (2014). Am J Physiol Endocrinol Metab, 306(5), E571–579. Contact c.libardi@ufscar.br

## **CONTRACTILE PROPERTIES OF MOTOR UNITS AFTER 14 DAYS OF HISTIDINE DEPRIVATION IN RATS**

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**Introduction** The role of carnosine, a dipeptide synthesized from L-histidine and beta-alanine, in skeletal muscle contraction and fatigue resistance is still incompletely understood. We recently found that increased muscle carnosine content by beta-alanine supplementation improved motor unit (MU) contractility. Several studies showed that a histidine-free diet decreases carnosine content in rodents (Tamaki et al., 1977, Clemens et al., 1984, Fuller et al., 1947). However, the effect of histidine deprivation induced carnosine depletion on muscle contractility is unknown. **Methods** Ten 6 month-old male Wistar rats were randomly assigned to experimental (HFD) or control (CON) group fed histidine-free or standard diet for 14 days, respectively. In order to maintain the same level of body mass loss, food intake was controlled and balanced between both groups. In HFD group body mass decreased by 11.7% while in CON group by 10.6%. In electro-

physiological experiments, contractions of MUs in medial gastrocnemius (MG) muscle were evoked by electrical stimulation of ventral root filaments. MUs were classified into fast fatigable (FF), fast resistant (FR) and slow (S). Maximum tetanic force (TetF) and force profile during the two separate fatigue tests were analysed. Results In HFD group, carnosine levels were significantly lower than in CON group in a white and red portion of MG muscle by 26% and 34%, respectively. Histidine deprivation did not result in lower muscle mass or muscle-to-body mass ratio. The TetF did not differ between groups either in fast or slow MUs. During the first fatigue test in FR MUs force was initially higher but from 40 to 120 s it was lower in HFD animals. Unexpectedly, in the second fatigue test the force of FR and S MU was better maintained in HFD than CON rats. Discussion In this study, we confirmed previous findings by Tamaki et al. (1977) and Clemens et al. (1984) that histidine deprivation decreases carnosine content, however, to a much lesser extent. The results indicate that short-term histidine deprivation and the carnosine decrease do not attenuate force of MUs. Based on these preliminary findings, it is possible that in this condition compensatory mechanisms may be involved in the regulation of MU force. Supported by NCN grant 2013/09/B/NZ7/02554. References Clemens RA, Kopple JD, Swendseid ME (1984). *J Nutr*, 114(11), 2138-2146. Fuller AT, Neuberger A, Webster TA (1947). *Biochem J*, 41(1), 11-19. Tamaki N, Tsunemori F, Wakabayashi M, Hama T (1977). *J Nutr Sci Vitaminol (Tokyo)*, 23(4), 331-340. Contact kaczmarek@awf.poznan.pl

## REGIONAL DIFFERENCE IN CEREBRAL OXYHEMOGLOBIN CHANGES DURING CYCLING EXERCISE: A NEAR-INFRARED SPECTROSCOPY STUDY

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During cycling exercise, cerebral oxyhemoglobin (O2Hb) changes in motor-related area were measured on near-infrared spectroscopy (NIRS) (Tsubaki et al, in press). However, regional differences in O2Hb within motor-related areas are unknown. The purpose of this study was to investigate the brain cortical activity within motor-related areas and to evaluate the regional difference during multistep incremental cycling exercise. Methods Eighteen healthy volunteers (9 women) participated in this study. After an incremental exercise test on a cycle ergometer to determine the VO2peak, the subjects performed a multistep incremental exercise on a separate day. After a 4-min rest and a 4-min warm-up on the ergometer, exercise began at workloads corresponding to 30%, 50%, and 70% VO2peak, with each stage lasting 5 min, followed by a 4-min cool-down after 70% VO2peak cycling. O2Hb from the supplemental motor area (SMA) and sensorimotor cortex (SMC) were measured by using a 34-channel NIRS system. Skin blood flow (SBF) and mean artery pressure (MAP) were measured synchronously during the experiment. The mean O2Hb in each area, MAP, and SBF were expressed as the change from the mean rest phase value and calculated every 60 s. The peak O2Hb values were compared according to exercise intensity by using one-way analysis of variance and changes in the values within the same load were compared according to area by using a paired t-test. Results SBF and MAP increased from 30% VO2peak to the end of exercise, and the peak value was increased by exercise intensity ( $F(3,68) = 18.225$ ,  $p < .01$  in SBF;  $F(3,68) = 17.490$ ,  $p < .01$  in MAP). The O2Hb increased from 30% VO2peak to the early phase of 70% VO2peak. The peak O2Hb value was increased by the exercise load in each area ( $F(3,68) = 6.227$ ,  $p < .01$  in SMA;  $F(3,68) = 8.965$ ,  $p < .01$  in SMC). During the latter half of 70% VO2peak, O2Hb decreased to the end of exercise. The change in SMC was  $-2.64 \pm 2.66$  (a.u.), and that in SMA was  $-1.34 \pm 2.38$  (a.u.). The decrement value in SMC was larger than that in SMA ( $p < .01$ ). Discussion A O2Hb decrement was observed in SMC and SMA, and the changes were greater in SMC during 70% VO2peak exercise. Motor cortex activity elevated the exercise intensity increment (Brümmner et al, 2011). Cortical activation pattern based on O2Hb differed by brain region (Jung et al, 2015). Our results suggest that SMA and SMC have different activation patterns during high-intensity exercise. References Tsubaki et al, *Adv Exp Med Biol* in press. Brümmner et al, *Neuroscience* 2011; 181: 150-162. Jung et al, *Exp Brain Res* 2015; 233: 1175-1180. Contact tsubaki@nuhw.ac.jp (Tsubaki, A.)

## EFFECTS OF LOWER LEG COMPRESSION SLEEVES ON LOCOMOTION ECONOMY

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Introduction Athletes increasingly use compression garments to enhance their physical performance. Previous investigations of lower leg compression sleeves on running mechanics did not reveal any systematic effects (Stickford et al. 2015). However, effects of compression sleeves on electrophysiological characteristics of muscular efficiency during locomotion have not been examined so far. Thus, this study was designed to identify if lower leg compression sleeves are able to systematically alter muscle strain during locomotion. Methods Twenty-two recreationally active men (age:  $25 \pm 3$  years) walked (6 km/h) and ran (12 km/h) on a treadmill for approximately 30 strides to avoid fatiguing effects with (SL) or without (CON) wearing special designed lower leg compression sleeves (Bauerfeind AG). Myoelectric activity of five lower leg muscles (tibialis anterior, TA; fibularis longus, FL; lateral and medial head of gastrocnemius, LG, MG; soleus, SO) was determined bilaterally using Surface EMG. Effects of applying lower leg compression sleeves on walking and running economy were analyzed by comparing the cumulative muscle activity per distance traveled (CMAPD, Carrier et al. 2011) of the CON and SL situations with repeated measures analyses of variance (sleeve(2)×side(2)×muscle(5)), separately for each velocity. This was followed by Tukey-HSD post hoc tests. Effect sizes were calculated as partial eta squared ( $\eta^2$ ). Results Since "side" did not show any main effect, data from both sides were pooled. Subsequent analyses showed significant interaction effects of "sleeve×muscle" for both locomotion types (walking:  $F(4, 80) = 4.7$ ,  $P = 0.002$ ,  $\eta^2 = 0.19$ ; running:  $F(4, 84) = 3.1$ ,  $P = 0.02$ ,  $\eta^2 = 0.13$ ). Independent of the locomotion type, post hoc comparisons revealed significantly ( $P < 0.001$ ) lower CMAPD values in TA (12%), FL (10%), MG (15%) and SO (14%) during walking and systematically reduced CMAPD levels of TA (9%), LG (12%) and SO (13%) during running. Discussion Lower leg compression sleeves reduce ankle muscle effort that has the potential to enhance locomotion performance, most probably caused by systematic alteration of local mechanisms. The actual findings may thus point towards an optimized muscular economy situation while wearing lower leg compression sleeves and the ability to postpone muscle fatigue during endurance locomotion. References Carrier et al. (2011). *Proc Natl Acad Sci USA*, 108, 18631-18636. Stickford et al. (2015). *Int J Sports Physiol Perform*, 10, 76-83. Contact eduard.kurz@med.uni-jena.de

## Nutrition

**EVALUATING THE EFFECT OF LYCOPENE ON THE LEVEL OF PLASMA MALONDIALDEHYDE IN ATHELETES BY HIGH PERFORMANCE LIQUID CHROMATOGRAPHY**

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**Introduction** Malondialdehyde (MDA), as the final product of lipid peroxidation, was usually detected as the marker of oxidative stress in human body. However, traditional detection methods of MDA, such as UV spectrophotometry and enzyme-linked immunoassay, were lack of specificity and sensitivity. Thus, the purpose of this study was to establish an accurate, rapid and effective method based on high performance liquid chromatography (HPLC) to determine MDA in human plasma. With this method, we quantitatively evaluated the extent of lipid peroxidation in human body and further studied the antioxidant effect of lycopene supplement on athletes. **Methods** (1) The method of HPLC was established with thiobarbituric acid (TBA) as the derivative reagent and the separation was performed on a Phenomenex LUNA C18 column (150 mm×4.6 mm, 5µm). The detection wavelength was set at 532 nm. (2) Fourteen professional female players from Shanghai Women's Field Hockey Team were randomly divided into two groups: the lycopene group (n = 7) and the control group (n = 7). The experiment was carried out in winter training with high training intensity. During the experiment, the lycopene group was supplied with lycopene capsule (which was equivalent to an intake of lycopene as 28 mg/d) for 30 days and the control group was not treated. All the subjects' MDA level in plasma before and after the experiment was detected with the established HPLC method. **Results** (1) Under the optimized HPLC conditions, good linearity of MDA was obtained in the range of 1.0-40.0 µmol/L and the correlation coefficient was 0.9998. The recoveries of MDA at the addition of three levels (2.5, 5.0 and 10.0 µmol/L) was in the range of 100.6%-118.6%. (2) The application research of lycopene supplement showed that after heavy-load training for one month, the MDA level of the control group was significantly increased ( $4.52 \pm 0.31$  vs.  $5.78 \pm 0.65$  µmol/L,  $P < 0.01$ ), while the lycopene group showed no significant difference ( $4.81 \pm 0.26$  vs.  $4.91 \pm 0.31$  µmol/L). Furthermore, after the experiment, the MDA level of the lycopene group was significantly lower contrasted with the control group. **Conclusion** From this study, we successfully established an accurate and reliable HPLC method with good specificity, which was suitable for the determination of MDA in human plasma. Based on the method, we further found that lycopene supplement could inhibit the increase of MDA level during the period of intensive training, which indicated lycopene does have some antioxidant effect in human body. It might also provide some evidence for the role of lycopene in heavy-load training, such as preventing sports fatigue and injury. **References** Richard MJ, Guiraud P, Meo J, Favier A. (1992). *J Chromatogr*, 577(1), 9-18. Rao AV, Ray MR, Rao LG. (2006). *Advances in Food and Nutrition Research*, 51, 99-164. Moselhy HF, Reid RG, Yousef S, Boyle SP. (2013). *J Lipid Res*, 54(3), 852-858. Spirlandeli AL, Deminice R, Jordao AA. (2014). *Int J Sports Med*, 35(1), 14-18.

**GASTROINTESTINAL DISORDERS CAUSED BY USING DRY FOOD**

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**Introduction** Military activities are characterized with high physical load and psychological load. Military personnel are trained in military field exercises several times. The meal in the field exercises support physical endurance and provide physical fitness of military personnel (Wang et al, 2015; Booth, 2003). According to the military legislation all military personnel should be supplied by the hot meal, but the cases when that is impossible, participants of the field training are provided by the dry meal with energy capacity 1200 kcal three times in the day. Energy expenses during the daily activities in the field exercises is high, therefore food energy capacity is high, about 3500-7200 kcal. In some cases combat feeding can cause health disorders that diminish physical fitness and operational readiness of individual (Cochet et al, 2015). **Material and Methods** We provide questionnaire for participants of the military field exercises that allow estimates quality and quantity of the dry food from the users' point of view. There are 120 respondents both genders: respondents from NAF Infantry instructor school and National Defence Academy. **Results** Dry meal covers requirements in food energy for 53% of respondents, the rest 47% feel hunger. Only 23% of respondents give positive assessment to the quality of the dry meal, the rest 73% of respondents dissatisfied with assortment of the component of the dry meal. Military personnel pass through annual health capacity evaluation procedures. 3% of respondents have gastrointestinal disorder. The dry meal that is used (during three days of military training) causes negative consequences: 30% of respondents pointed heartburn, and 10% stress attention to the pain in abdomen, but 3% note the vomiting and diarrhoea. **Conclusion** 1. Dry meal provides basic level of nutrients during the field exercises for individuals – military personnel, but amount of dry food is less than military regulation requires; 2. Gastrointestinal problems are not the leading position in the list of diseases, but for 30% of participants of the experimental group had gastrointestinal disorders as heartburn after using dry meal, 10% of respondents had abdominal pain, but 3% - vomiting and diarrhoea. Do not insert authors here

**THE EFFECT OF POMEGRANATE EXTRACT ON OXYGEN TRANSPORT AND EXERCISE PERFORMANCE IN HIGHLY-TRAINED CYCLISTS AT LOW AND HIGH ALTITUDES**

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**Introduction** Maximal aerobic exercise performance is often limited by the rate of oxygen (O<sub>2</sub>) delivery via the erythrocytes to the muscles for energy production (Wagner, 1996). Nitric oxide (NO), produced endogenously by NO synthases in epithelia and also from dietary nitrate (NO<sub>3</sub><sup>-</sup>), induces dilation of the arterioles, improving blood flow and reducing erythrocyte damage. Pre-exercise intake of NO<sub>3</sub><sup>-</sup>-rich beetroot juice (BJ), reduces O<sub>2</sub> uptake (VO<sub>2</sub>) for the same submaximal cycling workload, leading to an improvement in power output at VO<sub>2</sub>max and time to exhaustion during a cycling time trial (TT) (Bailey et al. 2009; Lansley et al. 2011; Larsen et al. 2007). However, BJ has little such effect in highly-trained athletes who have greater vascular control. Pomegranate extract (POM) is high in NO<sub>3</sub><sup>-</sup> and polyphenols; the latter increasing NO production in the stomach and protecting NO from oxidative damage (Ignarro et al. 2006). This study investigated whether POM reduces the O<sub>2</sub> cost of exercise in highly-trained cyclists and if the effect is greater at high altitude where lower atmospheric O<sub>2</sub> pressures impair O<sub>2</sub> delivery to the muscles. **Methods** Eight cyclists completed three stages of exercise at 50, 65 and 80% of their VO<sub>2</sub>max, followed by a TT to exhaustion (TTEX) at a workload calculated to elicit VO<sub>2</sub>max. The protocol was completed four times: at sea-level (SEA) and 1650m of altitude (ALT), with pre-exercise consumption of 1000mg of POM or a placebo (PL) at both altitudes. VO<sub>2</sub> was measured in the last minute of each stage. A repeated measures ANOVA was performed for all dependent variables. **Results**

Maximal VO<sub>2</sub> during the TT was significantly decreased in SEAPOM compared to SEAPL and increased in ALTPOM compared to ALTPL ( $p=0.022$ ). Submaximal VO<sub>2</sub> values were not affected. TTEX was reduced in ALT ( $p=0.01$ ), but was not influenced by POM. Discussion The improved O<sub>2</sub> transport efficiency following POM allowed a similar TTEX with a lower maximal O<sub>2</sub> cost at SEA, but POM enabled restoration of SEA VO<sub>2</sub>max values at ALT. Previous research has proposed that NO-induced vasodilation increases blood perfusion and O<sub>2</sub> delivery to distal areas of myocytes, improving the matching of O<sub>2</sub> delivery and requirement (Bailey et al. 2009). In POM, the combination of NO<sub>3</sub>- to produce NO and polyphenols to protect it, were effective in limiting the restrictions to O<sub>2</sub> delivery in high altitude conditions. References Bailey S, Winyard P, Vanhatalo A. (2009). J Appl Phys, 107, 1144-1155. Ignarro L, Byrns R, Sumi D. (2006). Nitric Oxide, 15, 93-102. Lansley K, Winyard P, Bailey S. (2011). J Appl Phys, 110, 591-600. Larsen F, Weitzberg E, Lundberg J. (2007). Free Radic Biol Med, 48, 342-347. Wagner P. (1996). Annu Rev Physiol, 58, 21-50. Contact E.Crum@massey.ac.nz

## ACUTE ORAL CAPSINOIDS SUPPLEMENTATION HAS NO BENEFICIAL EFFECT ON RECOVERY FROM EXERCISE-INDUCED FATIGUE IN HUMANS

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**Introduction** Previous studies showed that capsinoids (CNS) are able to enhance energy expenditure, fat oxidation, antioxidant and insulin action in mice and humans (Kawabata et al., 2009; Luo, Peng, & Li, 2011; Snitker et al., 2009). Little study is regarding to whether CNS administration is expected to cause metabolic consequence in turn to affect muscle glycogen conservation following a glycogen depletion cycling exercise and attenuate exercise induced fatigue in humans. Therefore, this study has been proposed to demonstrate the effect of acute oral capsinoids (CNS) supplementation on attenuating exercise induced fatigue and conservation of muscle glycogen exhaustion following a glycogen-depletion cycling exercise. **Methods** Eleven healthy male subjects (aged  $20.5 \pm 0.2$  years old; height  $171.3 \pm 2.4$  cm; weight  $67.0 \pm 3.4$  kg; BMI  $21.5 \pm 0.6$ ; VO<sub>2</sub>max  $46.4 \pm 2.4$  ml/kg/min) were participated in this crossover designed study, and considered them as CNS or placebo trials. Participants in respective trials consumed either 30 mg CNS or placebo with light breakfast (300kcal, 60 % carbohydrate, 25 % fat, 15 % protein) before exercise, and then completed a 70-min cycling exercise with glycogen-depletion protocol. Subjects were crossed-over and repeated the study 7 days after washout period. Biopsied muscle samples were obtained from vastus lateralis before and immediately after exercise. Simultaneously, expired gas and blood samples were measured during the study periods for all subjects. **Results** The results showed that there were no difference responses in muscle glycogen, blood glucose, lactate dehydrogenase and creatine kinase levels between CNS and placebo trials. Plasma NH<sub>3</sub> was lower in CNS compared to placebo immediately and 3-h after exercise. Nevertheless, lower response of circulating NEFA was found in CNS trial compared to placebo. Furthermore, the rate of glycogen depletion in CNS trial was similar to that in placebo before and immediately after exercise. **Discussion** The results of this study were inconsistent with the evidences in previous animal and human studies (Kawabata et al., 2009; Luo, Peng, & Li, 2011; Snitker et al., 2009). Therefore, the hormesis effect of CNS supplementation on human study will be examined in next study. **Findings** from blood biomarkers in this study showed no supporting evidence that CNS could attenuate exercise-induced fatigue in young men. Besides acute CNS supplementation is unable to influence metabolic consequences, which in turn affect the conservation of glycogen depletion following glycogen-depletion cycling exercise. **References** Kawabata, F., Inoue, N., Masamoto, Y., Matsumura, S., Kimura, W., Kadowaki, M., . . . Fushiki, T. (2009). Bioscience, biotechnology, and biochemistry, 73(12), 2690-2697. Luo, X.-J., Peng, J., & Li, Y.-J. (2011). European journal of pharmacology, 650(1), 1-7. Snitker, S., Fujishima, Y., Shen, H., Ott, S., Pi-Sunyer, X., Furuhashi, Y., . . . Takahashi, M. (2009). The American journal of clinical nutrition, 89(1), 45-50. Contact ischeng1965@mail.ntcu.edu.tw ischeng1965@ntcu.edu.tw

## EFFECTS OF ALKALINE VERSUS MINERAL WATER ON ENDURANCE PERFORMANCE IN TRAINED CYCLISTS

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**Introduction** Water provides a performance-limiting factor during exercise. Besides quantity and time of consumption, quality and composition are important. It has been shown that alkaline supplementation (AS) can prevent a decrease in blood HCO<sub>3</sub>- during high intensity exercise (Pouzash et al., 2012). Therefore AS with hydrogen carbonate may increase endurance capacity (EC). The aim of the study was to evaluate the influence of natural alkaline glacier water (AGW) and commercially available mineral water (MW) on aerobic and anaerobic EC. **Methods** The quasi-experimental study involved 7 female and 11 male cyclists (mean age  $26.4 \pm 4.8$  yr, BMI  $23.1 \pm 2.6$  kg/m<sup>2</sup>) that engaged in  $7.2 \pm 2.6$  hours of physical activity per week. Subjects displayed a mean VO<sub>2</sub>max of  $56.9 \pm 7.8$  ml min<sup>-1</sup> kg<sup>-1</sup> in male, and  $42.4 \pm 2.4$  ml min<sup>-1</sup> kg<sup>-1</sup> in female. Using a controlled, blinded cross-over design subjects were randomized in two groups. Time-to-exhaustion-test (TET) at 80% of individual VO<sub>2</sub>max and anaerobic 75-s-cycling test (A75) at 90 R/min were conducted with a 20 minute recovery in between. Test protocol was repeated after 7 days. Three days before each test protocol athletes consumed 3 liters of MW or AGW every day. On test days, athletes drank another liter of MW or AGW one hour before and a pint in between the two tests. The diet in the days before was controlled and standardized with respect to the liquid supply. Statistical analysis was performed using SPSS 20.0. The significance level was set to  $p \leq 0.05$ . **Results** Cyclists consuming AGW scored a significant ( $p < .01$ ) longer travel time in the TET than cyclists consuming MW ( $47.4 \pm 6.7$  min versus  $43.4 \pm 9.3$ ; 8.4%). After the test, oxygen uptake in the intervention with AGW was significantly higher ( $p = .027$ ) than in the intervention with MW ( $46.8$  ml min<sup>-1</sup>kg<sup>-1</sup> versus  $44.9$  ml min<sup>-1</sup>kg<sup>-1</sup>). During A75 subjects drinking AGW achieved a significant higher ( $p < .01$ , 8.2%) output ( $446.6 \pm 164.9$  watts) compared to subjects drinking MW ( $410.0 \pm 128.8$  watts). **Discussion** Milieu shifts are an important limiting factor in endurance performance (Heil, et al., 2012). During intense physical stress the blood pH can fall below 7.0, decreasing the oxygen binding properties. Various buffer systems can influence the pH value (Pilegaard et al., 1999) effecting the acid-base balance. In this context it has been shown, that alkaloids can increase the blood buffer capacity and therefore improve EC (Nielsen et al., 2002). An improved buffering capacity and oxygen-binding capacity through AGW may have contributed to the improved performance in the cycling test, highlighting the performance enhancing effects induced by a natural product from the glaciers. **References** Heil D, et al. (2012). J Int Soc Sports Nutr., 9: 8. Nielsen HB, et al. (2002). J Appl Physiol. 93: 724-731. Pilegaard H, et al. (1999). Am J Physiol- Endoc Metab., 276 (2) 255-261. Pouzash R, et al. (2012). Bal J Heal Physol Act., 4 (2) 84-90. Contact kuno.hottenrott@sport.uni-halle.de



## INFLUENCE OF A PALEO-DIET INTERVENTION ON TASTE PERCEPTION IN HEALTHY PEOPLE

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**Introduction:** A balanced and healthy diet is fundamental for a general performance in sports. The Paleolithic diet (PD) is associated with positive health due to its relation to the human genome and the exclusion of processed products. The eating pattern of recreational athletes is largely disturbed and relay to troubles in taste perception [2]. Therefore the aim of this explorative study was to investigate the effect of PD on taste thresholds. The knowledge of bitter taste perception suggests that it will undergo the most significant change under modified circumstances (e.g. altitude) [3]. **Methods:** Taste thresholds [detection threshold (DT); variation threshold (VT)] of 16 healthy subjects ( $m=13$ ;  $w=3$ ;  $age=22.3\pm3.2$ ;  $BMI=23\pm2.1$ ) were investigated before (d-6), during (d2, d5) and after (d+1, d+60) a 10 day PD intervention. Increasing molar concentrations of compounds representing sweet, salty and bitter were presented by using the Three-Drop-Test [1]. **Results:** Mean DT of bitter and salty decreased absolutely on d2, d5, d+1 and d+60 compared to d-6 [bitter:  $4.3\pm2.0$ ,  $4.1\pm1.9$ ,  $3.8\pm1.2$ ,  $3.6\pm1.6$ ,  $4.1\pm1.6$ ; salty:  $4.6\pm2.0$ ,  $4.6\pm2.1$ ,  $4.1\pm1.5$ ,  $3.6\pm1.0$ ,  $3.8\pm1.3$ , respectively]. Mean DT of sweet decreased absolutely from day d-6 to d2, d5, d+1 and d+60 [ $3.9\pm1.3$ ,  $3.1\pm1.4$ ,  $3.5\pm1.2$ ,  $3.7\pm1.4$ ,  $3.4\pm1.4$ , respectively]. Mean VT of bitter increased absolutely from d-6 to d2, d5, d+1 and d+60 [ $1.8\pm0.9$ ,  $2.1\pm1.3$ ,  $2.3\pm1.4$ ,  $2.3\pm1.1$ ,  $2.0\pm1.2$ , respectively]. Mean VT of salty decreased absolutely from d-6 to d2, d5, d+1 and d+60 [ $2.1\pm0.9$ ,  $1.9\pm0.9$ ,  $1.9\pm0.8$ ,  $2.0\pm0.8$ ,  $1.8\pm0.8$ , respectively]. Mean VT of sweet show considerable fluctuations. It decreased absolutely from d-6 to d5 and d+60 [ $2.0\pm1.2$ ,  $1.7\pm0.9$ ,  $1.8\pm1.1$ , respectively], but it also increased absolutely on d2 and d+1 [ $2.3\pm1.3$ ,  $2.1\pm0.9$ , respectively]. **Conclusion:** The study showed that a 10-day PD application affects the taste thresholds in healthy people. When looking at the DT of all tastes, particularly in long-term cases, the results indicate a tendency of increasing sensitivity. As already suspected an especially continuous shift was seen at the DT of bitter [3]. We speculate that the sensitivity of tastes increase because of the intake of only natural food and the absence of foodstuff additives in processed products. Literature 1. Ahne, G., et al. (2000). Assessment of Gustatory Function by Means of Tasting Tablets. The Laryngoscope. 110 (8), 1396-401. 2. Darcy A. M., et al. (2013). The Eating Disorder Examination Questionnaire (EDE-Q) among university men and women at different levels of athleticism. In Peter M. Miller (Ed.), Eating Behaviors (pp. 378-381). Charleston, SC: Medical University of South Carolina. 3. Maga, J. A. & Lorenz, K. (1972). Effect of altitude on taste thresholds. Percept Mot Skills. 34, 667-670.

## DOES A PALEOLITHIC DIET INFLUENCE PERFORMANCE OR METABOLIC PARAMETERS AND IS IT SUITABLE IN EVERYDAY LIFE OF YOUNG SOCCER PLAYERS? – A PILOT STUDY

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A balanced and healthy diet is essential for elite athletes and thus it is for soccer players. Nevertheless many investigations show that the eating patterns of young soccer players are largely inadequate. To satisfy energy needs and optimize performance a modification seems to be necessary. A paleolithic diet (PD) is assumed to be associated with positive health due to its exclusion of processed food products. The aim of the present study was to investigate whether a PD is compatible for young German soccer players and to evaluate metabolic parameters at rest and during endurance exercise. 17 young soccer players ( $age: 14.4\pm0.5$  years;  $body\ mass: 64.8\pm6.5$  kg;  $height: 173.5\pm6.5$  cm,  $fat\ mass: 10.8\pm1.2$  %) completed two test trials, separated by a 4-week intervention period. The intervention group (PG) ate a paleolithic diet based on the lifestyle conditions more than 10.000 years ago preferring minimally processed food, wild fruits, vegetables and different animal food. The control group (CG) was instructed to follow their normal diet. Between the test trials all participants completed a nutrition diary and underwent identical training protocols. The test days started with venous blood sampling to determine lipid profile, glucose, electrolytes, urea and uric acid, and anthropometric measurements followed by different exercises, such as sprints, jumps and an incremental step test on a treadmill for the determination of  $VO_{2max}$ . Furthermore, they completed the 30-15 intermittent fitness test during their training sessions one day later. Additionally, an interview was performed for the determination of compliance and possible side effects. Because of illness, injury, incompatibility or an insufficient level of compliance with the intervention guidelines, five participants did not complete the study or were excluded from statistical analysis. Weight (PG: pre  $65.6\pm5.8$  kg vs. post  $64.9\pm5.6$  kg; CG: pre  $61.6\pm7.0$  kg vs. post  $61.7\pm6.4$  kg), fat mass (PG: pre  $10.5\pm0.8$  % vs. post  $9.9\pm1.0$  %; CG: pre  $10.2\pm1.4$  % vs. post  $10.7\pm1.5$  %) and metabolic blood parameters remained unaffected by the dietary intervention. Performance parameters like sprint time, jump height and endurance performance showed no significant differences within and between groups, as well as metabolic parameters during exercise. However, 4 out of 9 participants reported gastrointestinal discomfort during the paleolithic diet intervention, two complained about having headaches and two about a loss of concentration or sleeping problems. To summarize, a 4-week paleolithic diet did not affect performance or metabolic parameters during rest or exercise in young football players, but caused symptoms of discomfort in the majority of them.

## ASSOCIATION BETWEEN THE JAPANESE CHILDREN AND MOTHERS ABOUT THEIR LIFESTYLE AND NUTRIENT INTAKE

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**Introduction** Eating habits of children are greatly affected by their parents. However, the relationship of the nutrition situation has not been much studied. The present study examined that the relationship between mothers and children about their lifestyle, preference and nutrition. **Methods** Thirty-two Japanese primary school children aged 8 to 11 years (19 boys, 13 girls ; mean age  $10.1\pm0.8$  years, percent overweight  $-0.2\pm16.2\%$ ). and their mothers (mean age  $40.5\pm3.9$  years, BMI  $21.1\pm2.4$  kg/m<sup>2</sup>) were searched about their lifestyle, preference and nutrition. Their lifestyle and preference were investigated by original questionnaire, and their nutrient intake were used by the brief self-administered diet history questionnaires (BDHQ; for adult, BDHQ\_10y; for primary school children). BDHQ and BDHQ\_10y consist of 60 questions that can answer about 15 to 20 minutes, and their reliability and validity have been described by previous study (Okuda et al. 2009; Kobayashi et al. 2011; Kobayashi et al. 2012). We examined the relationship their lifestyle, preference and nutrition, using partial correlation analysis. **Results and Discussion** No differences were found in height, weight, percent overweight and age between boys and girls. There were no correlations between percent overweight and BMI. Primary school children, many lifestyle and preference were significantly correlated with mother's. Children's intake of energy, protein and fat were significantly correlated with mother's, and the coefficient of correlation values were about 0.4 to 0.5. On the other hand, there were no correlations with any of the following: carbohydrate, vitamin D, vitamin B12, sodium or salt. However, most vitamins and minerals were significantly correlated between children's and mother's, and the coefficient of correlation values were about 0.4 to 0.7. These finding suggests that schoolage children's lifestyle, prefer-

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## SIDE EFFECTS OF ENERGY DRINKS AND CAFFEINATED BEVERAGES

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Do not insert authors here Introduction There has recently been a major growth in the consumption of products containing caffeine, such as energy drinks and energy drinks mixed with alcohol among teenagers and young adults (Gradwohl and colleagues, 2015). Not long ago caffeine appeared on the dope-list as banned performance enhancing drug. Apart from its stimulant effect it can cause numerous unpleasant symptoms. Several studies describe, that high caffeine dose contributes to cardio-vascular, neurological, metabolic problems (Ibrahim-Iftikhar, 2014). Energy drinks combined with alcohol increase consumers' desire for alcohol (McKetin-Coen, 2014). Method In our quantitative research we examined 1459 persons. The target-group was the of 10-26 year old population, chosen randomly (mean age: 15,6±3,8 year). The survey was based on questionnaire and asking people about their energy drink consumption habits and their possible side-effects. Results According to the collected data 81,8% of the participants have consumed at least once energy drink, 63,3% has tried several products of the kind. 75,4% of the energy drink consumer are young, from 10 to 17 years old. 21,1% of the studied population mixes it with alcohol, 1,7% it with other caffeinated drinks. 19,8% consumes it on a daily basis, 23,1% more than once in a week, while 39,3% drinks it very rarely. 67,1% experienced unpleasant symptoms, 42,7% complained about more than one side-effects, such as rapid Heart Rate (51%), insomnia (38,8%), weakness, shiver (25,4%), headache (21,4%), in some cases even loss of consciousness. These symptoms or syndromes occurred among 86,5% of the participants, who were mixing energy drinks with alcohol, and affected 95% of those consuming more caffeinated products at a time. After collecting these data now we study the immediate physiological effect of different caffeinated drinks in 18-26 year olds adults under exercise load (eg 20m Shuttle Run test). Heart rate changes and the status of the vegetative system are analyzed. Furthermore the impacts of these products in terms of coordination and reaction time are also investigated. Conclusion The results show that high proportion of the 10-26-year-old participants consumes energy drinks and even mixed with alcohol, leading in many cases to harmful side-effects of caffeine overdose. References Gradwohl, E., Vida, K., Rácz, J. (2015): Fillitup...Survey of the relationship between alcohol and energy drink consumption and risky behavior among young adults. *Orv.Hetil.*, 2015.156(27), pp.1100-1108. Ibrahim, N.K., Iftikhar, R. (2014): Energy drinks: Getting wings but at what health cost? *Pak J MedSci*, 30 (6), 1415-1419. McKetin, R., Coen, A. (2014): The Effect of Energy Drinks on the Urge to Drink Alcohol in Young Adults. <http://www.ncbi.nlm.nih.gov/pubmed/25041069> (7. 02 2016) Contact soosrita8@gmail.com mwilhelm@gamma.ttk.pte.hu

## THE EFFECTS OF RED GINSENG INTAKE ON CENTRAL AND PERIPHERAL FATIGUE IN TRAINED MICE

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Introduction Fatigue is mainly divided into central nervous system fatigue, which the cerebrum perceives, and peripheral fatigue, which occurs in muscle and nerve tissues. There are a few natural substances that are so-called adaptogen in Korea, including Korean ginseng and red ginseng (RG), as well as other familiar medicinal herbs. This study aims to analyze energy utilization from the combination of RG administration and exercise, and to investigate the mechanism and the effect of RG administration on exercise-induced fatigue by analyzing 5-HT mRNAs, a central nervous system fatigue factor that is induced exercise, energy utilization during exercise (a peripheral fatigue factor), and change in mRNA related to energy control through 2 weeks intervention of RG and treadmill training in an animal model. Methods Seven-week old male ICR-mice were randomly divided into 2 groups, CON-Tr (CON-Tr, no RG administered with treadmill exercise training, n=24) and RG-Tr (RG-Tr, RG administered with treadmill exercise training, n=24). Red ginseng extract (RG) dissolved in distilled water was administered to the RG group daily at a dose of 1 g/kg body weight for 2 weeks. The gene expression was determined by semi-quantitative analysis using RT-PCR. Results The expression of Tph-2, 5-HTT mRNAs in brain region was not different between the two groups. Also, the levels of 5-HT1A and 5-HT2A receptor mRNAs were no significant differences between the groups. The changes of GLUT4, MCT4 and FAT/CD36 mRNA expression in gastrocnemius, did not significantly different between the groups. But the expression of MCT1 and CPT1b mRNA tended to be higher in the RG-Tr group 1 hour after exercise and at recovery points. Discussion Fatigue is a warning signal not only for the brain, but also for muscles and other organs that signal the body's needs for rest [1][2]. Peripheral fatigue is mainly caused by depletion of stored energy in peripheral tissues[3]. Thus, to increase the ability to exercise efficiently it is necessary (1) to increase stored glycogen in the liver and muscle, (2) to promote oxidation of stored fat, and (3) to promote blood circulation. Therefore, in our results, the intake of RG is considered to be an effective ergogenic aid in improving endurance exercise ability. From this study, further research looking for a supplement (ergogenic aid) that helps improve exercise ability is still required. References [1] Shulman RG, Rothman DL. (2001). *Proc Natl Acad Sci*, 98, 457-461. [2] MP Davis, D Walsh. (2010). *J Support Oncol*, 8(4), 164-174. [3] Ikeuchi M, Koyama T, Takahashi J, Yazawa K. (2006). *Biol Pharm Bull*, 29, 2106-2110.

## EIGHT WEEKS ORAL GREEN TEA EXTRACTS SUPPLEMENT INFLUENCED ENERGY METABOLISM DURING HIGH INTENSITY CYCLING EXERCISE IN HUMANS

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Introduction Green tea contains GTEs of polyphenolic flavonoids known as tea catechins (TC), which comprise epigallocatechin gallate (EGCG) and epicatechin gallate (ECG). Most of studies showed that Green tea extracts (GTEs) are able to enhance energy expenditure and antioxidant capacity in humans (Kuo et al., 2015; Venables et al., 2008). Previous studies showed that GTEs enhanced fatty acids oxidation to promote fat metabolism on moderate-intensity exercise in regularly trained subjects (Venables et al., 2008). Little study is regarding to whether short term oral GTEs supplementation can influence energy metabolism during high intensity exercise. Therefore, this

study investigated energy metabolism, fat oxidation, carbohydrate oxidation and blood biomarkers to demonstrate the influences of oral eight weeks supplementation during 75% peak VO<sub>2</sub> 60 minutes high-intensity cycling exercise. Methods Eleven healthy male subjects (aged  $22.0 \pm 1.06$  years old; height  $172.7 \pm 1.08$  cm; weight  $67.0 \pm 3.4$  kg; BMI  $24.25 \pm 0.76$ ; VO<sub>2</sub>max  $43.23 \pm 2.41$  ml/kg/min) were participated in this crossover designed study, and considered them as GTE or placebo trials. Participants in respective trials consumed eight-week either 500 mg GTEs (375 mg Polyphenols & 125 mg EGCG) or placebo, and then completed 60 minutes with 75% VO<sub>2</sub> max cycling exercise. Subjects were crossed-over and repeated the study 28 days after washout period. Simultaneously, expired gas and blood samples were measured during the exercise periods for all subjects. Results Lower respiratory exchange ratio was found immediately after exercise in GTE trial, based on exchange gaseous measurement. Therefore, higher fat oxidation response was found in this study after GTE supplementation. However, no effect of eight weeks of GTEs on blood markers of lipolysis compared to placebo trials. Interestingly, higher total energy expenditure was found in GTE trial compared to placebo trial. Discussions This study demonstrated that oral eight weeks GTE supplementation influenced energy metabolism including energy expenditure, fat oxidation and carbohydrate rates based on exchange gaseous measurement following a 75% peak VO<sub>2</sub> 60 minutes high-intensity cycling exercise. Randell et al. found that no effect of 1 or 7 day of GTE ingestion on fat oxidation during 60-min cycling exercise with 50% Wmax (Randell et al., 2013). However, all results of this study were consistent with the evidences in previous human studies (Kuo et al., 2015; Venables et al., 2008). Our study demonstrated eight weeks oral GTE supplementation influenced energy metabolism during a 60-min with 75% VO<sub>2</sub>max cycling exercise challenges in humans. References Kuo YC, Lin JC, Bernard JR, Liao YH. (2015). *Appl Physiol Nutr Metab*, 40(10), 990-996. Randell RK, Hodgson AB, Lolito SB, Jacobs DM, Boon N, Mela DJ, Jeukendrup AE. (2013). *Med Sci Sports Exerc*, 45(5), 883-891. Venables MC, Hulston CJ, Cox HR, Jeukendrup AE. (2008). *Am J Clin Nutr*, 87(3), 778-784. Contact fatbear110@gmail.com

## PANACEO SPORT SUPPLEMENTATION SHOWS NO EFFECT ON BLOOD LACTATE CONCENTRATION AND ENDURANCE PERFORMANCE

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Introduction: Panaceo Sport is a dietary supplement based on zeolite (71.7%). Further components are dolomite (18.3%), lepidium meyenii (6.7%) and royal jelly (3.3%). Zeolites are microporous, aluminosilicate minerals that can accommodate cations. Panaceo Sport is taken by athletes to reduce blood lactate concentration (La) and to enhance endurance performance. Aim of this study was to evaluate these properties. Method: 16 trained male cyclist (VO<sub>2</sub>max:  $52.7 \pm 6.0$  ml/kg/min) performed an incremental exercise test (starting workload of 100 W was increased by 20 W every minute) at the beginning (pretest) and at the end of two supplementation phases. Randomized, Panaceo Sport or placebo was taken in the first and changed vice versa in the second supplementation phase (cross over). Each supplementation phase was 2 weeks. Placebo was siliceous earth (96.0%) and lycopodium (4.0%). First (LTP1) and the second lactate turn point (LTP2) were defined as reported by Hofmann & Tschakert (2011). Results: La at rest ( $0.83 \pm 0.36$  mmol/l,  $0.98 \pm 0.35$  mmol/l and  $0.97 \pm 0.30$  mmol/l, respectively), 100 W ( $0.95 \pm 0.26$  mmol/l,  $0.93 \pm 0.24$  mmol/l and  $0.98 \pm 0.22$  mmol/l, respectively), LTP1 ( $1.28 \pm 0.27$  mmol/l,  $1.24 \pm 0.27$  mmol/l and  $1.33 \pm 0.33$  mmol/l, respectively), LTP2 ( $3.19 \pm 0.67$  mmol/l,  $3.27 \pm 0.64$  mmol/l and  $3.25 \pm 0.56$  mmol/l, respectively) and termination of test ( $9.84 \pm 1.64$  mmol/l,  $9.97 \pm 2.06$  mmol/l and  $10.57 \pm 1.60$  mmol/l, respectively) showed no difference ( $p > 0.05$ ) between pretest, Panaceo Sport and placebo. Power output at 2 mmol/l ( $256.3 \pm 37.0$  W,  $259.4 \pm 38.0$  W and  $258.6 \pm 39.3$  W, respectively), 4 mmol/l ( $303.7 \pm 36.8$  W,  $308.6 \pm 39.3$  W and  $304.4 \pm 39.3$  W, respectively), LTP1 ( $213.8 \pm 24.2$  W,  $216.4 \pm 23.9$  W and  $213.8 \pm 24.2$  W, respectively), LTP2 ( $290.9 \pm 36.1$  W,  $295.9 \pm 34.2$  W and  $293.6 \pm 38.5$  W, respectively) und termination of the tests ( $362.5 \pm 41.2$  W,  $369.4 \pm 42.2$  W and  $370.0 \pm 41.3$  W, respectively) was unchanged ( $p > 0.05$ ). No difference ( $p > 0.05$ ) was also found in VO<sub>2</sub>max ( $3.826 \pm 0.536$  l/min,  $3.889 \pm 0.586$  l/min and  $3.792 \pm 0.621$  l/min, respectively). Conclusion: Independent studies are needed to analyse publicized effects of dietary supplements. In this study Panaceo Sport showed no effect on blood lactate concentration and endurance performance. Further studies are needed on zeolite based dietary supplements. References Hofmann & Tschakert (2011) Article ID 209302. doi:10.4061/2011/209302

## FRUCTOSE SUPPLEMENTATION ABROGATES EXERCISE INDUCE CHANGES IN IRON METABOLISM

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Introduction Exercise has been shown to induce changes in iron metabolism mainly by inducing increase in blood hepcidin. Hepcidin limits intestinal iron absorption thus it has been reported that physically active people are characterise by lower body iron stores. Study on animals demonstrated that fructose can affect iron metabolism leading to its liver accumulation. In this study we hypothesise that diet rich in simple sugars like fructose or glucose will modulate the effects of exercise on iron metabolism. Methods 17 young men ( $21 \pm 1$  years old) took part in the experiment. The participants were divided into following sub-groups fructose (GF) and glucose (GG) supplemented. All of them received the same diet for 3 days supplemented with fructose (4g/kg b.w) or glucose (4 g/kg b.m.) respectively. Aerobic test was performed at the beginning of the study and after three days of sugars supplementation. Blood was collected from an antecubital vein before and 1 hour after aerobic test. The serum hepcidin and genetic testing for HFE mutations (H63D) was performed. Results In the present study we demonstrate that 3 days sugar diet when enriched in fructose or glucose abrogates exercise induced increase in blood hepcidin concentration. Moreover, we observed that exercise induced rise in blood hepcidin even in subjects who are heterozygotes for HFE mutations. Discussion To the best of our knowledge this is the first study which demonstrate that diet rich in simple sugars like fructose and glucose modified iron metabolism. It is important to note that exercise induced rise in blood hepcidin is usually not observed in all subjects [1]. This study suggests that diet but not HFE mutation could be responsible for this.

## LOW DOSE OF CAFFEINE INGESTION OF 3 MG/KG BODY WEIGHT DOES NOT ENHANCE RESISTANCE EXERCISE PERFORMANCE

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Introduction: In competing sports, caffeine has been widely used to improve performance. Previous studies suggest that ingestion of caffeine enhance performance in resistance exercise (1-5). In contrast, research suggest that administration of low doses of caffeine does not enhance resistance exercise performance (6,7). The aim of this study was to determine the acute effects of low dose of caffeine ingestion on resistance exercise performance. Methods: Thirteen well trained individuals (13 males, mean age  $26 \pm 3.8$  years, weight  $86.3 \pm$

11,2 kg, height  $183 \pm 5,7$  cm) ingested a caffeinated (3 mg/kg) or placebo solution, in a randomized, double-blind, cross-over procedure, 60 minutes before completing a bout of resistance exercise. Experimental conditions were separated by 48 hours. Resistance exercise sessions consisted of squat and bench press exercise to failure at an intensity of 80% and 60% of 1 repetition maximum. Serum levels of caffeine, plasma and capillary levels of lactate before and after resistance exercise was measured together with complete blood count with five-parts differential of leucocytes, in addition to components of neutrophil extracellular traps. Results: proved a significantly increase of caffeine in serum after ingestion of a caffeinated (3 mg/kg) solution. The serum caffeine concentration when the participant ingested placebo solution was equal to the control serum samples before ingestion. Results indicate that participants' rating of perceived exertion (RPE; 6-20 Borg scale) were equal and completed equal repetitions to failure, irrespective of exercise, in the presence of caffeine or not. No significant differences in peak heart rate and peak capillary whole blood lactate values were observed. Venous plasma concentration of lactate increased significantly after resistance exercise for all participants, however, the increase was not significantly different when comparing the placebo trial with the caffeine trial. This was also true when analyzing hemoglobin, hematocrit and leukocyte particle concentration. Discussion: low dose of caffeine ingestion of 3 mg/kg does not enhances resistance exercise performance. 1 Duncan, M. J., et al. *Eur J Sport Sci* 13, 392-399, (2013). 2 Duncan, M. J. & Oxford, S. W. *J Strength Cond Res* 25, 178-185, (2011). 3 Astorino, et al. *Eur J Appl Physiol* 102, 127-132, (2008). 4 Green, J. M. et al. *Int J Sports Physiol Perform* 2, 250-259 (2007). 5 Hudson, G. M., et al. *J Strength Cond Res* 22, 1950-1957, (2008). 6 Beck, T. W., et al. *J Strength Cond Res* 22, 1654-1658, (2008). 7 Williams, A. D., et al. *J Strength Cond Res* 22, 464-470, (2008).

## THE EFFECT OF TRAINING AND MICROBIOME CHANGES IN CELL METABOLISM

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**Introduction** The positive effect of physical activity on human health has been well documented. It helps to prevent obesity, cardiovascular diseases and diabetes. As a result of physical activity increased concentration of free radicals can be detected this plays an important role in the adaptation process of the antioxidant system, by eliminating the oxidative damage. Recent study has shown that exercise in early life alters the guts micro flora leading a better brain and metabolic activity. It reduces anxiety and depressive behaviours, inhibits fat accumulation and plays an important role in colorectal cancer prevention. Certain (strains of) bacteria are able to convert the fibre to butyrate, which is an energy source for colon cells. Agar, - a compound extracted from red algae (Rhodophyta) - can contain up to 80% of fibre and may provide energy. The aim of this study is to investigate the effect of the long-term high-intensity interval running exercise and agar supplementation on gut micro flora changes and cell metabolism. **Methods** 36 young female Wistar rats were assigned to four groups: control group, a group with agar treatment, training group and complex (agar and training). After 20 weeks of treatment cognitive tests (open field, Morris maze, passive avoidance test) were performed and tissues (brain, liver, skeletal muscle, gut) were collected for further use. **Results** According to our findings the training group's body weight was significantly higher than the group with agar treatment. In the passive avoidance test the treated groups showed better performance than the control group. The open field and Morris maze tests didn't reveal any significant difference. **Discussion** For a more detailed conclusion further investigation is needed. We are aiming to measure the changes in guts microflora, free radical concentration and mitochondrial biogenesis markers. Contact [szenasi.nikolett@gmail.com](mailto:szenasi.nikolett@gmail.com)

## NICOTINAMIDE TREATMENT ALTERS THE CONTENTS OF CELL METABOLISM CREGULATING PROTEINS IN GAS-TROCNEMIUS MUSCLE OF YOUNG AND OLD RATS

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**INTRODUCTION** Sirtuin proteins are member of histone deacetylases, but they readily remove the acetyl group from the lysine residues of all kinds of proteins. This transformational modification influences the activity of enzymes and the stability of proteins. Sirtuins play an important role in aging and different kind of diseases, because sirtuins control cellular metabolism, antioxidant and oxidative damage repairing systems. Physical exercise has been shown to modulate the content and activity of the sirtuin enzyme family. Sirtuins are NAD dependent enzymes and the hydrolysis of NAD results in deacetylated protein, O-acetyl-ADP ribose, and nicotinamide (NAM). Nicotinamide as a result of feedback mechanism inhibit the activity of sirtuins. The aim of our investigation was to inhibit SIRT1 by administration of nicotinamide on exercising rats, to study how sirtuins are related to exercise-induced adaptation. **METHODS** In our study, we worked with 24 old (28 month old) and 24 young (4 month old) female Wistar rats. The animals were divided into eight groups (n=6): control old, trainer old, nicotinamide treated old, combined old, control young, trainer young, nicotinamide treated young, combined young. Animals were subjected to treadmill running 5 times week for 6 weeks. The intensity of the running was low (10m/min) with the duration of 1hr at the end of the last week. Nicotinamide was placed in the drinking water treatment was every day. We used 1% nicotinamide dilution for 4 weeks, then we decreased for 0,5%, because 1% caused significant loss of body mass. The quantitative analysis of proteins were carried out by Western blotting, the mRNS levels were assessed by PCR, and the activity level of proteins by spectrophotometry. **Results and Discussion** NAM treatment significantly reduced the body mass of the animals. The protein content of SIRT1 decreased significantly in complex groups compared to control levels. Nicotinamide phosphoribosyltransferase (NAMPT) is important enzyme to the biosynthesis of NAM and our data revealed that aging results in significant loss in the levels of NAMPT. NAM treatment alone and with training significantly increased the levels of 5'AMP-activated protein kinase (AMPK) compared to trained and control groups. AMPK can directly activate PGC-1 $\alpha$ , which is the master regulator of the mitochondrial biogenesis. In this study we report that PGC-1 $\alpha$  levels increased significantly in NAM supplemented old group compared to age-matched trained and control groups. Our findings so far suggest that NAM supplementation causes weight loss, which is associated with alteration of cellular metabolism regulating proteins like AMPK, PGC-1  $\alpha$ . Our data revealed, that aging has significant effects on how the body copes with NAM treatment.

## EFFECT OF BLACK TEA DERIVED HIGH-MOLECULAR-WEIGHT POLYPHENOL ON FUNCTIONAL OVERLOAD IN MICE

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**Introduction** It has been reported that polyphenols have some good effects on skeletal muscle. In our laboratory, we extracted high-molecular-weight polyphenols from black tea, and named it Mitochondria Activation Factor (hereafter, MAF), because MAF enhanced mitochondrial membrane potential of ciliated protista *Tetrahymena pyriformis* (Fujihara et al.). We found MAF raise AMPK (regulator of



PGC-1 alpha, which stimulates mitochondria biogenesis) phosphorylation level and improves endurance performance in mice (Eguchi et al.). Recently, in order to use MAF for supplement, we extracted crude MAF fraction with 80% ethanol, and named this E80. In this study, we examined whether E80 affects on mice skeletal muscles during functional overload, which is an imitation of resistance training in human. Purpose To investigate whether E80 has some effects on hypertrophy process of mice skeletal muscles during functional overload Methods Adult mice (8 weeks of age) fed on food containing E80 for a week before functional overload. After one week pre-feed, we removed synergist muscles (gastrocnemius and soleus) and remained plantaris. Following 4 day, 7 day, 14 day of functional overload, mice were euthanized by cervical dislocation and excised plantaris muscle. Results We investigated the phosphorylation level of signal molecules and found some molecules were activated by administration of E80. Discussion Previously, Eguchi et al. reported MAF improved mice endurance performance in mice. In this study, we demonstrated E80 improved resistance training effect too. Reference Fujihara et al. Biosci. Biotechnol. Biochem., vol. 71., No. 3., page: 711-719, 2007. Eguchi et al. PLOS ONE, vol. 8., No 7., Page: e69480, 2013.

## EFFECTS OF CREATINE SUPPLEMENTATION ON SPRINT PERFORMANCE IN YOUTH, ELITE FOOTBALL PLAYERS

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Introduction Creatine is a highly popular food supplement in football (Waddington et al., 2005). Whilst a wealth of data exists on the ergogenic effects of creatine supplementation in senior players, limited data are available in youth players. Therefore the aim of this study was to examine the effects of a standard, 8wk course of oral creatine monohydrate (CM) supplementation on sprint performance in youth, elite football players. Methods Fifteen U18 (age 16 to 18 yr), male, Football Academy players followed a randomised, double-blind, placebo-controlled, parallel-group trial during the early competitive season. Players ingested 0.3 g/kg/d of CM (n=7) or placebo (PLA, n=8) during a 1wk loading phase, followed by 5 g/day of CM or placebo during a 7wk maintenance phase. Pre- and post-supplementation participants underwent body composition assessment (via body mass and sum of 8 skinfold thicknesses) and performed a repeated-sprint ability (RSA) test (Rampinini et al., 2009). In a subgroup of 10 outfield players (4 on CM and 6 on PLA), GPS data were obtained during match play in the period leading to the supplementation period and in weeks 4 to 8 of the supplementation period. Key index of sprint performance was % of overall match distance covered at >19 km/h (Osgnach et al., 2010). Data are presented as mean  $\pm$  SD, compared by RM-ANOVA. Results Body mass did not significantly change over the course of supplementation in either group. A small but significant ( $P=0.007$ ) decrease in skinfold thickness was observed post-supplementation, with no group difference ( $-7\pm4\%$  in CM and  $-5\pm8\%$  in PLA). RSA did not significantly improve post-supplementation (mean RSA time pre- vs post-supplementation:  $7.57\pm0.18$  vs  $7.52\pm0.22$  sec in CM;  $7.44\pm0.30$  vs  $7.24\pm0.18$  sec in PLA). Sprint performance during competitive match play did not significantly differ pre- to post-supplementation, or between groups (overall match distance covered at >19 km/h: pre  $4.8\pm0.7$  and post  $5.6\pm1.6\%$  in CM vs pre  $7.3\pm2.8$  and post  $7.2\pm2.9\%$  in PLA). Discussion In youth, elite players 8wk of CM supplementation did not induce muscle mass gain beyond that observed with training alone. Further, CM did not significantly improve sprint performance. Thus these findings cast doubt about the effectiveness of CM as an ergogenic aid in youth, elite football. References Osgnach C, Poser S, Bernardini R, Rinaldo R, di Prampero PE (2010). Med Sci Sports Exerc, 42(1), 170-8. Rampinini E, Sassi A, Morelli A, Mazzoni S, Fanchini M, Coutts AJ (2009). Appl Physiol Nutr Metab, 34, 1048-54. Waddington I, Malcolm D, Roderick M, Naik R (2005). Br J Sports Med, 39, e18; discussion e18

## THE INFLUENCE OF ACUTE DIETARY NITRATE SUPPLEMENTATION ON PERFORMANCE DURING A SOCCER SPECIFIC TREADMILL PROTOCOL

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Introduction Research shows that dietary nitrate supplementation (DNS), reduces the O<sub>2</sub> cost of walking and running (Lansley et al. 2011) Further research suggests that DNS reduced the O<sub>2</sub> cost of low intensity exercise, and enhanced tolerance to high intensity exercise (Bailey et al. 2009). Field based research has shown that DNS improves intermittent running performance by around 3.8% when time to fatigue is assessed (Wylie et al. 2013). However no studies so far have examined the effect of acute DNS on the physiological responses to high intensity interval exercise (HIIE). Therefore the aim of the study is to show the effects of DNS on high intensity intermittent running. Methods Participants visited the Human Performance Laboratory (HPL) four times. The first visit was a maximal oxygen uptake (V<sub>O2max</sub>) test, to volitional fatigue. Following a pilot session, the participants then performed two exercise tests 10 days apart, in a doubly blind randomised crossover design. Participants ingested a 70 ml shot of Beetroot juice (BRJ) containing 0.4 g (4mmol) of dietary nitrate, or 70ml placebo (PL) 60 min prior to an intermittent treadmill protocol. Results At time of submission, seven participants completed study. Mean Oxygen uptake (V<sub>O2</sub>) was 36.6 and 36.2 ml.kg.min<sup>-1</sup> between BRJ and PL respectively. Mean blood lactate concentrations are 4.89 and 5.76 mmol.L<sup>-1</sup> for BRJ and PL respectively. Mean blood glucose concentrations are 4.38 and 4.46 mmol.L<sup>-1</sup> for BRJ and PL respectively. Perceptual responses are 13 v 12 for BRJ and PL respectively. Discussion Early results suggest that acute dietary nitrate supplementation reduces the perceptual effort of high intensity exercise, despite no changes in oxygen consumption. Blood lactate and glucose also show no differences between BRJ and PL respectively. Further data to be collected to ensure type I or II errors are not made. References Bailey, S. J., Winyard, P., Vanhatalo, A., Blackwell, J. R., Dimenna, F. J., Wilkerson, D. P. Jones, A. M. (2009). Dietary nitrate supplementation reduces the O<sub>2</sub> cost of low-intensity exercise and enhances tolerance to high-intensity exercise in humans. Journal of Applied Physiology 107, 1144–1155. Lansley, K. E., Winyard, P. G., Fulford, J., Vanhatalo, A., Bailey, S. J., Blackwell, J. R., ... Jones, A. M. (2011). Dietary nitrate supplementation reduces the O<sub>2</sub> cost of walking and running : a placebo-controlled study. Journal of Applied Physiology, 591–600. Wylie, L., Mohr, M., Krstrup, P., Jackman, S., Ermdis, G., Kelly, J. Jones, A. (2013) Dietary nitrate supplementation improves team sport-specific intense intermittent exercise performance. European Journal of Applied Physiology, 113(7), 1673–1684. Contact gary.peters@bucks.ac.uk

## DIETARY VITAMIN D INTAKE, SERUM VITAMIN D CONCENTRATION, AND MUSCLE STRENGTH OF COLLEGIATE FEMALE BASKETBALL PLAYERS IN JAPAN.

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BACKGROUND & PURPOSE: Vitamin D is one of the substances involved in bone metabolism, besides, vitamin D receptor expresses on several organs and it has been shown that vitamin D play many positive roles in human body (Cannell, 2009). It is reported that vitamin D

supplementation in older individuals improved muscle strength and mobility (Zhu, 2010), and serum vitamin D concentration respond to vitamin D supplementation in a dose-dependent manner (Heaney, 2003). The aim of this study is to investigate and assess relationships between Vitamin D intake, serum Vitamin D concentrations, and muscle strength of collegiate female basketball players in Japan (FBPJ). METHODS: The subjects were eleven FBPJ. We used Food Frequency Questionnaire designed for vitamin D intake (Uenishi, 2008). Blood test of serum 25(OH) D was performed and quadriceps strength was measured with Biodex. Regression analysis was done for the assessment of correlations between dietary Vitamin D intake, serum 25(OH)D, and quadriceps strength. RESULTS: FBPJ had enough intake of vitamin D (mean  $410.9 \pm 86.3$  IU), however, almost all FNPJ had low concentrations of serum 25(OH) D (mean  $19.2 \pm 2.9$  ng/ml). Regression analysis revealed no significant correlations between dietary Vitamin D intake, serum 25(OH)D, and quadriceps strength. DISCUSSION: FBPJ had enough vitamin D intake, but almost all of them had low vitamin D concentrations. It seems that the lack of sun exposure has a negative effect on maintaining serum vitamin D concentrations. To maintain optimal serum vitamin D concentrations, sun exposure may be more effective than nutritional intervention for Japanese female athletes. This study could not reveal the relationships between dietary vitamin D intake, serum 25(OH)D, and muscle strength. It seems to be mainly because of small sample sizes. Further studies containing enough sample sizes are needed. REFERENCES: Cannell, J., Hollis, B., Sorenson, M., Taft, T. & Anderson, J. (2009). Medicine and science in sports and exercise, 41, 1102–10. Zhu, K., Austin, N., Devine, A., Bruce, D. & Prince, R. (2010). Journal of the American Geriatrics Society, 58,. Heaney, R., Davies, M., Chen, T., Holick, M. & Barger-Lux, J. (2003). The American journal of clinical nutrition, 77, 204–10.

## EFFECT OF HIGH-FAT DIET AND INSULIN DEFICIENCY ON METABOLISM OF BIOACTIVE SPHINGOLIPIDS IN DIFFERENT BLOOD COMPARTMENTS.

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Bioactive sphingolipids play very important regulatory role in the body. There are data indicating that exercise affects metabolism of the sphingolipids not only in skeletal muscles but also in different blood compartments (1,2,3). However, factors regulating metabolism of the blood sphingolipids is very poorly recognized. The aim of the present study is to examine effect of high-fat diet and insulin deficiency on the level of different bioactive sphingolipids in plasma, erythrocytes and platelets. Methods The experiments were carried out on three groups of rats, 280-300g of body weight: 1-control, 2- fed on high-fat diet (HFD), 3- with insulin deficiency (streptozotocin diabetes, STD). Sphingolipids were extracted from plasma, erythrocytes and platelets. The following sphingolipids were analyzed by mass spectrometry: eight ceramides (CER), sphinganine (SA), sphingosine (SE) and sphingosine-1-phosphate (SIP) (2). Plasma insulin and blood glucose level was also determined. Results Plasma. The diet elevated the level of SA, SE and reduced the total level of CER (it was the sum of individual CER). STD did not affect the plasma level of either compound determined. HFD increased and STD markedly reduced the plasma insulin concentration. Erythrocytes. HFD reduced the level of SA and SE and increased the level of SIP. STD elevated the level of SE, SIP and total CER. Platelets. HFD increased the level of each compound with the exception of SIP. STD reduced the level of SA and SE. Discussion The source of plasma sphingolipids is different. CER is secreted by the liver, SA and SE come from solid tissues and SIP is released mostly by erythrocytes, platelets and endothelial cells. Regarding CER, we found that behavior of particular ceramides is not uniform but depends both on a type of ceramide and the blood compartment. It would indicate on selective metabolism of the compounds in the blood compartments. The blood cells do not have an ability to synthesize sphingolipids de novo. They take up plasma SE, phosphorylate it and release into the plasma. The elevation of SIP in erythrocytes with concomitant reduction in the content of SE would indicate increased phosphorylation of the latter compound by HFD. The results obtained in STD indicate on a role of insulin in regulation of sphingolipid metabolism in different blood compartments. Conclusion: Both HFD and severe reduction in the plasma insulin level affect metabolism of sphingolipids in plasma, erythrocytes and platelets. 1. Baranowski et al. Intern J Sport Nutr Exerc Metab 2014, 24, 148-156 2. Baranowski et al. Eur J Appl Physiol 2015, 115, 993-1003 3. Bergman et al. Am J Physiol Endocrinol Metab 2015, 309, E398-E408

## Philosophy and Ethics

## Physical Education and Pedagogics

## COMPARISON OF BADMINTON LONG SERVE BETWEEN SKILLED PLAYERS AND BIGGINERS IN PHYSICAL EDUCATION CLASS

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Introduction Long service is a fundamental skill in badminton with which rallies start. But stroke production of long serve is somewhat difficult for beginners. If the serve flight length is short, the rally will be disadvantageous for the server. Therefore, we compared long serve between skilled players and beginners in PE class to find important elements. Methods All participants were university students who attended badminton (physical education) class. 15 skilled players and 15 beginners were selected from these students by the initial shuttlecock speed of long serve all participants were right handed. Participants were asked make long service from the right side of the badminton court to the target placed on the back boundary line and center line of the opposite court. They tried 5 times and successful services were analyzed. The players' motions were recorded with 4 cameras 300 frames per second. The control points were recorded before making the services. 3 dimensional coordinates of the shoulders, the right elbow, the right wrist, racket head of the servers were calculated with computer software. We defined the start of the forward swing as the time when the racket head vertical speed changed to downward. We used t-test for the statistical comparison between the two groups and considered significant if  $p < 0.05$ . Results Average initial shuttlecock speed was significantly higher in the skilled players (15.7m/s) than the beginners (10.8m/s). Increment of speed from the right shoulder to the right elbow was significantly larger in the skilled player than the beginners at the start of forward swing but similar at impact. Increment of speed from the right elbow to the right wrist was also significantly larger in the skilled player than the beginners at the start of forward swing but not significant at the impact. In contrast, increment of speed from the right wrist to the racket head was not significantly different at the start of forward swing but significantly larger in the skilled player than the beginners at impact. Discussion We focused on the increment of speed from proximal point to distal point for the servers. Speed increment was larger in the skilled player from the shoulder to the wrist at the start of forward swing. These results suggest the skilled server can accelerates speed from the prox-

imal points to distal points from forward swing start to the impact. In the beginners, acceleration was especially weak at the start of forward swing, this resulted small speed increment from the wrist to the racket head. Wang et al.,(2009) reported beginners tend to use elbow flexion and extension only for overhead strokes. In accordance with their study, although participants performed underhand service, beginners tended to use simple segmental movement which caused less speed increment from proximal to distal point than skilled servers. Reference Wang, J. et al. Steps for arm and trunk actions of overhead forehand stroke used in badminton games across skill levels Perceptual and Motor Skills, 109,177-186, 2009.

## THE RELATIONSHIP BETWEEN MOTOR PERFORMANCE AND ATTENTION PERFORMANCE AMONG 11-12 YEARS OLD AUSTRIAN STUDENTS

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Introduction Studies suggest that there is a positive association between participation in physical activity and cognitive performance (Etnier et al., 2006). Therefore the aim of this study was to investigate the relationship between motor performance and attention among 11-12 years old Austrian students. Methods Height, weight and motor performance among 255 11-12 years students (57% males,) were measured using the German motor performance test DMT 6-18 (Bös and Schenker 2011) delivering age- and gender-related z-parameters of 20-meters-sprint (ZSp20m), backward balancing (ZBall), jumping sideways (ZSHH), stand-and-reach (ZRB), push-up (ZLS), standing long jump (ZSW) and 6-minute run (ZL6Min), and total motor performance (ZGes). In addition, students completed the d2-test of attention (Brickenkamp and Zillmer 2002). To assess the relationship between motor performance and attention, correlation analyses between the values for the total motor performance (ZGes) and for each single motor test item with the total attention performance value (KL) were conducted. Results Correlation analyses showed significant relationships between the attention value KL and total motor performance value ZGes ( $r=.218$ ) as well as between KL and ZSp20 ( $r=.162$ ), ZSHH ( $r=.200$ ), ZRB ( $r=.152$ ), ZLS ( $r=.167$ ), ZSU ( $r=.228$ ), and ZSW ( $r=.132$ ), respectively. Discussion Among this cohort of secondary school children small but significant positive correlations between attention and total motor performance as well as between attention and 6 out of 8 motor test items were detected. In accordance, Vanhelst et al. (2016) found that the attention capacity of adolescents (measured via d2-test of attention) was significantly and positively associated with longer time spent in moderate or moderate-to-vigorous physical activity in free-living conditions. Ericsson and Karlsson (2014) found that daily physical education lessons during compulsory school years improved not only motor skills but also school performance and the proportion of pupils who qualified for upper secondary school. Therefore, an increase in physical activity and motor performance through an increased number of physical education lessons in school settings may be beneficial not only for health reasons but also for cognitive performance and academic achievement of adolescents. References Birckenkamp R, Zillmer E (2002) d2 Test of Attention. Hogrefe, Göttingen Bös K, Schenker L (2011) Bildung im Sport, doi: 10.1007/978-3-531-94026-7\_21 Ericsson I, Karlsson MK (2014) Scan J Med Sci Sports, 24, 273-278. Etnier JL, Nowell PM, Landers DM, Sibley BA (2006) Brain Res Rev, 52, 119-130. Vanhelst J, Béghin L, Duhamel A, et al. (2016) J Pediatr, 168, 126-131 Contact Gerhard.ruedl@uibk.ac.at

## EFFECT OF THE SENSORY INTEGRATION THERAPY ON POSTURAL STABILITY IN CHILDREN 4-6 YEARS OLD

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The aim of research was to examine the influence of sensory integration therapy (SIT) on one leg standing test in children with very low level of postural stability. Twenty eight children between the ages of 4 – 6 participated in this study. Children that could not stand on one leg for more than 20 seconds were randomly divided into two groups – control “C” (7 boys and 7 girls) and experimental “E” (8 boys and 6 girls). Children from group “C” participated in standard classes in the kindergarten and did not make any changes to their daily routine. Children from group “E” participated in SIT for 2 weeks (additionally to the standard classes). Therapy was conducted 5 times a week. Each session lasted 30 minutes. Postural stability in children was measured with use of one leg standing test. The test always was performed in the same sequence: 1) on the right leg with eyes open, 2) on the left leg with eyes open and 3) on the right leg with eyes closed, 2) on the left leg with eyes closed. The change in time of standing on the right leg with eyes open in the “E” group was statistically significantly higher than the changes observed in the same time in group C ( $F = 22.5$ ,  $p = 0.001$ ,  $\eta^2 = 0.44$ ). Results of standing on the right leg with eyes closed in group “E” were higher in group “E” than in group “C” ( $F = 16.1$ ,  $p = 0.004$ ,  $\eta^2 = 0.36$ ). Similar results were observed during on the one, left leg standing. The time of one leg standing with both eyes open and closed improved more significantly in group “E” than in group “C” ( $F = 20.4$ ,  $p = 0.001$ ,  $\eta^2 = 0.42$  respectively for the test with eyes open and  $F = 7.4$ ,  $p = 0.010$ ,  $\eta^2 = 0.21$  for the test with eyes closed). The positive influence of SIT on children with low level of postural stability was observed. Its statistically significant improvement in children is important not only for the current functioning of those children but for their future. Good level of postural stability can help children develop their gross motor skills and be more active. Staying active through gross motor exercise can also help children avoid the obesity that can come through inactivity.

## THE EFFECTS OF A SPORTS GAME-ORIENTATED EXERCISE PROGRAM ON PEOPLE WITH MENTALLY DISABILITY - A PILOT STUDY

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Motor abilities and concentration skills are critical factors while working with people with intellectual disabilities and can be improved by specific sport programs such as the Ballschule Heidelberg [1]. Their program was created in order to improve children's technical, tactical and motor abilities. The aim of this study is to evaluate the efficacy of this specific program on concentration and coordination skills in people with intellectual disabilities. 12 adults participated in this study (6m/ 6w;  $29.9 \pm 11.4$  y) and were divided into two groups (group 1: 1m/ 3w,  $34.0 \pm 16.7$  y; group 2: 5m/ 3w,  $27.9 \pm 8.4$  y) by their level of disability (group 1: mental disorders, group 2: learning disabilities). Subjects were tested prior and after the intervention of 6 weeks (1-d/w for 45 min) with the d2 [2] and KTK [3] test. D2 showed no differences over all subjects in the concentration capacity ( $p \geq .05$ ). However, an increase in concentration capacity was recorded in group 2 ( $81.5 \pm 33.1$  vs.  $101.4 \pm 45.3$ ,  $p = .065$ ). Whereas the processing speed of group 2 increased significantly ( $343.3 \pm 78.0$  vs.  $405.0 \pm 86.4$ ,  $p \leq .05$ ), that of group 1 remained unaffected ( $p \geq .05$ ). No change between pre- and post-testing was found in KTK ( $p \geq .05$ ). A higher increase in concentration capability was found in participants of group 2. Thus, the ability to improve mental and physical capacities through sport tends to depend on the degree of intellectual disability. Further studies are needed, including a larger group of participants as well as a

control group to provide definite results. [1] Roth, K. & Kröger, C. (2011). Ballschule. Ein ABC für Spielanfänger (4th ed.). Schorndorf: Hofmann. [2] Brickenkamp, R. (1994). Test d2 Aufmerksamkeits-Belastungs-Test (8th ed.). Göttingen: Hogrefe. [3] Kiphard, E. J. & Schilling, F. (2007). Körperkoordinationstest für Kinder (2nd ed.). Göttingen: Belz Test.

### CORE VALUES IN NOVICE PHYSICAL EDUCATION TEACHERS AND SPORT SCIENCE STUDENTS

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**Introduction:** The purpose of this study is to explore the values orientation of individuals (students and teachers) involved in Sport Science and Sport Pedagogy fields. **Methods:** 147 individuals (mean  $\pm$ SD age:  $30 \pm 6.8$  years, range 23-53 years, 79 females and 68 males) enrolled either in a Master's Degree in Sport Science (36.7%) or enrolled in PE Teaching specialisation courses for Secondary School (TFA 42.9%; PAS 20.4%) at the Catholic University of Milan were recruited for this study. The participants completed an ad-hoc prepared socio-anagraphic questionnaire and the PVQ (Portrait Values Questionnaire), a list of 40 item that describe the values of a general person and the subjects express how much they perceive themselves similar to the hypothetical person (in a Likert 6 points scale). The values orientation is organized in two bipolar dimensions: self-enhancement versus self-transcendence; conservatism versus open to change. **Results:** Regarding the bipolar values orientation, the sample showed higher values in self-transcendence (mean 4.77) and open to change (mean 4.39). Self-enhancement was higher in men (Student's t-Test,  $p < 0.01$ ) and in young people (Pearsons'  $r = .334$ ,  $p < 0.01$ ); instead self-transcendence was greater in the teachers, who were also the eldest (positive correlation with age;  $r = .223$ ,  $p < 0.01$ ). **Discussion:** Individuals involved in physical activity seem to have a good social predisposition (prevalent values orientation of self-transcendence), especially those who chose a teaching career and are interested in other people's wellbeing. **References:** 1) Schwartz, S.H. (2012), An Overview of the Schwartz Theory of Basic Values, *Online Readings in Psychology and Culture*, 2 (1) 2) Capanna, C., Vecchione, M., Schwartz, S.H. (2005), La misura dei valori. Un contributo alla validazione del Portrait Values Questionnaire su un campione italiano, *Bollettino di Psicologia applicata*, 246, 29-41.

### PERSONALITY TRAITS IN PHYSICAL EDUCATION PRE-SERVICE TEACHERS AND SPORT SCIENCE STUDENTS

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**Introduction:** The aim of the study is to trace the personological profile of individuals involved in Sport Science and Sport Pedagogy fields (students and teachers) in order to identify their specific personality traits. **Methods:** A sample of 147 individuals (mean  $\pm$ SD age:  $30 \pm 6.8$  years, range 23-53 years, 53.7% females and 46.3% males) following a Master's degree in Sport Science (36.7%) or enrolled in PE Teaching specialisation courses for Secondary School (TFA 42.9%; PAS 20.4%) at the Catholic University of Milan, were recruited for this study. The participants completed a socio-anagraphic questionnaire - evaluating education and experience both in school teaching and in sports context as fitness centers and sports teams - and the BFO (Big Five Observer), a questionnaire designed to investigate the main dimensions of personality (Energy/extraversion, Agreeableness, Conscientiousness, Emotional Stability, Mental Openness) through a list of 40 pairs of bipolar adjectives. **Results:** The sample - comparing to general population's standardized values - shows high levels of emotional stability (T points mean 57; 58 in men) and mental openness (T higher points mean 56). Student's t-Test ( $p < 0.01$ ) highlighted some gender differences: females presented values in conscientiousness and males in emotional stability. Instead, there were no significant differences between students and teachers about personological aspects. There was a positive correlation (Pearsons'  $r = 0.166$ ,  $p < 0.05$ ) between age and energy/extraversion: this dimension grewed with the years. **Discussion:** Personological aspects are often overlooked when studying the population of sport science and sport pedagogy, but it seems important to consider this information both to understand the reason of this career choice (also comparing in the future our study population with another sample, for example of human sciences) and to define appropriate training courses in sport education field. **References:** 1) Caprara, G.V., Barbaranelli, C., Borgogni, L., Big Five Observer, OS, Firenze, 1994

### SLEEP DURATION AND ACADEMIC PERFORMANCE IN JAPAN'S JUNIOR HIGH SCHOOL STUDENTS

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**Introduction.** In recent years, there have been many reports on the effects of lifestyle of students on to academic performance. In particular, the length of the sleep time is thought to be involved strongly with academic performance. According to Ortega et al. (2010), male adolescents who take sleep more than 8 hours has shown higher cognitive performance than others with less than 8 hours sleep. However, many of these studies were intended for children in Europe and North America, it has not been clear yet about the actual situation of children living in other cultures, including in Asia. The purpose of this study is to reveal the influences of sleep duration on the school grades as the actual academic achievement in Japanese junior high school students. **Methods.** Participants were 218 male students (body mass index [BMI]:  $19.1 \pm 3.3$ ) and 192 female students (BMI:  $18.9 \pm 2.9$ ) of 1st grade (7th grade in USA style) in public junior high schools in Japan. All students and their parent completed the questionnaires about their sleep duration, household income, and mother's educational background. BMI and academic performance (school grades) were received from school records. The sum total of the 9 subjects grades (Japanese, social studies, math, science, English, art, music, Technology and Home Economics, and physical education) were used as the academic achievement score. The participants were divided into three groups according to their sleep duration separately for male and female (Group 1 < 6 hours, 6 hours  $\leq$  Group 2 < 8 hours, 8 hours  $\leq$  Group 3). **Results.** Using ANCOVA that controlled for covariates (household income and mother's educational background), Group 1 (less than 6 hours sleep, mean grade:  $28.1 \pm 1.2$ ) had significantly lower school grades than Group 2 (6-8 hours sleep, mean grade:  $31.6 \pm 0.5$ ,  $p < 0.05$ ) in male students. On the other hand, in female students, there were no significant differences among the 3 groups in school grades. **Conclusions:** These results suggest that short sleeping less than 6 hours retard the school grades in Japanese male students. Because this result had some differences in the length of sleep duration from previous studies in Europe and the USA, we have to consider the cultural and ethnic aspects in the relationships between academic achievement and sleep duration. **Acknowledgements:** This study was supported by Challenging Exploratory Research and Scientific Research C from Grants-in-Aid for Scientific Research in Japan. **References:** Ortega, FB., et al., (2010). Sleep duration and cognitive performance in adolescence. (The AVENA Study) . *Acta Paediatrica* . 99: pp454-456.



means systematically to strengthen their health-oriented recreational motion activity in later life; • showing the growth of the health self-esteem and moderate fatigue at the end of Physical Education lessons.

## DEVELOPMENT OF STUDENTS' PHYSICAL EDUCATION BASED ON REMOTE TEACHING.

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Introduction A promising line of development of high school students' physical education is to apply some forms and methods of students' physical education remote teaching. These require the development of appropriate electronic resources. Methods A set of theoretical (analysis and synthesis of scientific literature, generalization of advanced pedagogical experience, etc.) and empirical (pedagogical observation, questioning, pedagogical testing, pedagogical experiment, etc.) research methods was used in the work; these methods complement each other. Results The developed technology provides multiple differentiation of lessons on 'Physical Education': physical exercise (taking into account the level of physical fitness of students) and physical exercise duration (taking into account the level of students somatic health). One of the characteristics of the technology is the modular organization of the educational process based on the following modules: M1 – «Active motivation of students to take care of their health»; M2 – «System of health and fitness self-training and self-control»; M3 – «Correctional and supporting sports and fitness activities». Each module includes a section of theoretical and methodological information and assessment procedures provided on thematic sites. Discussion The implementation of development of technology of high school students' physical education by way of health and fitness remote teaching provides gradual formation of students' physical fitness knowledge, motivation attitude towards physical education and their health, motion activity and skills for a healthy lifestyle, practice and methodical ability, etc. The work shows that the number of students with the following characteristics increased significantly within the experimental group compared to the control group: • having full knowledge system for choosing and using physical education means, content and organization of motion activity to promote health as well as acquired practical skills of personal self-esteem of physical education I

## FUNDAMENTAL MOVEMENT SKILLS IN YOUNG CHILDREN FROM LOW SES: THE INFLUENCE ETHNICITY

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Introduction Children from South Asian backgrounds in the UK have the lowest physical activity levels. Less active children have low levels of fundamental movement skill (FMS) competence and poorer health. While there is some evidence to suggest that age, sex, physical activity, SES is associated with FMS (Barnett et al., 2016), the role of ethnicity in FMS competence is underexplored, particularly in South Asian children. The aim of the study was to examine differences in FMS between White EU and South Asian children aged 4-5 years from low SES areas in West Midlands, UK. Methods Following ethical approval, 42 children aged 4-5 years (21 White EU, 21 South Asian, 24 male, 18 female) were recruited from low SES areas of West Midlands, UK. Each child was assessed performing 4 locomotor skills (run, gallop, hop, and jump) and 4 object skills (strike, catch, kick and overarm throw) according to the Test of Gross Motor -2 checklist (Ulrich, 2001). A 2 (sex) by 2 (ethnicity) ANOVA assessed differences in locomotor composite score, object composite score and total FMS. Significance was set at  $P < 0.05$ . Results Preliminary data shows, no main effect of gender or ethnicity was found for locomotor or total FMS ( $P > 0.05$ ). A main effect of ethnicity ( $P = 0.016$ ) and an interaction effect between ethnicity and gender ( $P = .007$ ) was found for Object skills. Post hoc analysis following an ANOVA identified significant differences in object skills of White EU females compared to male White EU (mean difference = 5,  $P = 0.10$ ,  $d = 1.47$ ) male South Asian (mean difference = 4,  $P = .009$ ,  $d = 1.49$ ) and female South Asian (mean difference = 6,  $P = .006$ ,  $d = 1.86$ ), whereby White EU females had poorer object skills. No further significant differences were found between ethnicity and gender for object skills. Discussion The findings suggest that South Asian children irrespective of gender have better object skills than low SES matched White EU females. This is particularly interesting given that South Asian children have lower PA levels, which has previously been associated with FMS. Further research should examine the association between ethnicity, FMS, PA in a larger sample of multi-ethnic children to confirm this. Reference Barnett LM, et al. (2016) Sports Med, DOI 10.1007/s40279-016-0495-z Contact Emma.Eyre@coventry.ac.uk

## PHYSICAL EDUCATION'S STUDENTS AT THE UNIVERSITY OF BRASILIA IN VIRTUAL LEARNING ENVIRONMENT AND THE CHARACTERIZATION AND HABITS OF STUDY DURING THE COURSE

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The students's sociodemographic characteristics in a Virtual Learning Environment (VLE) course are diversified. These, may influence the teaching-learning process in VLE. The aim of the study was to describe the characteristics of undergraduate physical education's students distance of UNB and their study habits. There were 81 students in the study. The google docs tool for data collection was used. The descriptive analysis was performed by the statistical software Minitab 17. This study project was approved by the research ethics committee in humans, Faculty of Health Sciences at the University of Brasilia (CEP / CONEP: 03/20/2014). It was observed a predominance of males (51.9%), singles (54.3%) aged over 36 years (44.4%) paid jobs (90.1%) no graduation (84%) attending more than 5 subjects (74.1%), participated in a blended course or distance (60.5%), studying on the internet (38.3%) studying off the internet (63 %) up to 6 hours per week, preferably time to study between 6 p.m to 12 a.m (60.5%) studying alone (86.4%), read just over half of the course content (49.4%). The preponderance of economic, social, demographic and educational characteristics may facilitate the teaching-learning process established in subjects and courses in the distance. However, these characteristics can help the development of strategies's mediation between the tutor and students seeking a more active and reflective participation of students. References: SILVA, A., R., da; BARROS, J. F.; PEIXOTO, H. M.; BENITO, L. A. O.; MIRANDA, D. B.; COSTA, C. M. A.; ALVES, E. D. . Characterization of school semipresential undergraduate and graduate subjects in the area of health promotion at the University of Brasilia - UnB. In: 7th International Conference on Education and New Learning Technologies Barcelona - 6th - 8th of July 2015, 2015, Barcelona. INTED2015 Abstracts, 2015. LOBATO, R. S.; FREITAS, T. C.; SILVA, A., R., da . Recursos de avaliação em um curso de licenciatura em educação física na modalidade a distância no Brasil. In: III Congresso Internacional TIC e Educação, 2014, Lisboa. Poster, 2014. LOBATO, R. S.; FREITAS, T. C.; SILVA, A., R., da resource of assessment in a degree course in physical education in the distance mode in Brazil. In: III International Congress TIC and Education, 2014, Lisboa. Poster, 2014.

## HOW DOES PHYSICAL EDUCATION AFFECT THE DEVELOPMENT OF LOCOMOTOR AND OBJECT CONTROL SKILLS IN PRESCHOOL CHILDREN

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**Introduction** Unlike other European countries, in Italian kindergartens the physical education (PE) teacher is not including in the school organic personnel. This is frequently associated with lack of opportunities to perform PE by preschool children. Therefore, the aim of this study was to analyse whether the effects of a PE program on the development of locomotor and object control skills in preschool children would depend on the hour amount of intervention. **Methods** This study involved 189 children (age:  $4.62 \pm 0.97$  years; Height:  $107.83 \pm 7.82$  cm, body weight:  $19.84 \pm 4.95$  kg) of 8 Palermo kindergartens who were randomly divided in a control group (C,  $n = 29$ ), an intervention group 1 (I1,  $n = 120$ ) and an intervention group 2 (I2,  $n = 40$ ). I1 and I2 children performed a PE program of 16-week length for 4 and 10 hours/week respectively (total hours: 52 and 180), carried out by PE teachers, while C children do not perform any PE program. This program was planned in 21 learning sessions aimed to develop the body schemes, basic motor skills, fine motor control, coordination abilities, confidence and autonomy, socialization, emotion and affect control. Locomotor and object control skills were evaluated with the Test of Gross Motor Development (TGM), (Ulrich, 1985) before and after PE program. Analyses of covariance (ANCOVA) were performed to compare outcomes for I1, I2 and Control groups at post-test and the covariate was the participants' measures of motor skills at pre-test. **Results** I1 and I2 groups showed a significant increase in both locomotor and object control skills compared with C group after PE program. I2 ability level was significant higher than I1 group. The improvement in locomotion skills was bigger than object manipulation those. The two abilities combined provide a Quotient of Gross-Motor Ability that was in the average at baseline in all groups and became high in I1 and I2 after PE program. **Discussion** The improvement of locomotor and object control skills in both intervention groups indicates that PE program positively affects the motor development of preschool children. We suppose that this is dependent on the duration of the intervention given the higher level of improvement showed by the I2. The difference in the ability levels between locomotor and object control skills might be associated with the maturation of nervous system and sensory-perceptual and motor experiences of children. **References** Ulrich DA. Test of Gross Motor Development. Austin, TX, USA: PRO-ED; 1985 Contact marianna.bellafiore@unipa.it

## Physiology

### DEVELOPMENT OF A NEW PREDICTIVE MODEL ENABLING THE ASSESSMENT OF THE ANAEROBIC CAPACITY FROM A STANDARD AEROBIC EXERCISE STRESS TEST

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Graded exercise stress test (GXT) is a common and widely accepted method to assess the aerobic capacity and to predict maximal oxygen consumption and cardiorespiratory fitness. The first part of the GXT is aerobic while the last part includes the anaerobic component; meaning, utilization of ATP occurs mostly via anaerobic metabolism. The anaerobic capacity can be determined by the Wingate anaerobic test (WAnT) which is an intense test, performed on a bicycle against constant resistance. Our goal is to develop a new computational simulative predictive model, enable to predict the anaerobic capacity from a single GXT. We collected data from ( $n=52$ ) subjects who underwent cardiopulmonary exercise stress test (CPET) and the WAnT. We looked at two cluster of features: 49 aerobic variables/features that can be extracted from the CPET and 12 features that can only be extracted from a GXT. We used the greedy heuristic algorithm model to test the best aerobic feature at each iteration and added it into the vector of selected features in order to predict peak and mean anaerobic power output obtained from the WAnT. The model was tested separately on the two clusters. All analyses were performed on MATLAB. When using features from CPET, we observed high peak power and mean power predictions [w] of  $r=0.88$  and  $r=0.87$ , respectively. Lower predictions of peak power and mean power were observed when the anaerobic components were normalized by the body weight [w/kg]:  $r=0.74$  and  $r=0.80$ , respectively. Relatively lower peak power and mean power [w] predictions were also observed when using features that were obtained from the GXT,  $r=0.68$  and  $r=0.69$ , respectively and when normalized to body weight [w/kg]:  $r=0.69$  and  $r=0.74$  for peak and mean power, respectively. Our results indicate that prediction of the anaerobic component is feasible by using advanced statistical prediction tools such as greedy heuristic algorithm. Good prediction was noted when using gas exchange data (CPET) ( $r=0.87$ ), but lower prediction values when using GXT data ( $r=0.68$ ). Thus, oxygen consumption and carbon dioxide production are significant factors during aerobic exercise stress test that can predict the anaerobic power output using a single exercise stress test. **References** Smith JC, Hill DW. (1991). British Journal of Sports Medicine, 25, 196-199. Hawley JA., Noakes, TD. (1992). Eur J Appl Physiol Occup Physiol., 65, 79-83. Luttikohl H, McNaughton LR, Midgley AW, Bentley DJ. (2006). Int J Sports Physiol Perform., 1:122-36.

### ROLE OF SODIUM-HYDROGEN EXCHANGER-1 IN THE EFFECTS OF EXERCISE ON INTERMITTENT HYPOXIA-INDUCED LEFT VENTRICULAR CARDIAC FIBROSIS

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**Background:** Intermittent hypoxia (IH) of obstructive sleep apnoea (OSA) can increase oxidative stress levels that exacerbates the progression of cardiac fibrosis, leading to left ventricular dysfunction. Exercise can attenuate oxidative stress-induced myocardial sodium-hydrogen exchanger-1 (NHE-1) hyperactivation, preventing IH-induced left ventricular dysfunction. However, whether exercise attenuates cardiac fibrosis by reducing myocardial NHE-1 hyperactivity is still unclear. **Purpose:** To investigate the role of NHE-1 in exercise-mediated cardiac fibrosis attenuation in OSA patients using an animal model mimicking the IH of OSA. **Methods:** Eight-week-old male Sprague-Dawley rats were randomly assigned to room air (CON), IH, exercise (EXE) or IH combined with exercise (IH+EXE) group. All groups were randomly assigned to subgroups receiving a vehicle or cariporide, NHE-1 inhibitor, at the beginning of 9th week. IH rats were raised without any intervention for the first 8 weeks and exposed to 14 days of IH (2–6% O<sub>2</sub>, 2–5 s/75 s) for 8 h/day at the 9–10th week. EXE rats were subjected to an animal treadmill for 10 weeks (5 days/week, 60 min/day, 24–30 m/min, 2–10% grade) without IH exposure. IH+EXE rats were made to exercise with IH at the 9–10th week. At the end of 10th week, the rats were sacrificed, and hearts were removed to determine the myocardial levels of fibrosis index (Masson's trichrome stain and Sirius red stain), lipid peroxidation, catalase activity and NHE-1 activation. **Results:** Compared with CON rats, IH caused an increased cardiac fibrosis, a decreased myocardial catalase activity and an increased lipid peroxidation and NHE-1 activation ( $p < 0.05$ , in all) that were abolished by cariporide. These changes were not

observed in EXE and IH-EXE rats ( $p > 0.05$ , in all). Compared with IH rats, an increased anti-oxidant capacity and a decreased cardiac fibrosis, lipid peroxidation and NHE-1 activation were found in IH-EXE rats ( $p < 0.05$ , in all). Conclusion: The 10-week exercise training caused inhibition of IH-induced myocardial NHE-1 hyperactivity, which can provide potent cardioprotective effects by attenuating IH-induced cardiac fibrosis. Thus, NHE-1 plays a critical role in the effects of exercise on IH-induced cardiac fibrosis.

## EFFECT OF RAIN ON THERMAL RESPONSES AND ENERGY METABOLISM WHILE RUNNING AT HIGH INTENSITY IN COLD TEMPERATURES

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**Introduction:** Outdoor exercise such as marathons, soccer, and rugby often proceed under rainy conditions. We previously showed that esophageal temperature decreases and oxygen consumption and plasma lactate concentrations increase while moderately running in rain at 5°C. However, only a few studies have investigated physiological responses in humans during exercise in rainy conditions. To our knowledge, no reports to date have investigated human physiological responses in the cold, rainy conditions during high intensity exercise such as competitive outdoor sports. **Purpose:** The present study aimed to determine the effects of rain on physiological responses while running at 80%VO<sub>max</sub> at 5°C. **Methods:** Seven healthy men [age,  $21.7 \pm 3.3$  y; height,  $176.6 \pm 8.5$  cm; mass,  $68.8 \pm 7.1$  kg; VO<sub>2max</sub>,  $62.3 \pm 5.09$  mL/kg/min; means  $\pm$  SD] who were non-smokers and not currently under medication participated in this study. They rested for 10 min and then exercised on a treadmill at 80%VO<sub>max</sub> intensity for 60 min in the presence (RAIN) or absence (CON) of rain at 5°C. A headwind equal to running speed was blown during both trials, which were randomly assigned and balanced for order. **Results:** Rectal temperature was significantly lower in RAIN than that in CON at 10, 40, 50, and 60 min ( $p < 0.05$ ). Weighted mean skin temperature was significantly lower in RAIN than that in CON during exercise ( $p < 0.05$ ). Thermal sensation was significantly lower in RAIN than in CON from 30 to 60 min ( $p < 0.05$ ). Oxygen consumption, heart rate, and rating of perceived exertion were significantly higher in RAIN than in CON at 50 and 60 min ( $p < 0.05$ ). Plasma lactate was significantly higher in RAIN than in CON from 40 to 60 min and plasma norepinephrine was significantly higher in RAIN than that in CON at 10, 40, 50, and 60 min (both  $p < 0.05$ ). Plasma glucose, plasma epinephrine, serum triglycerides, serum free fatty acids, and the respiratory exchange ratio did not significantly differ between RAIN and CON. **Discussion:** The lower rectal temperature and higher plasma norepinephrine at 10 min in RAIN indicate that rain increases heat loss during the early phase of exercise in the cold. Thereafter, heat production increases through high-intensity exercise and transiently suppressed cold stress. However, a wet area that increased over time in RAIN intensified the loss of body heat and then energy expenditure and plasma lactate increased more in RAIN than in CON due to cold stress. **Conclusion:** Rain intensifies body heat loss and increases energy expenditure while running at high intensity at 5°C.

## EFFECTS OF COLD SHOWERS ON PHYSIOLOGICAL RESPONSES AFTER EXERCISE IN HOT ENVIRONMENT

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**Introduction** While CWI is the most popular recovery method in the literature worldwide, it has been reported to have adverse effects on cardiovascular response<sup>1</sup> and thermal comfort sensation<sup>2</sup> especially in those athletes who are susceptible to cold temperature. Taking a shower is an activity that millions of people make a part of their daily routine. Unfortunately, the information of cold showers for recovery purpose has yet to be identified for individuals in the tropical climate of Southeast Asia. The present study investigated recovery effects of cold water showers on heart rate (HR), core temperature (T<sub>c</sub>), cortisol and thermal comfort scale (TCS) after exercise in hot environment. **Methods** Nine healthy males (mean  $\pm$  SD: age  $21 \pm 1$  yr; body mass index =  $22.9 \pm 1.8$  kg.m<sup>-2</sup>, % fat mass =  $16.6 \pm 6.1$ , V'O<sub>2peak</sub> =  $32.6 \pm 4.1$  mL.kg<sup>-1</sup>.min<sup>-1</sup>[mean + S.D.]) randomly underwent two interventions following an exercise period of 45 minutes in a hot environment (35 °C room temperature, 40-60% relative humidity) on a cycle ergometer at 65% of their peak oxygen uptake. The two interventions compared a 15 °C water showers (CWS) with sitting in a 25 °C room (SIT25) for 15 min after exercise. After the 15 min intervention, measures of T<sub>c</sub> and HR were recorded at 30 min, 1h, and 2h; salivary cortisol levels determined at 1h and 2h; and the thermal comfort scale (TCS) recorded at the end of intervention. **Results** The results showed that the % change of HR had decreased significantly faster with a CWS than with a SIT25 at the first 30 min of recovery period ( $p < 0.05$ ), but no differences were observed for %change of T<sub>c</sub> as well as salivary cortisol levels at all the time points of recovery period. TCS was lower in SIT25 (+2; Just comfortable) than CWS (+4; Very comfortable) after 15 min of intervention. **Discussion** The finding of significant recovery benefits for CWS over SIT25 on HR and TCS demonstrates that taking a cold shower can be a good choice for facilitating HR recovery after high intensity performance in a hot environment. **References** Tipton MJ (2015). Physiological response to cold water immersion and submersion: from research to protection. In: Taber, Michael, ed. Handbook of offshore helicopter transport safety: essentials of underwater egress and survival. Woodhead Publishing, Cambridge, UK, pp. 63-76. Halson SL, Quod MJ, Martin DT. (2008). Int J Sports Physiol Perform., 3:331-346. Contact: g4036011@gmail.com

## EFFECTS OF LEARNING TASKS ON HEART RATE VARIABILITY

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**Introduction** Cardiac autonomic activity has been extensively evaluated by analysis of Heart Rate Variability (HRV) in many physiological conditions, including the execution of cognitive tasks. It has been shown that the higher the mental load the larger the effect on HRV, vagal indices especially decreasing more in executive than in non-executive tasks. The influence of different cognitive functions on autonomic modulation of HR have not however clearly defined. Our aim was to evaluate the effect of learning tasks, specifically in motor and visual domain, on HRV. **Methods** Thirty healthy males (age:  $23 \pm 2$  yrs, mean  $\pm$  SD) were administered a motor task (MT) and a visual task in two separate sessions. The MT consisted of performing a sequence of 64 abduction movements with the left thumb as fast as possible. The visual task was an orientation discrimination task (ODT), in which the subject had to decide whether the presented stimulus was tilted clockwise or counter-clockwise relative to the previously presented stimulus. Heart Rate (HR) was continuously recorded (Polar S-810) before (6-8 minutes, while quiet sitting; control, ctrl) and during the execution of the tasks (each lasting about 5 minutes). HRV was analyzed in time and frequency domains and by Poincaré plot. **Results** R-R interval was  $819.6 \pm 133.4$  ms in ctrl and did not change during both MT and ODT ( $907 \pm 172$  ms and  $888 \pm 190$  ms, respectively). SDNN decreased from ctrl value ( $83 \pm 31$  ms) by about 25% in both tasks ( $p < 0.05$ ), whereas no change was found for rMSSD (overall mean  $63 \pm 53$  ms). SD1 showed no modification during the two tasks ( $44.78 \pm 37.2$  ms). In contrast SD2 decreased from  $107.9 \pm 34.9$  ms in ctrl to similar values in MT and ODT, i.e.  $70.9 \pm 39$  ms. LF/HF ratio was

5.15±4.2 in ctrl and dropped to 1.7±1.0 during MT and to 2.2±3.5 during ODT ( $p>0.05$  between tasks). Discussion The execution of both MT and ODT was associated with unchanged R-R interval, i.e. HR was stable compared to control, but with different values of HRV. During the two tasks, indices of slow fluctuations of HR (SDNN and SD2) were significantly lower than in control, while markers of rapid fluctuations (RMSSD and SD1) remained almost constant. This would suggest a selective effect of learning on rhythmic autonomic modulation of HR. The decreased LF/HF ratio found during both tasks would indicate a shift in the autonomic interaction toward a vagal dominance, possibly as an effect of the demand of learning process. renza.perini@unibs.it

### THE EFFECT OF PRACTICALLY APPLIED BLOOD FLOW RESTRICTION OF THE LOWER LIMBS DURING HIGH INTENSITY CYCLING EXERCISE ON CIRCULATING GROWTH HORMONE

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Introduction Growth hormone (GH), a key regulator of protein synthesis, is secreted in response to resistance and aerobic exercise in an intensity-dependent fashion. Blood flow restriction (BFR) during low intensity resistance and aerobic exercise has been demonstrated to potentiate GH secretion (Abe, Kearns, & Sato, 2006). The objective of this study was therefore to investigate whether the GH response to high-intensity exercise (HIE) is further potentiated by BFR. Methods Eight young healthy males (age  $22.5 \pm 2.1$  y, height  $177 \pm 5.9$  cm, weight  $76 \pm 11.0$  kg) completed two trials consisting of 3 x 30s maximum sprints on a cycle ergometer with 4min of active recovery between sprints. Trials were performed in random order with (RBF) or without (CON) elastic wraps applied around the proximal thigh with a compression equivalent to a subjective rating of seven on the Pain Visual Analog Scale. Venous blood samples collected before and 20min post-exercise were analysed for GH by ELISA (Leinco Technologies Inc., Missouri) and capillary blood lactate concentration (Blac) was determined before and immediately post-exercise. Cycling power and pre-to-post changes in GH and Blac were compared between trials using a paired t-test. Results No differences were observed between trials in peak power (CON =  $1192 \pm 31.5$  W; RBF =  $1153 \pm 47.7$  W;  $p = 0.30$ ), mean power (CON =  $517 \pm 43.5$  W; RBF =  $517 \pm 45.1$  W;  $p = 0.50$ ), Blac (CON =  $12.2 \pm 0.25$  mmol/L; RBF =  $12.1 \pm 0.17$  mmol/L;  $p = 0.60$ ) or GH-response (CON =  $32.2 \pm 5.87$  ng/ml; RBF =  $32.1 \pm 6.36$  ng/ml;  $p=0.98$ ). Discussion Restricted blood flow induced muscle hypoxia resulting in accumulation of metabolic products and secretion of anabolic hormones is the primary postulated mechanism underlying adaptations associated with RBF during low intensity exercise (Pearson & Hussain, 2015). However this study showed no effect of RBF during HIE on exercise performance, Blac or GH. Perhaps the time course of oxygen uptake and the heavy dependence on anaerobic metabolism during non-RBF HIE renders the muscles in a similar state to RBF HIE, therefore resulting in little additional effect of RBF. References Abe, T., Kearns, C. F., & Sato, Y. (2006). Muscle size and strength are increased following walk training with restricted venous blood flow from the leg muscle, Kaatsu-walk training. *Journal of Applied Physiology* (Bethesda, Md. : 1985), 100(5), 1460–6. doi:10.1152/jappphysiol.01267.2005 Pearson, S. J., & Hussain, S. R. (2015). A review on the mechanisms of blood-flow restriction resistance training-induced muscle hypertrophy. *Sports Medicine* (Auckland, N.Z.), 45(2), 187–200. doi:10.1007/s40279-014-0264-9

### ACUTE PHYSIOLOGICAL RESPONSES IN MUSICIANS DURING A PUBLIC CONCERT AND REHEARSAL: A PILOT STUDY

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Introduction Playing music is a demanding activity, but up to now only few studies evaluated the physiological responses in musicians (1, 2). The aim of this pilot study was, therefore, to analyse the metabolic and cardiorespiratory responses during a public concert and a rehearsal in Rock'n'Roll band members. Methods 4 male musicians (all of them members of a Rock'n'Roll Band; age:  $26 \pm 3$  years old; height:  $180 \pm 10$  cm; weight:  $75 \pm 8$  kg;  $VO_{2max}$ :  $51.2 \pm 10.3$  ml/min/kg) were tested while playing their instruments (drums, double bass, e-guitar, accordion). Heart rate (HR) was measured during a public concert and a rehearsal. The blood lactate concentration (La) was measured during the rehearsal at the end of each song. The determined data were compared to the values at the first (LTP1) and second (LTP2) lactate turn point detected during a preliminary maximal incremental exercise test (IET) performed on a cycle ergometer (3). Results In absolute terms and expressed as % of the according values at LTP2, playing drums, double bass, e-guitar, and accordion induced the following acute responses during the rehearsal: HRmean: 142, 151, 110, 103 b/min (88, 92, 73, 64 % of HR at LTP2); Lamean: 4.7, 4.0, 2.7, 2.4 mmol/l; HRpeak: 180, 177, 132, 126 b/min (112, 108, 87, 78 % of HR at LTP2); Lapeak: 6.1, 5.6, 4.2, 2.8 mmol/l. During the public concert, values were found at: HRmean: 162, 165, 142, 111 b/min (101, 101, 94, 69 % of HR at LTP2); HRpeak: 175, 182, 162, 148 b/min (109, 111, 107, 92 % of HR at LTP2). Discussion The level of physiological strain depends on the style of the song, the intensity of movement which varies according to the certain instrument and extra activities e.g. vocals. Rock'n'Roll music was shown to be a physiologically demanding activity inducing acute physiological responses which were mostly higher compared to LTP1 and partly higher compared to LTP2 from IET (1, 2). Double bass playing combined with singing and the higher amount of movement in drumming are expected to be responsible for the increased physiological responses in these two instruments. The need for an appropriate endurance capacity for musicians to sustain long lasting concerts is obvious. Due to the received data, playing music is supposed to generate aerobic effects and regular exercise training should be suggested to maintain quality during concerts. Playing this kind of music might be a possible alternative to sportive activities especially for inactive people. References 1) Vellers HL, Irwin C, Lightfoot JT.: *Med Probl Perform Art.* 2015 Jun;30(2):100-5. 2) Iñesta C, Terrados N, García D, Pérez JA.: *Occup Med Toxicol.* 2008 Jul 25;3:16. 3) Hofmann, P. & Tschakert, G.: *Cardiology research and practice*, 2011: 209302.

### HAEMATOLOGICAL PARAMETERS IN MIDDLE-AGED AMATEUR FEMALE RUNNERS FOLLOWING TWO DIFFERENT SCHEDULE TRAINING FOR A HALF-MARATHON RUN

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INTRODUCTION Amateur running for distances from 10 to 20 km is being increasingly popular. Since the half-marathon is a common challenge for amateur runners, several training schedules are available, even for master sport practitioners (1). Most are extensive schedules involving high training volumes in km/wk. We designed an intensive schedule with higher loads and lower running volumes. Our objective was to evaluate the changes in haematological parameters before and after two different training schedules. METHODS Twenty-two women ( $39 \pm 6$  years) followed an extensive (EX) or intensive (IN) schedule of 3 sessions/wk during 12 wk. EX group trained a mean of  $31 \pm 4$  km/wk at an intensity below 80%  $VO_{2max}$ . IN group run  $25 \pm 5$  km/wk (80-100%  $VO_{2max}$ ) combined with uphill running



and resistance training circuits. Blood samples were obtained before (S1) and after (S2) both training programmes and after 20h of a half-marathon run (S3). One way ANOVA with repeated measures allowed to compare S1-S2-S3 within schedules whereas a Student's *t* test was used to contrast the two programs. RESULTS Haemoglobin concentration (Hb) and RBC count showed a non-significant decrease in both groups, with a greater decrease in EX (Hb, 2.3%; RBC, 2.1%) than in IN (Hb, 0.8%; RBC, 0.6%). Haematimetric indices related to Hb concentration showed significant ( $P<0.001$ ) decreases from S1 to S2 in EX but not in IN, whilst MCV increased in both groups ( $P<0.05$ ) from S1 to S3. Haematocrit (Hc) increased in EX (S1=40.0%, S2=42.3%;  $P<0.001$ ) but remained almost unchanged in IN (S1=39.3%, S2=39.5%), resulting in higher significant ( $P<0.05$ ) values in S2 for EX group. From S2 to S3, WBC counts increased (26%,  $P<0.05$ ) only in IN, whilst platelets decreased in both groups (EX, 13%; IN, 17%;  $P<0.01$ ). DISCUSSION A 12-wk schedule of EX training (S2) caused a greater reduction in total and mean Hb concentrations, and in RBC count as compared to IN training, maybe due to a greater haemolysis provoked by the higher volume of running. The greater Hc in EX group indicates that this schedule could elicit a greater aerobic capacity. After 20h of the half-marathon (S3), macrocytosis of RBCs reflect an elevated RBC turnover response to intense exercise (2) and the lower platelet count a result of a shear-induced platelet adhesion and aggregation (3). The half-marathon also induced a higher increase in WBCs in IN than in EX, which may be related with different inflammatory and oxidative stress responses provoked by the different training schedules. REFERENCES (1) Utzschneider C (2014) Human Kinetics. Champaign. USA. (2) Santos-Silva et al (2001) Clin Chim Acta 306:119-126. (3) Posthuma et al (2015) Blood Rev 29:171-178.

## INHIBITION OF ERK 1/2 PHOSPHORYLATION DOES NOT SUPPRESS EXERCISE-INDUCED S6K1 PHOSPHORYLATION AND MUSCLE PROTEIN SYNTHESIS

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Introduction Muscle contractions that generate large amounts of force, like resistance exercise, rapidly increase muscle protein synthesis (MPS) and subsequently cause hypertrophy. Exercise-induced increase in MPS has been reported to be regulated by multiple signaling pathways, of which the mTORC1 signaling pathway is a pivotal regulator. The MAPK signaling pathway is considered another regulator of the increase in MPS. The mTORC1 and MAPK pathways are coordinated; although activated mTORC1 phosphorylates the T389 site in S6K1, the phosphorylation of T421/S424 sites in S6K1 through the MAPK pathway and subsequent conformational change in S6K1 are necessary. Although ERK 1/2, a molecule in the MAPK signaling pathway, is known to phosphorylate T421/S424 in S6K1, only one study has reported the impact of the inhibition of ERK 1/2 phosphorylation on the exercise-induced increase in MPS in vivo. Thus, we examined whether inhibition of ERK 1/2 phosphorylation affects the exercise-induced increase in MPS. Methods Rats were divided into two groups ( $n=5$  in each group) and were intraperitoneally injected with 10 mg/kg/day of either vehicle (40% DMSO in PBS, vehicle group) or MEK inhibitor (U0126 group) every other day for 1 week. For exercise, an electrical stimulation model from our previous study was modified and employed (Tsutaki et al., 2013). Briefly, rats were anesthetized with 2.5% isoflurane and the right leg was isometrically contracted for 40 contractions by electrical stimulation at 100 Hz. Rats were dissected at 1 h post exercise. The left leg of the rats served as the unexercised leg. Western blotting was used to analyze MPS and signal proteins. In statistical analyses, the paired *t*-test was used for MPS and two-way ANOVA was used for signal proteins. Results We found that ERK 1/2 phosphorylation was significantly lower in the U0126 group than in the vehicle group, irrespective of exercise. In the same group, ERK 1/2 phosphorylation in exercised muscle was significantly higher than that in unexercised muscle. Increased MPS and phosphorylation of T389 and T421/S424 of S6K1 in exercised muscle were observed in both the vehicle and U0126 groups. Discussion The above results suggest that inhibition of ERK 1/2 phosphorylation does not suppress exercise-induced MPS and phosphorylation of S6K1. Other signaling molecules may be involved in the modulation of mTORC1 signaling in the exercise-induced increase in MPS. References Tsutaki A, Ogasawara R, Kobayashi K, Lee K, Kouzaki K, Nakazato K. (2013). Biomed Res Int, 2013, 480620. Contact tsutaki.a@nii.ac.jp

## CARDIORESPIRATORY RESPONSES TO GRADUAL AND ACUTE HYPOXIA DURING CONSTANT LOAD EXERCISE

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Introduction Acute mountain sickness (AMS) is caused by high altitude hypoxia, and can be fatal. During climbing to high altitude, inspired oxygen content gradually becomes lower. Simulating this situation in a laboratory at sea level may help us predict who is more likely to suffer from AMS before climbing to high altitude, thereby reducing individuals' risk to develop AMS. We are now able to generate a gradually increasing hypoxic stimulus by controlling a gas generator. The purpose of this study was to confirm the validity of this method for screening potential AMS. Methods Sixteen collegiate subjects performed constant load (40%  $\dot{V}O_{2peak}$ ) cycling exercise for 5 min at room air, and then continued to exercise for 15 min while inhaling a hypoxic gas mixture. Gradual hypoxia (GR) was conducted by reducing inspired oxygen concentration ( $FIO_2$ ) linearly from 20.9% (sea level) to 11.8% (4500m altitude) at the rate of 1% / min. Acute hypoxia (AC) was archived by a sudden decrease in oxygen to  $FIO_2=11.8\%$ . Each test consisted of two different end tidal  $CO_2$  (PET $CO_2$ ) conditions: poikilopnea (PO) simulating a climbing situation, and isocapnea (IS) induced by adding  $CO_2$  to the inspired gas mixture in order to clarify the influence of hypoxia per se. Four hypoxic exercise conditions were studied in total. The same exercise was also performed in room air normoxic conditions (NR). The gradual hypoxia test was also performed in resting poikilopneic conditions (RS). Results Hypoxia increased minute ventilation (VE) exponentially without delay in AC, while it increased VE in sigmoidal fashion with some delay in GR, and thereafter both reached steady state. The steady state VE in GR was a little smaller than that in AC but there was no significant difference. The steady state VE in PO was significantly smaller than that in IS. The arterial oxygen saturation (SpO $_2$ ) change mirrored VE change, but the magnitude of decrease in IS was smaller than that in PO. Heart rate showed a similar change as VE, independently of PET $CO_2$ . The rate of perceived exertion (RPE) estimated by Borg's scale in GR increased mildly as compared with that in AC during early stage of hypoxic exercise. Discussion Physical and mental stress seems milder during GR than that during AC so that GR can safely simulate climbing to high altitude. However, these cardiorespiratory responses had some intra-subject differences. Detailed investigation of these differences between climbers who have or have not experienced AMS may afford prediction of AMS. Further investigation is required. Conclusion Our results suggest that gradual hypoxia during exercise could successfully simulate climbing to high altitude. Contact E-mail: ishida@htc.nagoya-u.ac.jp

### THE ANTI-PHASIC RESPONSE OF BRACHIAL ARTERY BLOOD FLOW TO SINUSOIDAL WORK RATE LEG EXERCISE

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**Introduction** It has been classically accepted that the blood flow (BF) to non-active muscles decreased during dynamic exercise (i.e., BF in arm muscles during leg cycling). The recent studies (e.g., Simmons et al., 2011), however, showed that, during leg cycling, the BF in brachial artery (BA) did not reduce, rather increased with work rate (WR). To clarify such discrepancy, we observed the control of BF in BA during leg cycle exercise with sinusoidal WR forcing. **Methods** Nine healthy young male subjects exercised using an electromagnetically braked ergometer which is able to control the sec-by-sec WR via transport cable by external PC software. The subjects were performed for 30 min at a constant WR (the mean of sinusoidal WR forcing) followed by 16-min sinusoidal WR exercises of 4-min period (i.e. 4 times repetitions) where WRs were fluctuated in the range of 20 W to 50 % of peakVO<sub>2</sub>. During the protocol, we measured pulmonary gas exchange [breath-by-breath], heart rate (HR) and mean arterial blood pressure (MAP) [Photoplethysmograph], blood velocity (BV) and cross sectional area of BA [Ultrasound Pulsed-Doppler], and forearm skin BF (SBF) [Laser Doppler] and sweating rate (SR) [Capacitance Hygrometry]. The sec-by-sec variables were superimposed every three cycles during 2nd to 4th sinusoidal exercises to fit the sinusoidal model which was parameterized by mean level (M), amplitude (A), and phase delay. **Results and Discussion** Almost all responses were well described by the sinusoidal model, e.g., the conventional indicators of goodness of fit ( $r^2$ ) for VO<sub>2</sub>, Cardiac Output, BF in BA, and SBF (forearm) were averaged as 0.868, 0.801, 0.533, and 0.682, respectively. The phase delays of variables regarding pulmonary gas exchange and central circulation followed sinusoidal WR fluctuation with approximately 30-60 ° which were similar to those in the previous studies (e.g., Casaburi et al., 1977). Contrarily, the response of BF in BA showed the anti-phase (175±28 °) and large amplitude (A/M: 30±9 %), and did not reflect the phase delays of skin BF and SR. **In conclusion**, the control of non-active limb circulatory control is substantially different to the main gas exchange and circulatory control of the O<sub>2</sub>-delivery to active muscles. **Acknowledgements** This study was supported by JSPS-KAKENHI; 26350698 to Y Fukuba. **References** Casaburi R, Whipp BJ, Wasserman K, Beaver WL, Koyal SN. (1977) J Appl Physiol, 42, 300-311. Simmons GH, Padilla J, Young CN, Wong BJ, Lang JA, Davis MJ, Laughlin MH, Fadel PJ. (2011) J Appl Physiol, 110, 389-397. Contact fukuba@pu-hiroshima.ac.jp

### EFFECT OF RESISTANCE TRAINING ON INFLAMMATION MARKERS AND ANTI-OXIDANT ENZYME IN AORTA OF OBESE RATS

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**Introduction:** Obese individuals have excess abdominal visceral fat, which is a better predictor of cardiovascular and metabolic risk than total body fat alone and is also linked to altered vascular function. There is a lack of research in the investigation on the effects of resistance training on obesity resulting in increase of inflammatory response and antioxidant enzymes. Therefore, we investigated the effect of resistance exercise on the inflammatory makers (including NF- $\kappa$ B, TNF- $\alpha$ , COX-2) and Cu-Mn SOD expression in aorta of type 2 diabetic rats. **Methods:** Six week-old male ZDF (Zucker diabetic fatty) and ZLC (Zucker lean control) rats were randomly divided into 3 groups: sedentary ZLC (ZLC-Con), sedentary ZDF (ZDF-Con), and exercised ZDF (ZDF-Ex). ZDF-Ex rats were trained (once every 3 days for 8 weeks) to climb a 1.1-m vertical (80° incline) ladder with weight secured to their tail for progressive resistance exercise. The expressions of inflammatory markers (including NF- $\kappa$ B, TNF- $\alpha$ , Cox-2) and SOD were evaluated using western blotting. **Results:** NF- $\kappa$ B expression was significantly decreased ( $p < 0.05$ ) in ZDF-Ex group compared to ZDF-Con group. In TNF- $\alpha$  expression, we there were significant decreased ( $p < 0.01$ ) in ZDF-Ex group compared to ZDF-Con group. In similar trend with NF- $\kappa$ B expression, Cox-2 expression was significantly decreased in ZDF-Ex compared to ZDF-Con. In Cu-Mn SOD expression, there was no difference between ZLC-Con and ZDF-Con group, however, significant increases ( $p < 0.01$ ) of Cu-Mn SOD was found in ZDF-Ex compared to ZDF-Con group. **Discussion:** Chronic vascular inflammation is the fundamental mechanism of vascular diseases associated with variety of risk factors, contributing to pathogenesis of atherosclerosis and plaque rupture, leading to acute coronary syndrome [1] Oxidative stress is characterized with the excessive production of oxidant molecules that overwhelm the anti-oxidant defense systems, resulting in oxidative damage [2]. Based on the previous reports and our results, resistance exercise training might be efficient intervention for the modulation of vascular inflammation and oxidative stress in obesity **References** [1] Lonn ME, Dennis JM, Stocker R. Actions of 'antioxidants' in the protection against atherosclerosis. Free Radic Biol Med. 2012;53:863-84. [2] Hansson GK, Hermansson A. The immune system in atherosclerosis. Nat Immunol. 2011;12:204-12. Contact sok@qjou.ac.kr

### THE EXTRA FAT MASS AND BODY FLUID VOLUME OF THE RUGBY PLAYER ATTENUATE BY A CAMP

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**[Introduction]** Many competition athletes often participate in a camp to update their self-record and to win in a game. In this study, we investigated a camp of a rugby club and examined the change in body composition of competition athletes before and after the camp. **[Methods]** The subjects were 15 university students who were members of rugby football clubs. Using bioelectrical impedance analysis, we calculated their body composition before and after the camp. **[Results]** The weight [pre (90.0 ± 2.5 kg), post (84.8 ± 2.6 kg)] ( $p < 0.01$ ), fat mass [pre (18.3 ± 1.7 kg), post (14.9 ± 1.5 kg)] ( $p < 0.01$ ), body fat percentage [pre (20.3 ± 1.5%), post (17.3 ± 1.4%)] ( $p < 0.01$ ), and body fluid volume [pre (51.6 ± 1.2 L), post (50.9 ± 1.3 L)] ( $p < 0.05$ ) showed a significantly low value after the camp in comparison with before the camp. Skeletal muscle mass [pre (40.6 ± 1.0 kg), post (40.4 ± 1.0 kg)] showed no significant difference. However, Skeletal muscle percentage [pre (45.8 ± 0.9%), post (47.8 ± 0.8%)] and extracellular water [pre (0.21 ± 0.003 L/kg), post (0.22 ± 0.003 L/kg)] ( $p < 0.01$ ) showed a significantly high value after the camp in comparison with before camp. **[Conclusions]** This study demonstrated a decrease in weight and body fat percentage and an increase in skeletal muscle percentage in the subjects after the camp. However, these changes were not due to an increase in the quantity of muscle, but were due to a decrease in extra fat mass and body fluid volume.

## THE CURRENT STATE OF THE WATER INTAKE OF SPECTATORS AT A HIGH SCHOOL BASEBALL IN JAPAN

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**Introduction** Not only sports players but also spectators have the possibility of heat stroke. However, a field survey report about thermo physiological response of sports spectators in a hot environment isn't found. In Japan, the whole country's Senior High School baseball summer championship is the most popular sports event under education. Therefore, this event has many spectators that include students, children and elderly. On the other hand, the heat stroke onset of spectators at this event is actualized. So, the purpose of this study was to show clearly the current state of water intake of spectators at a high school baseball. **Methods** We carried out an investigation in spring and summer. Seven healthy young men ( $23.0 \pm 4.5$  yrs,  $172.1 \pm 7.2$  cm,  $72.0 \pm 8.0$  kg) in spring investigation and ten healthy young men ( $21.1 \pm 0.6$  yrs,  $169.9 \pm 4.0$  cm,  $63.4 \pm 7.1$  kg) in summer volunteered for this study. These investigations were condition that the subjects could drink mineral water freely during watching one game of a high school baseball. The measurement contents were water intake, sweat loss, weight loss, temperature, humidity and WBGT. **Results and Discussion** The environment condition of spring was temperature:  $14.8 \pm 0.6^\circ\text{C}$ , humidity:  $23.3 \pm 0.4\%$  and WBGT:  $10.3 \pm 0.4^\circ\text{C}$ . That of summer was temperature:  $36.2 \pm 0.9^\circ\text{C}$ , humidity:  $50.2 \pm 4.2\%$  and WBGT:  $34.6 \pm 0.7^\circ\text{C}$ . In the spring condition, water intake was  $35.7 \pm 37.8$  ml, body weight loss was  $0.2 \pm 0.3$  kg, and sweat loss was  $0.3 \pm 0.3$  kg. In the summer condition, water intake was  $370.5 \pm 132.4$  ml, body weight loss was  $0.5 \pm 0.3$  kg, and sweat loss was  $0.9 \pm 0.3$  kg. All measurement contents in the summer condition were significantly higher than that in the spring condition ( $P < 0.05$ ). In summer, though the water intake increased, the weight loss increased, too. This result showed that the spectators at high school summer baseball lacks water intake which depended on thirst rating. We concluded that there is possibility that heat stroke onset even if it is the watching sport that is almost rest condition. It's necessary to be careful when watching Tokyo Olympic Games, too.

## THE EFFECT OF TAPING ON PAIN-RELATED SOMATOSENSORY EVOKED POTENTIALS

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**Introduction** Taping is widely used in sports medicine to prevent injury, protect affected sites post injury and relieve pain. However, it is not clear whether taping affects the perception of noxious stimulation because in previous studies, it was difficult to selectively activate Aδ fibers. A recently developed, useful, new tool named intra-epidermal electrical stimulation (IES) can preferentially activate Aδ fibers. We aimed to clarify the effect of taping on pain-related somatosensory evoked potentials (pSEPs) using IES. **Methods** We recorded pSEPs following IES of the right medial forearm in seven healthy volunteers. pSEPs were recorded from 9 electrodes on the scalp under control, elastic-taping and white-taping conditions. Under the control condition, subjects relaxed on a comfortable reclining seat without taping, whereas under the taping conditions, they were subjected to taping along the forearm with tension (elastic-taping) and without tension (white-taping). Subjects were asked to assign a visual analog scale (VAS) score after each session. **Results** The peak amplitudes of N2-P2 were significantly lower under the elastic-taping and white-taping conditions than those under the control condition, and VAS score in the elastic-taping condition was the lowest among three conditions. Moreover, there was a significant positive correlation between the amplitude of N2-P2 and VAS. **Discussions** We revealed that taping along the forearm decreased pSEPs and subjective pain perception under the white-taping and elastic-taping conditions. The underlying mechanism of pain relief was the distraction effect in both taping conditions. In addition, elastic taping with tension changes various afferent inputs from the muscle spindles and the skin, and this might more effectively decrease the pain perception than that achieved under the white-taping condition.

## PHYSIOLOGICAL STRAIN IN HELICOPTER PILOTS IN EMERGENCY MEDICAL SERVICES

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1: Institute of Sports Science, Exercise Physiology, Training & Training Therapy Research Group, University of Graz; 2: Medical University Graz; 3: AMEZ GRAZ, Austria **Introduction** Pilots in helicopter-based emergency medical services operate up to 16 h of duty for 7 consecutive days. This kind of work represents mainly heavy peak psychological strain with permanent operational readiness which is not hard work in a traditional sense. But acute and chronic stress can lead to depression, metabolic syndrome, myocardial infarction with a higher probability (Öhlin et al. 2004; Hamer et al., 2012). Samel et al. (2004) showed that stress hormones in emergency helicopter pilots increased up to 80% due to a monitoring day. Aim of the study was to determine physical strain and stress parameters (HRV, stress hormones) in emergency medical services pilots in Austria. **Methods** The study included 21 male (age:  $44.5 \pm 6.2$  yrs) pilots of emergency medical services in Austria. Cycle ergometer test to determine exercise performance was performed in 12 pilots. Thresholds for blood lactate and gas exchanges variables were determined by linear regression break point analysis. Heart rate (HR) and HR variability (HRV) were measured during 24 hours including a whole work-shift (A) ( $13.25 \pm 1.68$  h), different phases during worktime (e.g. in flight, in alerting time) and was compared to a leisure time day off (F). 24 hour cortisol, adrenalin, noradrenalin and dopamine were measured in urine samples. Every three hours cortisol was measured from saliva samples. **Results** Pilots had a maximal oxygen uptake of  $3.202 \pm 0.367$  l/min and HR at the first lactate turn point (LTP1), a marker of heavy work occupational work, was  $116.3 \pm 9.4$  b/min. Mean HR during work time was significantly different from the day off (A:  $75.7 \pm 9.0$  b/min; F:  $70.6 \pm 9.1$  b/min). HRmax during different phases in work reached  $156 \pm 14.3$  b/min. RMSSD during worktime was 30% lower than in F. Significant differences were also found for cortisol, adrenalin, noradrenalin and dopamine being 50 to 70 % higher in worktime. Cortisol in saliva was not significantly different between work and leisure time. **Discussion** Considerably increased stress parameters were found in pilots in Helicopter-based emergency medical services which was similar to the study of Samel et al. (2004). It has to be questioned which health related consequences this kind of psychological strain combined with long duty cycles of up to 12 hours and longer could cause. In future long term studies are needed to investigate possible health consequences. **References** Samel A, Vejvoda M, Maass H. *Aviat Space Environ Med* 2004; 75:935–40. Öhlin, B; Nilsson, PM; Nilsson, JA; Berglund, G. *European Heart Journal* 2004, 25:867- 873 Hamer, M; Kivimaki, M; Stamatakis, E; Batty, D *CMAJ*, September18, 2012, 184(13): 1461 – 1466

### TREADMILL RUNNING AMELIORATES MUSCULAR DYSFUNCTION IN LACTATIONAL DEHP-EXPOSED RATS

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**Introduction** Di-(2-ethylhexyl)-phthalate (DEHP), a plasticizer usually applied in polyvinyl chloride manufacture, is regarded as an endocrine disruptor to exert adverse effects on the myogenic differentiation (Chen et al., 2013). Exercise has been proposed as a strategy for ameliorating a range of muscular disorders by strengthening strength and increasing resistance to fatigue (Alexanderson et al., 2014). In this study, we conducted an experiment regarding the effects of treadmill running on muscle strength in young adult male rats receiving postnatal DEHP exposure. **Method** Rat dams were fed with vehicle or DEHP (10 mg/kg per day) during lactation. After weaning, the male offspring were divided into 4 groups: control (C), DEHP (D), exercised control (Cex), and exercised DEHP (Dex). Rats were trained to exercise on a treadmill for 5 weeks from postnatal day 22 to 60 and then the muscle strength was measured by force transducer. The function of gastrocnemius was evaluated by measuring the plasma levels of insulin-like growth factor (IGF-1), the expressions of myosin heavy chain (MHC), peroxisome proliferator activated receptor gamma coactivator-1 $\alpha$  (PGC1 $\alpha$ ), and mammalian target of rapamycin (mTOR). **Result** The results demonstrate that the lactational DEHP-exposed rats exhibited decreased muscle strength. Decreased IGF-1, MHC-I, PGC1 $\alpha$ , and phosphorylated mTOR (p-mTOR) were observed in the lactational DEHP-exposed animals. Importantly, in the lactational DEHP-exposed animals, treadmill running during childhood-adolescence restored the muscle strength by normalizing the expressions of MHC-I, PGC1 $\alpha$ , and p-mTOR. **Discussion** Lactational DEHP exposure may impair the muscle strength and the muscular development. Meanwhile, treadmill running during the childhood-adolescence can restore the muscle strength by improving the expressions of MHC-I, PGC1 $\alpha$ , and p-mTOR in DEHP-exposed young male rats. These findings suggest that treadmill running may provide beneficial effects on ameliorating the dysfunction of muscle in the lactational DEHP-exposed adolescent male rats. **References** 1. Chen SS, Hung HT, Chen TJ, Hung HS, Wang DC. Di-(2-ethylhexyl)-phthalate reduces MyoD and myogenin expression and inhibits myogenic differentiation in C2C12 cells. *J Toxicol Sci.* 2013; 38(5):783-91. 2. Alexanderson H, Berggård J, Björnådal L, Nordin A. Intensive aerobic and muscle endurance exercise in patients with systemic sclerosis: a pilot study. *BMC Res Notes.* 2014; 7(1):86.

### TREADMILL RUNNING PROTECTS THE SPATIAL LEARNING IN LACTATIONAL DEHP-EXPOSED YOUNG RATS

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**Introduction** Aerobic exercise can improve learning and memory by enhancing the expression of brain-derived neurotrophic factor (BDNF) (Singh and Staines, 2015). Early life exposure to di-(2-ethylhexyl)-phthalate (DEHP), a plasticizer usually applied in polyvinyl chloride manufacture, may impair the expression of BDNF in rats (Smith and Holahan, 2014). In this study, we investigated the effects of treadmill running on the expression of BDNF and the performance of spatial learning in young rats that were exposed to DEHP during their lactational period. **Method** Rat dams were fed with vehicle or DEHP (10 mg/kg per day) during lactation. After weaning, the male offspring were divided into 4 groups: control (C), DEHP (D), exercised control (Cex), and exercised DEHP (Dex). Rats were trained to exercise on a treadmill for 5 weeks from postnatal day 22 to 60 and then the spatial learning was examined by Morris water maze. The functions of brain were evaluated by measuring the plasma levels of brain-derived neurotrophic factor (BDNF), hippocampal expressions of activity-regulated cytoskeleton-associated protein (Arc), phosphorylated cAMP response element-binding protein (p-CREB) and synaptophysin. **Result** Spatial learning of Morris water maze was impaired in the D group. Expressions of BDNF, Arc, and p-CREB were significantly decreased in the D group compared to the C group, however, there was no difference in the expression of synaptophysin between groups. After 5 weeks of treadmill running, spatial learning was improved in Dex group compared to D group. Biochemical evidence showed that expressions of BDNF, Arc, and p-CREB were increased in Dex group compared to D group. **Discussion** Lactational DEHP exposure may impair the spatial learning and the learning-induced expressions of BDNF, Arc, and p-CREB in the hippocampus, suggesting an impairment of synaptic plasticity in the DEHP-exposed rats. Meanwhile, aerobic exercise during the childhood-adolescence can restore the synaptic plasticity by improving the learning-induced expressions of BDNF, Arc, and p-CREB in the hippocampus of DEHP-exposed young male rats. **References** 1. Singh AM, Staines WR. The Effects of Acute Aerobic Exercise on the Primary Motor Cortex. *J Mot Behav.* 2015, 7:1-12. 2. Smith CA, Holahan MR. Reduced hippocampal dendritic spine density and BDNF expression following acute postnatal exposure to di(2-ethylhexyl) phthalate in male Long Evans rats. *PLoS One.* 2014, 9(10):e109522.

### ACUTE IMPACT OF COFFEE INTAKE ON CEREBRAL BLOOD FLOW AND ARTERIAL STIFFNESS IN THE SYSTEMIC CIRCULATION

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**Introduction** Previous research suggests an acute increase in risk of ischemic stroke in the hour after coffee intake (Mostofsky et al., 2010), while caffeine increases acutely arterial stiffness as well as blood pressure and peripheral resistance (Mahmud et al., 2001). An increase in brachial-ankle pulse wave velocity (baPWV) elevated pulsatility index (PI) of middle cerebral artery velocity (MCAv) with an increase in systemic pulse pressure (Xu et al., 2012). Therefore, coffee drinking-induced increase in arterial stiffness may increase pulsatile stress which may cause to microvascular damage at highly-perfused organs, such as the brain (Zarrinkoob et al., 2016). The purpose of the present study was to examine whether coffee intake elevates PI of MCAv which is associated with an increase in baPWV. **Methods** Ten healthy young subjects participated in the present study. Arterial blood pressure and MCAv were measured throughout the experiment. Also, the baPWV and PI of MCAv were calculated under two different conditions; coffee and decaffeinated coffee-intake conditions. After baseline measurement in upright sitting position, each subject drank coffee (250ml, caffeine 150mg) or decaffeinated coffee (250ml) randomly. **Results** Coffee intake increased mean arterial blood pressure ( $P<0.01$ ) with decreases in mean MCAv and MCA conductance index ( $P=0.02$ ,  $P<0.01$ ). Also, coffee increased baPWV, while it did not change PI of MCAv compared with decaffeinated coffee. **Discussion** Main finding of the present study is that coffee intake does not increase PI despite an increase in baPWV. This findings suggest that coffee drinking dose not increase pulsatile stress in the intracranial cerebral circulation. Thus, acute increase in arterial stiffness after coffee intake does not impair cerebral blood flow regulation, indicating that coffee intake induced increase in risk of ischemic stroke may not be associated with an elevation in arterial stiffness in the systemic circulation. **References** E.mostofsky, G.Schlaug, K.J.Mukamal, W.D.Rosamond, M.A.Mittleman. (2010). *Neurology*, 75, 1583-1588. A.Mahmud, J.Feely. (2001). *Hypertension*, 38, 227-231. T.Y.Xu, J.A.staessen, F.F.Wei, J.Xu, F.H.Li, W.X.Fan, P.J.Gao, J.G.Wang, Y.Li. (2012). *American Journal of Hypertension*, 25, 319-324. L.Zarrinkoob,



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## FLUTTERING ON OXYGEN PULSE DURING EXERCISE IN DIASTOLIC HEART FAILURE

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Oxygen pulse (OP) is a quantity defined by the oxygen uptake ( $\text{VO}_2$ )/heart rate (HR) ratio and represents the amount of oxygen being consumed by the body for each single cardiac beat. Moreover, it is an index of stroke volume (SV). In normal subjects, evidence suggests that this parameter increases linearly with respect to workload. Moreover, other research has demonstrated that, in the presence of cardiovascular disease such as ischemic myocardial disease and systolic heart failure, OP does not increase linearly with the increasing effort. Rather, it shows a leveling-off behavior at relative mild work intensities. However, to date there is not study on the OP time course in patients with diastolic heart failure (DHF). This investigation was set to analyze the difference in the OP time course during an incremental exercise test in DHF patients and normals. Methods: Two groups took part in this study: CTL group composed by 8 healthy subjects (3 females,  $33.2 \pm 6$  yrs); and DHF group composed by 9 patients suffering from DHF (4 females,  $59.8 \pm 9.4$  yrs). Each individual performed an incremental exercise test with on an electromagnetically-braked cycle-ergometer until exhaustion during which cardiopulmonary (CPX) parameters were collected. Workload,  $\text{VO}_2$ , and HR were assessed throughout the test. OP was also calculated as  $\text{VO}_2/\text{HR}$ . Results: The analysis of OP time course revealed that this parameter was significantly different between groups. In detail, in the CTL group OP continuously increased from 25% to 100% of the workload achieved ( $+7.04 \pm 3.99$  ml/bpm in the difference between 100%-25% workloads), whereas in the DHF group it showed a blunted increment ( $+3.31 \pm 2.74$  ml/bpm in the difference between 100%-25% workloads,  $p < 0.05$  vs the CTL group). Similarly, in the transition from 75% to 100% of the workload achieved patients showed a reduced capacity to increase OP as compared to normals ( $+0.68 \pm 0.65$  vs.  $+2.98 \pm 1.68$  respectively,  $p < 0.05$ ). Conclusions: This investigation demonstrates that DHF patients can not properly increase OP during incremental exercise. This finding is in accordance with their impaired capacity to recruit the pre-load reserve and to enhance SV. Finally, these results indicate that OP can be useful in order to detect differences between normals and DHF patients during the CPX test. References: 1 Crisafulli A et al. Anaerobic threshold and the oxygen consumption/cardiac output relationship during exercise. Sport Sci. Health 2005, 2:75-80 2 Crisafulli A et al. Estimating stroke volume from oxygen pulse during exercise. Physiol. Meas., 2007, 28:1201-1212

## THE EFFECTS OF EXERCISE TRAINING ASSOCIATE WITH LOW-LEVEL LASER THERAPY ON BIOMARKERS OF BROWNING IN OBESE WOMEN

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Introduction Recently investigations suggest the benefits of Low-Level Laser Therapy (LLLT) in improvement of body contouring noninvasive treatment. However, the mechanism for such potential effects associated to exercise training (ET) to reduce body fat, inflammation, insulin resistance and possible implications in browning adiposity process still unclear. Methods It was involved 49 obese women, aged of 20-40 years, body mass index (BMI) 30-40  $\text{kg}/\text{m}^2$ . The voluntaries were allocated in Phototherapy (ET-PHOTO) and SHAM (ET-SHAM) groups. Interventions consisted on exercise training and application of phototherapy post exercises during 4 months. Body composition, lipid profile, insulin resistance, atrial natriuretic peptide (ANP), WNT5 signaling, interleukin-6 (IL-6) and fibroblast growth factor-21 (FGF-21) were measured. Results It were demonstrated improvement in body mass, BMI, fat mass, lean mass, visceral fat, waist circumference, insulin, HOMA-IR, total cholesterol, LDL-cholesterol, triglycerides and ANP in both groups. Only ET-PHOTO group showed reduction in interleukin-6 and increase in WNT5 signaling. Moreover, it was showed that exercise training associated to LLLT is more effective than exercise training alone to reduce fat mass, insulin, HOMA-IR and to promote change in FGF-21 concentrations. Discussion In the present investigation it was confirmed that exercise training associate to LLLT promote an improvement in body composition, inflammatory process as previous demonstrated (da Silva Campos et al., 2015; Duarte et al., 2015; Sene-Fiorese et al., 2015). In highlight, in ET-PHOTO group was showed benefic modifications of WNT5 signaling, FGF-21 and ANP, possible biomarkers associated with browning adiposity process, suggesting that this kind of intervention promote results applicable in the clinical practice to control of obesity and related comorbidities. Contact: raquelmunhoz@hotmail.com References da Silva Campos RM, Dâmaso AR, Masquio DC, et al. (2015). Lasers Med Sci, Jul;30(5):1553-1563. Duarte FO, Sene-Fiorese M, de Aquino Junior AE, et al. (2015). J Photochem Photobiol B, 153:103-110. Sene-Fiorese M, Duarte FO, de Aquino Junior AE, et al. (2015). Lasers Surg Med, 47(8):634-642. Funding: FAPESP (2013/08522-6; 2015/14309-9), CNPq (573587/2008-6; 300654/2013-8; 150177/2014-3) and CAPES

## ACUTE AND TWO-WEEK EFFECTS OF HIGH-INTENSITY INTERVAL TRAINING AND ENDURANCE TRAINING ON FLOW-MEDIATED DILATION

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INTRODUCTION: Endothelial dysfunction is an early clinical biomarker of atherosclerosis and cardiovascular risk. Studies have demonstrated the benefits of long-term high-intensity interval training (HIIT) and endurance training (ET) on the surrogate marker, flow-mediated dilation (FMD). However, even in healthy populations, there is still a lack of knowledge regarding their acute effect, minimum effective dose and possible relations between the two. PURPOSE: To investigate the acute and two-week effects of HIIT and ET on FMD in young healthy adults. METHODS: Twelve healthy men ( $29 \pm 3$  yr.;  $177 \pm 7$  cm;  $78 \pm 8$  kg) were assigned to either HIIT ( $n = 7$ ) or ET ( $n = 5$ ) and performed six training sessions over two weeks. Each session consisted of either 8-12 intervals at 100% peak power output ( $335 \pm 55$  W) separated by 75 s of recovery (HIIT) or 90-120 min continuous cycling at 65%  $\text{VO}_{2\text{peak}}$  ( $165 \pm 20$  W, [ET]) (HIIT vs. ET total exercise volume:  $\sim 1375$  kJ vs.  $\sim 6250$  kJ). Baseline FMD of the brachial artery was assessed using B-mode ultrasound prior to training intervention, acutely after the first training session and again after two weeks of intervention.  $\text{VO}_{2\text{peak}}$  and peak power output were determined pre- and post-intervention. Data are described descriptively (means  $\pm$  SD). To investigate differences between baseline and post-exercise values, a two-way repeated measures ANOVA (between and within factors) was employed, ( $\alpha = 0.05$ ). Correlations between acute and two-week effects were analyzed with Pearson's correlation coefficients (r). RESULTS: Preliminary results show FMD is decreased acutely after both HIIT ( $8.3 \pm 2.1\%$  v  $4.7 \pm 2.3\%$ ) and ET ( $10.2 \pm 2.0\%$  v  $2.8 \pm 2.7\%$ ),  $p = 0.02$ , with a significantly greater decrease immediately after ET,  $p =$

0.01. These changes and differences were independent of baseline artery diameter and shear stress. Although increases in VO<sub>2</sub>peak (HIIT:  $44.5 \pm 7.6$  v  $47.3 \pm 8.6$  ml/kg/min; ET:  $43.8 \pm 7.6$  v  $47.3 \pm 5.0$  ml/kg/min,  $p = 0.001$ ) and peak power output (HIIT:  $4.3 \pm 0.7$  v  $4.6 \pm 0.6$  W/kg, ET:  $4.3 \pm 0.4$  v  $4.6 \pm 0.3$  W/kg,  $p = 0.001$ ) were observed, no changes in FMD were found after two weeks of either HIIT ( $8.3 \pm 2.1\%$  v  $7.6 \pm 1.8\%$ ) or ET ( $10.2 \pm 2.0\%$  v  $10.7 \pm 2.5\%$ ),  $p = 0.31$ . No relationship between acute and two-week FMD effects was found in either group (HIIT:  $r = 0.46$ ,  $p = 0.55$ ; ET:  $r = -0.23$ ,  $p = 0.62$ ). CONCLUSIONS: Considering differences in total work and volume, HIIT and ET both provoked acute reductions in FMD with ET having greater effect. However, no improvements in FMD could be demonstrated after two weeks of training despite both HIIT and ET enhancing VO<sub>2</sub>peak and peak power output. Future studies should include longer interventions and more heterogeneous cohorts to help clarify the minimum effective dose of exercise to elicit favorable FMD adaptations and if acute effects of exercise on FMD could help predict intervention outcomes. CONTACT: rector@uni-potsdam.de

## EFFECTS OF PILATES EXERCISE ON S-IGA SECRETORY LEVELS IN OLDER WOMEN

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Effects of Pilates exercise on S-IgA secretory levels in older women Yoonyoung Hwang<sup>1</sup>, Jonghoon Park<sup>2</sup>, Kiwon Lim<sup>1,3\*</sup> 1 Physical Activity & Performance Institute, Konkuk University, Seoul, Republic of Korea 2 Department of Physical Education, Korea University, Seoul, Republic of Korea 3 Department of Physical Education, Konkuk University, Seoul, Republic of Korea Purpose The purpose of this study was observed whether the mucosal immune function could change during acute high-intensity exercise after 3 months of Pilates exercise. METHODS Subjects The study population comprised 12 older women who were divided into a Pilates group (PG, n=6) that participated in a Pilates exercise program and a control group (CG, n=6) that did not participate in an exercise program. Study design The Pilates exercise program Before and after was performed for 3 months. In addition, acute high-intensity exercise was performed before and after the 3-month Pilates exercise program, and saliva samples were obtained immediately after exercise and at 30 and 60 min after exercise. Pilates exercise program The experiment group (PG group) carried out the program for twelve weeks (three days a week, 50 minutes a session). The intensity of the exercises was 40% of the Target Heart Rate (THR) at the beginning and was progressively increased to 60% of the THR by the end of the study. Aerobic capacity/graded exercise test All subjects performed a trial consisting of 50 rpm with 50 watts for a 6-minute single-stage protocol. If HR was < 130 bpm at the end of the exercise session, the workload was increased to 60 watts at 60 rpm for 6 more minutes. Saliva collection Saliva samples were collected in 10 ml tubes. The acute exercise was always performed between 09:00 and 10:00 AM. To measure salivary flow rate, saliva was collected in a tube for 15 min. Results Mucosal immune function before and after the 3-month Pilates exercise program The exercise intensity was measured during the 3-month Pilates program and was 45% of the maximum HR at 8 weeks and 61% of the maximum HR at 3 months. Mucosal immune function after acute high-intensity exercise before and after the 3-month Pilates exercise program (a) Salivary flow rate After the 3-month Pilates exercise program, salivary flow rate was significantly higher before and after acute high-intensity exercise at all-time points in the PG than in the CG. (b) Absolute S-IgA concentration This level was sustained 30 min after acute exercise in the PG, but the S-IgA level decreased 30 min after acute exercise in the CG. (c) S-IgA secretion rate The S-IgA secretion rate was significantly higher at 30 min after acute high-intensity exercise in the PG than in the CG. Conclusion This study suggests that participation in a moderate-intensity Pilates exercise program can increase the resting salivary flow rate in older women. Furthermore, a Pilates exercise program can increase the S-IgA secretion rate when needed during high-intensity physical activity.

## EFFECTS OF SUPINE IMMERSION OF THE BODY IN WATER ON THE REGIONAL PULSE WAVE VELOCITY

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Background: A human body is immersed in water is affected by the physical properties of water and accordingly manifests physiological responses. In this study, we compared the brachial-ankle pulse wave velocity (baPWV) of the body when it was in the supine position at rest on the ground with that when it was immersed in water at a temperature of 30°C. The results showed that the baPWV in the supine position in water was significantly higher than that at rest on the ground. However, baPWV is an indicator of arterial stiffness, including both elastic and muscular arteries, and therefore, it is difficult to determine in terms of arterial stiffness which parts of the body are affected by the immersion in water at 30°C. Thus, this study aimed to demonstrate the effects of supine immersion of the body in water on the regional pulse wave velocity. Method: The subjects were eight healthy adult males. Measurements were conducted during the 15 min of rest in the supine position at the poolside with a room temperature of  $28.3 \pm 1.3^\circ\text{C}$  and humidity of  $84.0 \pm 6.6\%$ . Similarly, measurements were conducted during the 15 min of immersion in water at a temperature of 30°C. The participants were in the supine position and were fully immersed in water except for the face. The parameters measured were baPWV, heart-carotid PWV (hcPWV), heart-femoral PWV (hfPWV), femoral-ankle PWV (faPWV), heart rate, blood pressure in the upper arm and ankle, rectal temperature, skin temperature (using the 4-point method), and skin blood flow at the dorsum of the foot. Results and Discussion: The baPWV, faPWV, and diastolic blood pressure values in the ankle during immersion in water were significantly higher than those in the supine position at rest on the ground ( $P < 0.05$ ). Rectal temperature, skin temperature, and skin blood flow values were all significantly lower when immersed in water compared with those in the supine position at rest on the ground ( $P < 0.05$ ). There was a significant positive correlation between faPWV and baPWV at 5, 10, and 15 min after entering the water (5min:  $r = 0.94$ ,  $P < 0.01$ ; 10min:  $r = 0.80$ ,  $P < 0.05$ ; 15min:  $r = 0.93$ ,  $P < 0.01$ ). The pulse wave is conducted from the central arteries to the peripheral arteries. The faPWV is an index of muscular arterial stiffness. The results of this study suggest that increases in baPWV associated with supine immersion of the body in water may not be caused by changes in both elastic and muscular arterial stiffness but by changes in only muscular arterial stiffness. Conclusion: The results suggest that faPWV may be associated with an increase in baPWV during supine immersion of the body in water. [This work was supported by JSPS KAKENHI Grant Number 15H06786.]

## FUNCTIONAL ASSESSMENT OF SEVERE HAMSTRING MUSCLE DAMAGE FOLLOWING INTENSIVE ECCENTRIC EXERCISE: DIFFERENCES BETWEEN AND WITHIN SUBJECTS

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**Introduction** The aims of this study were to investigate the degree of damage inflicted to the hamstring muscles by an intensive voluntary eccentric exercise and to analyse differences in the extent of damage between-subjects and within-subjects (limb-to-limb comparison). **Methods** Thirteen healthy and physically active men (age  $22.9 \pm 2$  yr) performed six sets of 10 eccentric unilateral hamstring leg curls (EULC) (Prone Leg Curl TechnogymTM, Italy) at 120% of their 1-repetition maximum (1-RM) with each leg, with 3-min rest between sets. Proxy markers of exercise-induced muscle damage (EIMD) such as force-generating capacity (FGC) (measured as maximal isometric voluntary contraction (MVC)), creatine kinase (CK) and magnetic resonance imaging (MRI) transverse relaxation time (T2) were measured at baseline and at regular intervals for 7 d after exercise. **Results** Two groups of subjects were identified according to the extent of EIMD reflected by MVC declines: high responders (HR) ( $n=10$ ) and moderate responders (MR) ( $n=3$ ) (3). Significant differences were also found in MVC within-subjects (limb-to-limb comparison) from the HR group. Changes in the CK serum levels after EULC were significantly different between HR and MR, and were correlated with MVC losses. The MRI T2 analysis revealed that semitendinosus (ST) was the hamstring muscle mainly damaged by EULC. ST T2 values obtained 7 d after exercise from the leg whose hamstring muscles showed the greatest FGC decline were correlated to MVC reductions but no correlations were found between T2 values and MVC reductions in the leg whose hamstring muscles showed the lesser FGC decline. **Discussion** Although large differences between subjects (HR and MR) were found, results challenge the notion that severe EIMD in humans is restricted to electrical stimulation protocols (1). CK reflects the amount of damage, especially when damage becomes severe (2). Within-subjects (limb-to-limb comparison) differences reveals that experimental designs using contralateral limbs as a control need to take into account that different degree of hamstring damage can be induced between legs. When muscle function is recovered (i.e., MVC), long-lasting increases in T2 values suggests an adaptive process rather than EIMD. **References** 1. Crameri RM, Aagaard P, Qvortrup K, Langberg H, Olesen J, and Kjaer M. J Physiol 583: 365-380, 2007. 2. Lauritzen F, Paulsen G, Raastad T, Bergersen LH, and Owe SG. J Appl Physiol (1985) 107: 1923-1934, 2009. 3. Paulsen G, Mikkelsen UR, Raastad T, and Peake JM. Exerc Immunol Rev 18: 42-97, 2012. **Acknowledgements** Funded by Institut Nacional d'Educació Física de Catalunya (INEFC), Generalitat de Catalunya (2014SGR/1629) and MICINN; DEP2013-46574-P

## LEUKOCYTE ALTERATION IN RESPONSE TO A SOCCER GAME

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**Introduction** Soccer is one of the most popular modern sports played by men and women all around the world. It is estimated that players cover approximately 8 to 13 km per game, including different intensities of movement: walking, moving backwards, jogging, running and sprinting. During the game soccer players experience a number of short accelerations and decelerations at near maximal or even maximal intensities that could represent an important source of muscle damage and inflammation. The aim of the study was to determine the effect of soccer game on changes in leukocyte subpopulations in young soccer players. **Methods** 44 male field players aged 16 to 18 years, members of two soccer teams competing on junior national level, volunteered to participate in this research. All subjects signed informed consent. The study was carried out in accordance with and approved by the Research Ethics Committee of Faculty of Kinesiology University of Zagreb. 30 minutes before and immediately after the game (2 x 45min) blood samples were taken and leukocyte numbers were determined. Focus X2 was used to analyze player on-field activities. Statistical computations were performed using Statistica for Windows software. **Results** Total absolute number of leukocytes increased significantly from  $5271$  to  $9465 \times 10^9/L$ . Compared with circulating numbers at rest before the game increased number of neutrophils, eosinophils and monocytes were determined, while the number of lymphocytes significantly decreased. Significant differences were determined among the changes according to the player's position. **Discussion** The changes in total leukocyte numbers and all leukocyte subpopulations were identified. The similar changes were observed for all positions of players, but the level of changes was different. In goalkeepers the changes were not significant which is in accordance to their lower load during the game. More pronounced differences were present for defenders and midfield players. **Conclusion** These large increases in total number of leukocytes and especially in segmented neutrophils from pre-match to post-match are in agreement with other studies observing muscle damage changes in soccer players during the game. The correlation with distances covered was noticed. **References** Meyer T, Meister S (2011). Routine blood parameters in elite soccer players. Int J Sports Med, 32(11):875-81. Mohr M, Draganidis D, Chatzinikolaou A, Barbero-Álvarez JC, Castagna C, Douroudos I, Avloniti A, Margeli A, Papassotiropoulos I, Flouris AD, Jamurtas AZ (2016). Muscle damage, inflammatory, immune and performance responses to three foot ball games in 1 week in competitive male players. Eur J Appl Physiol, 116(1):179-93. Silva JR, Rebelo A, Marques F, Pereira L, Seabra A, Ascensão A, Magalhães J (2013). Biochemical impact of soccer: an analysis of hormonal, muscle damage, and redox markers during the season. Appl Physiol Nutr Me, 39(4):432-8. Contact: antonela.devnrja@kif.hr

## WHOLE-BODY BIOELECTRICAL IMPEDANCE VECTOR ANALYSIS IN MALE TRAIL RUNNERS: PRELIMINARY RESULTS

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**INTRODUCTION** Trail running consist in long-distance outdoor running through mountains, backcountry and/or deserts. As is known, inadequate fluid strategies in prolonged exercises can lead to dehydration, negatively affecting health and performance. Body mass (BM) is usually used to control the hydration status. Other techniques, such as BIVA, have emerged for the assessment of hydration variations. This study applied BIVA to assess possible hydration changes evoked by different distances of trail running (14km, 35km and 52km) in three groups of trail runners (TR). **METHODS** 56 TR (14km:  $n=14$ ; 35km:  $n=28$ ; 52km:  $n=14$ ) were assessed before and after running (14km:  $102 \pm 24$ min; 35km:  $228 \pm 42$ min; 52km:  $408 \pm 78$ min). A 50 kHz, phase-sensitive bioimpedance analyser (BIA-101 ASE; Akern Srl) was used to measure resistance (R) and reactance (Xc). Electrodes (Biatrode, Akern Srl) were placed according to the standard tetrapolar electrode placement. Whole-body impedance vectors were analysed using the RXc graph method. Hotelling's T2 tests were performed to analyse

the vectors of TR. RESULTS Significant changes were observed after runs in BM ( $p < .01$ ): 14km:  $-0.9 \pm 0.9$ kg; 35km:  $-2.5 \pm 1.6$ kg; 52km:  $-2.2 \pm 0.8$ kg. Athletes showed vectors significantly shifted to the left compared to their healthy reference population ( $p < .001$ ). No statistical differences were found in BIVA between athlete groups (Fig. 1). BIVA showed significant whole-body vector migration after runs in all groups ( $p < .001$ ) (Fig. 2). DISCUSSION Differences in BIVA between TR and the reference population indicate increased body cell mass and fluid content, maybe due to sport adaptations (Micheli et al., 2014). Significant differences in BM were found after runs. Additionally, BIVA also showed significant vector migrations after exercise, identifying fluid loss and likely indicating fluid shifts between intracellular and extracellular compartments (Gatterer et al. 2014). Surprisingly, 52km runners showed a vector displacement smaller than 14km and 35km runners. Weather conditions, previous performance level, running intensity, and fluid/food intake strategy during the run, could explain these results and should be taken into account in future investigations to determine the causes of the vector migration. Therefore, BIVA appears to be sensitive to hydration changes in different distances of trail running. Further research is needed in order to support these findings. REFERENCES Gatterer H, Schenk K, Laninschegg L, Schlemmer P, Lukaski H, Bartscher M (2014). PloS One, 9(10):e109729. Micheli M, Pagani L, Marella M, Gulisano M, Piccoli A, Angelini F, Bartscher M, Gatterer H (2014). Int J Sports Physiol Perform, 9(3):532-539. Piccoli A, Nigrelli S, Caberlotto A, Bottazzo S, Rossi B, Pilon L, Maggiore Q (1995). Am J Clin Nutr 61:269-270. CONTACT airuria@gencat.cat

## INFLUENCE OF EXERCISE INTENSITY ON CHANGES IN HUMAN SKIN-GAS ACETONE CONCENTRATIONS FOLLOWING SUBMAXIMAL CYCLE EXERCISE

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Introduction Increased ketone bodies (3-hydroxybutyrate, acetoacetate and acetone) during exercise are results of fatty acids oxidation in the liver, and export to peripheral tissues, such as the brain, heart, kidney and skeletal muscle for use as energy fuels (Mitchell et al. 1995). Because acetone is generated from decarboxylation of circulating acetoacetate, a few studies (Mori et al. 2008, Yamai et al. 2009) have reported increased human skin-gas acetone concentrations according to exercise intensity. On the other hand, Romijn et al. (1993) have reported that peripheral lipolysis was stimulated maximally at 25 %  $\text{VO}_2\text{max}$  during constant-load exercise. However, no one has confirmed influence of exercise intensity on changes in skin-gas acetone concentrations during submaximal exercise. Therefore, the purpose of the present study was to examine whether differences in submaximal exercise intensity would affect on changes in skin-gas acetone concentrations or not. Methods Ten healthy male students randomly performed three kinds of constant-load (10, 30, 60%  $\text{HR}_{\text{max}}$ ) cycle exercise for 30 min. The skin-gas samples were obtained by the covering left hand for 30 sec with a polyfluorovinyl bag (Tedlar bag; GLScience, Tokyo, Japan) in which pure nitrogen gas was introduced, and collected in a sampling bag at rest, 3, 6, 9, 12, 15, 20, 30 min after, and 5, 10, 20 min recovery of the exercise. Acetone concentration was analyzed by gas chromatography Results Skin-gas acetone concentrations significantly increased during 30 and 60%  $\text{HR}_{\text{max}}$  exercise compared to the resting values ( $p < .01$ ), however, 10%  $\text{HR}_{\text{max}}$  exercise did not change skin-gas acetone concentrations significantly. Thus, skin-gas acetone levels following 30 and 60%  $\text{HR}_{\text{max}}$  exercise were significantly ( $p < .01$ ) higher than 10%  $\text{HR}_{\text{max}}$  exercise. Discussion In this study, more than 30% exercise intensity increased skin-gas acetone concentrations and reached almost maximum. These results indicated following possibilities. First, the production of ketone bodies in the liver might be reached maximum (Romijn et al. 1993) during 30%  $\text{HR}_{\text{max}}$  exercise for 30 min and eliminated as expired air and (or) skin-gas acetone (Yamai et al. 2009). Second, the total amount in ketone production in the liver and consumption in peripheral tissues such as skeletal muscles might be same between 30 and 60 %  $\text{HR}_{\text{max}}$  exercise. References Mitchell GA et al. (1995) Clin Invest Med 18: 193–216. Mori et al. (2008) Redox Rep 13: 139–42. Yamai et al. (2009) Redox Rep 14: 1–5. Romijn et al. (1993) Am J Physiol 265: E380–E391. Contact Hiroshi Itoh [ito.hiroshi@nitech.ac.jp]

## ISCHEMIC PRECONDITIONING IMPROVES CARDIAC AUTONOMIC RECOVERY IN MIDDLE-AND LONG-DISTANCE RUNNERS: A RANDOMIZED, PLACEBO AND NOCEBO-CONTROLLED STUDY

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Introduction: Vagal reactivation and sympathetic withdrawal to the heart take place during recovery from exercise (1). This can be assessed by heart rate recovery (HRR) and used to monitor athletes' recovery and performance (2). Ischemic preconditioning (IPC) has been shown to improve exercise performance (ref. 3 for review). However, the effect of IPC on cardiac autonomic recovery remains uninvestigated. Herein, we tested the hypothesis that IPC improves HRR in middle- and long-distance runners. Methods: Eighteen middle- and long-distance runners [14 males (mean  $\pm$  SD;  $22 \pm 3$  yrs;  $\text{VO}_2\text{max}$   $67.2 \pm 5.1$  ml/kg/min) and 4 females ( $24 \pm 4$  yrs;  $\text{VO}_2\text{max}$   $55.8 \pm 4.1$  ml/kg/min)] were submitted to three interventions, in random order [IPC; sham ultrasound session (SHAM); and resting control (CT)]. Subjects were told that: 1) IPC and SHAM would similarly improve recovery compared to CT, to control for placebo; and 2) IPC would cause no harm, despite circulatory occlusion pain, to avoid nocebo. Then, subjects underwent a maximal discontinuous incremental test (30-s interval each 3 min) on a treadmill. Blood was drawn for lactate analysis. Ten min later, a supramaximal constant test was performed till exhaustion. HRR after 30 s (HRR30s) and short-term time constant of HRR (T30) were calculated after each stage of the incremental test. HRR30s, T30 and HRR after 60 s (HRR60s) and 120 s (HRR120s) were calculated after the constant test. Results: The lactate threshold (LT) corresponded to  $85 \pm 4\%$  of peak velocity. IPC increased the HRR30s only at 70% (IPC:  $31 \pm 2$  vs. SHAM:  $26 \pm 2$  vs. CT:  $26 \pm 3$  bpm,  $P < .01$ ) and 75% (IPC:  $29 \pm 2$  vs. SHAM  $24 \pm 2$  vs. CT  $25 \pm 2$  bpm,  $P < .01$ ) of peak velocity. IPC did not change T30 in the incremental test, and HRR30s, T30, HRR60s and HRR120s in the constant test ( $P > .05$ ). Discussion: IPC improved cardiac autonomic recovery from exercise in middle- and long-distance runners and this effect was independent from placebo. The IPC effect was observed only below the LT, which indicates it was intensity-dependent. References 1. Lamberts RP, et al. Heart rate recovery as a guide to monitor fatigue and predict changes in performance parameters. Scand J Med Sci Sports. 2010;20(3):449–57. 2. Salvador AF, et al. Ischemic preconditioning and exercise performance: A systematic review and meta-analysis. Int J Sports Physiol Perform. 2016;11(1):4–14. 3. Imai K, et al. Vagally mediated heart rate recovery after exercise is accelerated in athletes but blunted in patients with chronic heart failure. J Am Coll Cardiol. 1994;24(6):1529–35.



## FUNCTIONAL OUTCOMES AND MUSCLE PROTEINS INTO CIRCULATION AFTER ECCENTRIC EXERCISE IN HUMANS

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**Introduction** A series of eccentric contractions can result in muscle damage characterized by sarcomere overstretching, loss of sarcolemma integrity, leakage of muscle enzymes into the bloodstream and functional impairment of the exercised muscle (Clarkson et al., 1992). The concentration of these enzymes into the circulation depends on their structural size and the degree of muscle damage (Heavens 2014). The aim of the present study was to examine functional outcomes and muscle proteins into circulation after an eccentric exercise protocol in humans. **Methods** Nine healthy men (years:  $23 \pm 3.4$ , height:  $180 \pm 3$  cm, mass:  $83.5 \pm 10.8$  kg, BMI:  $25.76 \pm 2.56$ ) performed 8 sets of 6 maximal eccentric actions of the knee extensors muscles of one leg. Baseline measurements including maximum strength, perceived muscle soreness evaluation (palpation and flexion-extension), range of motion (knee angle flexion) and proprioception (knee position sense) were performed in each leg 2 days prior to eccentric exercise, immediately after, as well as 48h and 96h post exercise. Blood samples were also collected at each testing session before the functional measurements and were analysed for CK, MB, LDH, AST. One-way ANOVA with repeated measures was used for statistics. **Results** Eccentric exercise protocols 14.2mm in a 100 mm visual analogue scale at 0h, 48h and 96h, respectively. Knee angle flexion decreased from 126.6 at baseline to 112.6, 113.8, and 114.2 degrees, and a deflection of 10.4, 7.9, and 5.9 degrees was reported during the position sense test, at 0h, 48h and 96h post-exercise, respectively. Baseline values for CK, MB, AST, and LDH were changed from 170 U/L, 55µg/L, 26 U/L, 147 U/L, respectively at baseline to CK: 227, 5494, 9770 U/L, MB: 71, 96, 99µg/L, AST: 26, 91, 191 U/L, LDH: 152, 301, 441 U/L, at 0h, 48h, 96h, respectively. **Discussion** Our findings suggest that the eccentric exercise protocol used in this study resulted in muscle damage, as reflected by the prolonged force loss, delayed onset muscle soreness range of motion impairment, and muscle proteins release into circulation post-exercise. These findings suggest that the eccentric protocol caused a severe muscle damage based on the CK levels ( $>10000$  U/L) combined with the degree of force loss (by  $>50\%$ ) (Paulsen et al., 2012). Interestingly, the eccentric protocol led also to a prolonged impairment of proprioception of the exercised muscles. **References** Clarkson et al. Med Sci Sports Exerc 1992;24:512-20 Heavens et al. J Strength Cond Res 2014;28:1041-1049 Paulsen et al. Exerc Immunol Rev 2012; 18:42-97 Contact kolliaslouk@gmail.com

## EFFECT OF EXERCISE AND GLUCAGON-LIKE PEPTIDE-1 ANALOGUES ON BODY WEIGHT AND GLUCOSE METABOLISM IN OBESE RATS

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**Introduction** Because of the increase in the type 2 diabetes epidemic, research has been performed in an attempt to develop new therapeutic methods. A promising treatment for diabetes is the use of incretins (hormones that work to increase insulin secretion). Medications such as GLP-1 analogues have been used for diabetes treatment, as has exercise, but it is not clear whether there is a positive additive effect when exercise and GLP-1 analogue medications are combined for the treatment of type 2 diabetes. In light of this question, the aim of this study was to analyze the effect of exercise and GLP-1 analogue on the glucose metabolism of the obese rats. **Methods** Wistar rats were fed a high-fat diet (HFD) for 12 weeks and were then separated into four groups: the VEIC-S group received the vehicle solution and was sedentary; the VEIC-T group received the vehicle solution and exercise; the GLP-S group received GLP-1 analogue and was sedentary; and GLP-T group received GLP-1 analogue and exercise. Exercise consisted of one hour of swimming per day for two weeks. GLP-1 (Liraglutide, 100 mg / kg) was administered subcutaneously twice a day (9:00am and 4:00pm) for two weeks to the GLP groups. At the end of the experiment, body weight was measured on a digital scale. After six hours of fasting, intraperitoneal insulin tolerance tests (IP-ITTs) and intraperitoneal glucose tolerance tests (IP-GTTs) were performed. The rats were killed for blood sample collection. **Results** There was a difference in body weight (g) between the groups: VEIC-S:  $574 \pm 70$ g; VEIC-T:  $565 \pm 52$ g; GLP-S:  $539 \pm 67$ g; and GLP-T:  $511 \pm 68$ g. In the case of glucose, the following areas under the curve were found (mg/dl20min): VEIC-S:  $20.326 \pm 1.621$ f; VEIC-T:  $17.478 \pm 1.795$ g; GLP-S:  $12.352 \pm 1.305$ e; and GLP-T:  $12.890 \pm 2.267$ e. The following KITT values were found (%/min): VEIC-S:  $2.26 \pm 0.93$ b; VEIC-T:  $3.17 \pm 0.99$ ba; GLP-S:  $3.45 \pm 0.88$ a; and GLP-T:  $3.46 \pm 0.89$ a. The blood concentrations of insulin were found to be: VEIC-S:  $5.69 \pm 1.82$ n; VEIC-T:  $2.14 \pm 0.85$ o; GLP-S:  $4.29 \pm 1.56$ n; and GLP-T:  $2.52 \pm 1.66$ o. Finally, the blood concentrations of IL-10 were as follows: VEIC-S:  $26.90 \pm 4.24$ j; VEIC-T:  $32.33 \pm 6.66$ i; GLP-S:  $38.95 \pm 15.00$ i; and GLP-T:  $52.00 \pm 17.08$ m. **Discussion** GLP-1 analogue and exercise were found to be effective in decreasing body weight. There were also improvements in glucose metabolism and an increase in the circulating antiinflammatory cytokine IL-10. Therefore, some of the parameters revealed the positive additive effects of combining physical exercise and the administration of GLP-1 analogue.

## EFFECTS OF CREATINE ADMINISTRATION ON SERUM CPK LEVELS AND SOME PHYSIOLOGICAL VARIABLES FOR ATHLETES DURING COMPETITION PHASE

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**Introduction:** Training enhancers have developed greatly during recent years, especially in natural nutrition supplements (Moon et al 2015). Nutrition supplements are natural food products that athletes use for improving their athletic achievement to the max. Creatine is one of the most popular nutrition supplements with random and uncontrolled usage among athletes. Creatine plays a major role in energy metabolism in the musculoskeletal system. An average human body needs nearly 2 grams of creatine per day. Athletes consume high doses that exceed the real needs and actual production of creatine in the human body. The current research aims to identify the effects of creatine administration on serum CPK levels and some physiological variables among judokas. This is very important according to the widespread uncontrolled use of creatine among athletes. **Methods:** The researcher used the experimental approach (one-group design) with pre- and post-measurements. Participants ( $n=8$ ) were purposefully chosen for the judo team of ALSAID Sports Club – Al-Mahalla Al-Kubra – Egypt. The researcher used the experimental approach (one-group design) with pre- and post-measurements. Blood samples were taken before creatine administration. Participants were asked to take 20 grams per day for four days during the first week (the loading phase) and then they were asked to take 5 grams per day for seven weeks. Creatine administration was with warm water to facilitate absorption. After eight weeks of creatine consumption, blood sample were taken as a post-measurement. **Results:** After creatine administration for (8) weeks, (I) calculated values reached (8.6) while its table value on  $P \leq 0.05 = (1.86)$  with a variance percentage of 180% for CPK. No statistically significant differences were noticed for pulse or blood pressure. **Discussion:** Results indicated that although creatine supplementation was controlled, CPK serum levels increased significantly beyond normal levels (Wang, L. 2015). This particular

enzyme affects muscular work negatively and makes the athlete feel exhaustion rapidly (Sureda et al 2015). References: 1. Moon, A., Heywood, L., Rutherford, S. M., & Cobbold, C. (2015). Creatine supplementation in the elderly: is resistance training really needed?. *Journal of Nutrition and Health Sciences*, 2(1). 2. Sureda, A., Mestre-Alfaro, A., Banquells, M., Riera, J., Drobnic, F., Camps, J., ... & Pons, A. (2015). Exercise in a hot environment influences plasma anti-inflammatory and antioxidant status in well-trained athletes. *Journal of thermal biology*, 47, 91-98. 3. Wang, L. (2015). THE INFLUENCE OF FOOD LOADING WITH VITAMIN AND ELECTROLYTE ON PHYSICAL INDEX OF ATHLETES. *Carpathian Journal of Food Science & Technology*, 7(1).

### VARIABILITY IN TOTAL HAEMOGLOBIN MASS TO ALTITUDE TRAINING

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**Introduction** Athletes use high altitude training (HAT) to increase their total haemoglobin mass (tHbmass). Previous studies suggest that there are athletes who do obtain increase in tHbmass (responders) but some do not have response (non-responders) (McLean et al. 2013). Those athletes who do not get a response are less likely to repeat a HAT camp. Assuming that there are marked individual differences among athletes and the response to HAT is personal and repeatable we studied tHbmass in athletes who visited HAT camp and focused on those who visited at least twice. **Methods** Using carbonmonoxide rebreathing method (Koponen et al 2013) we measured tHbmass, blood volume (BV), plasma volume (PV), haemoglobin (Hb), hematocrit (HCT) in 53 athletes (mean 25 years, SD 6 years). There were total of 77 HATs (at least 21 days, 1400 - 2300m). The researchers did not control training or living during HAT. Athletes attended HAT as following: 1 HAT - n=39, 2 HAT - n=8, 3 HAT - n=5, 5 HAT - n=1. All HATs were also categorized as response and non-response. **Results** Comparing changes in those athlete who visited HAT camp at least twice tHbmass increased or decreased on a randomized fashion. In all the athletes participating HAT during the study, there was a response in 54 HAT with an increase (mean and range) in tHbmass 4,9% (0,2% - 12,8%), BV 0,9% (-10,1% - 10,5%), Hb 4,2% (-7,5% - 14,5%), HCT 5,0% (-8% - 15,2%) and a decrease in PV -1,9% (-16,8% - 15,7%). In 23 HAT (non-response) there was a decrease in tHbmass -2,8% (-12,9% - -0,1%), PV -5,8% (-30,9% - 8,2%) and BV -4,8% (-24,4% - 3,3%) and an increase in Hb 2,5% (-6,3% - 20,0%) and HCT 2,3% (-7,9% - 17,2%). **Discussion** According to our results it seems to be that athletes cannot be categorized as responders and non-responders but the response of HAT to tHbmass seems to be random though majority of the HATs (70 %) increased athletes tHbmass. Because we did not control the HAT camp there may have been factors (e.g. infection, ironstatus,injury) that alter training and living during the camp and therefore the response to HAT. In the future it is important to find out why some camps fail to give a wanted response and if there are some predictable factors that can be helpful when timing the HAT. **References** Koponen A, Peltonen J, Päivinen M, Aho J, Häggglund H, Uusitalo A, Lindholm H, Tikkanen H. Low total haemoglobin mass, blood volume and aerobic capacity in men with type 1 diabetes. *Eur J Appl Physiol*, 2013 May;113(5):1181-8 McLean B, Buttifant D, Gore C, White K, Kemp J. Year-to-year variability in haemoglobin mass response to two altitude training camps. *Br J Sports Med*;2013;47:51-8 Contact timoer@student.uef.fi

### SEX DIFFERENCES IN CHOSEN CYTOKINE CONCENTRATIONS FOLLOWING AN EXERCISE STRESS IN SOCCER PLAYERS

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**INTRODUCTION** The production of cytokines in response to exercise is directly linked to the duration, intensity of exercise, the number of muscle fibers recruited and the fitness level of subjects. Recently, researchers have suggested there are sex differences in the immune response to exercise (Northoff et al., 2008, Gillum et al., 2011). It is recognized that women have more brisk immune responses than men and that woman's immune responses are influenced by sex hormones (Timmons et al., 2006). Female sex hormones fluctuate during the menstrual cycle and one would expect that in women immune responses to exercise may depend on the phase of the menstrual cycle. This study investigated whether there are any gender and menstrual phase related differences for physiological strain and whether the cytokine alterations to exercise stress are different in male and female soccer players. **METHODS** 12 men (M) and 15 women (W) completed an incremental intensity running test to exhaustion. Women were tested during the follicular (F) and luteal (L) phase of the menstrual cycle. All subjects trained football for about 8 years and underwent medical evaluations at the same point of the pre-season training process. Before exercise body mass and body composition were determined. During exercise oxygen uptake (VO<sub>2</sub>), heart rate (HR) and tympanic (T<sub>ty</sub>) temperature were continuously recorded. Before and at the end of exercise a physiological strain index (PSI) was calculated. In the blood samples collected before and following exercise the selected cytokine levels (IL-1 beta, TNF-alpha and IL-6), AIAT, AspAT activity and sex hormones (estradiol-E and progesterone-P only in women) were determined. **RESULTS** There were significant gender differences in subjects' characteristics. The VO<sub>2</sub>max, PSI and maximal power (Wmax) were significantly higher in M than W. Despite higher T<sub>ty</sub>max in M, the rise of T<sub>ty</sub>/min, delHR, HRmax were similar in both groups. The analysis of blood samples showed there are significant gender differences in IL-1beta, AIAT and AspAT activity. There were no significant differences in TNF-alpha and IL-6 cytokine responses to exercise between the M and W. There were significant menstrual phase-related differences for PSI, Wmax, E level and AIAT, AspAT activity in women. **CONCLUSION** There are gender and menstrual phase related differences in the physiological strain to exercise, however in relation to the PSI women have more visible cytokine responses to exercise than men. Women in the luteal phase demonstrated a slightly greater pro-inflammatory cytokine response to exercise than in the follicular phase. **REFERENCES** Gillum T, Kuennen M, Schneider S, Moseley P. (2011). E I R, 17, 104-120 Northoff H, Symon S, Zeiker D, et al. (2008). E I R, 14, 86-103 Timmons B, Hamadeh M, Tarnopolsky M. (2006). *Am J Physiol*, 291, 1513-19

### CFDNA CHANGES IN RESPONSE TO SWIMMING TRAINING; A PILOT STUDY

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**Introduction** The phenomenon of circulating cell-free DNA (cfDNA) concentrations is of importance for many biomedical disciplines including the field of exercise biochemistry and physiology. Increases of cfDNA due to exercise are described to be a potential hallmark for the non-functional overreaching (NFO) and overtraining syndrome (OTS) and might be related to, or trigger adaptations of, immune function induced by strenuous exercise. It is likely that cfDNA is released into the plasma by immune cells, endothelial cells and circulating endothelial progenitor cells. Chronic, strenuous exercise protocols, either long duration endurance exercise or regular high-intensity workouts, induce systemic inflammatory response that might lead to a slow, constant release of DNA fragments (Breitbach et al. 2012, Fatouros et

al. 2006, Velders et al. 2014). Yet, it has neither been implicated nor proven sufficiently whether cfDNA can serve as a marker for NFO/OTS in physically active men. The relevance of systemic inflammation and cfDNA with NFO/OTS still remains unclear. With this information, we designed the study to explain whether high level of blood cfDNA is caused by physical training at high intensity, and to assess the usefulness of cfDNA for monitoring of training load and to diagnose the NFO/OTS syndrome. **Methods** Fifteen young swimmers at 14-17 yr old (junior national team) participated in the 6-month study during intensive preparatory period for Junior Swimming Championships. At the every month of observation were performed the measure of maximal oxygen uptake (VO<sub>2</sub>max), body mass and body composition as well as serum cfDNA, C-reactive protein (hsCRP), creatine kinase (CK) and uric acid (UA) and white blood cells count. **Results** There were significant changes in VO<sub>2</sub>max, body composition (fat mass and free-fat mass) and serum cfDNA in young swimmers. The changes in cfDNA were related with training load and systemic inflammation (hsCRP and WBCs). **Discussion/Conclusion** This study demonstrates that serum cfDNA concentrations increase in proportion to training load, suggesting that cfDNA may be a sensitive marker for monitoring of NFO/OTS in young swimmers. **References** Breitbach S, Tug S, Simon P. (2012). *Sports Med*, 42(7), 565-586. Fatouros IG, Destouni A, Margonis K, Jamurtas AZ, Vrettou C, Kouretas D, Mastorakos G, Mitrakou A, Taxildaris K, Kanavakis E, Papassotiropoulos I. (2006). *Clin Chem*, 52(9), 1820-1824. Velders M, Treff G, Machus K, Bosnyák E, Steinacker J, Schumann U. (2014). *Clin Biochem*, 47(6), 471-474. Contact barbara.morawin@gmail.com

## HOW TEMPORAL PERCEPTION AFFECTS THE START OF SHORT-TRACK RUNNERS

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**Introduction:** Can temporal perception affect that start of short-track runners? Imagine the beginning of a short-distance race in which processing of temporal information is especially important, when the runners prepare for the start on their mark. With "ready", "get set", they assume the starting posture and initiate a dash in response to the "go" signal. To study the effect of time perception on motor preparation required for this process, we used a task in which durations of two sounds presented in succession (S1, S2) were compared. **Methods:** Subjects were 14 healthy volunteers. The duration of S1 (standard) was fixed in each session, either at 700, 2100, and 3500ms. For each trial, the duration of S2 was selected from among seven possible different durations, longer or shorter than the standard. The subjects were instructed to compare the two durations as soon as S2 ended. Reaction time (RT) of key presses and positive answer rate (PAR), i.e., percentage of trials in which S2 was judged as being longer than S1, were measured for each S2. The duration of S2 at which PAR was presumed to reach 50% was defined as PAR50%. **Results:** PAR50% was almost identical to the S1 duration when S1 was 700ms, but became slightly shorter for longer S1 durations (2100, 3500ms). RT was longest when the difference between S1 and S2 was smallest, and became shorter as the difference became longer. RT shortened and reached a steady level when the difference (up to 40% of the S1 duration) was very large. This steady level was significantly shorter when the duration of S2 was longer than that of S1 than when S2 was shorter than S1. **Conclusions:** The present study suggests that time perception can affect how fast a runner can start dashing in response to a go signal. The fact that PAR 50% was shorter than S1 duration for longer S1 durations suggested that the actual duration of S2 get underestimated as the standard S1 duration becomes longer. Thus longer durations between "ready" and "get set" may lead to a tendency for premature start due to this underestimation. Longer RT as the difference between S1 and S2 became smaller may reflect the difficulty in discriminating similar time durations. On the other hand, as for the stable level of RT when difference in S1 and S2 durations was large, RT was longer when S2 was much shorter than S1 than when S1 was much shorter than S2. In the former case, subjects have to respond to the end of S2 which occurred before the memorized length of S1, so that the subjects have to start a motor response on detection of the end of S2, hence longer RT. In the latter case, the subjects already know at the end of S2 that the memorized duration of S1 have already elapsed, so that they can fully prepare the motor response, hence shorter RT.

## CHANGES IN NEUROMUSCULAR JUNCTION MORPHOLOGY OCCURRING IN CONJUNCTION WITH MUSCULAR ATROPHY: A COMPARISON OF INACTIVITY, DENERVATION, AND AGING

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**Introduction:** Muscle atrophies as a result of inactivity. Inactivity has a profound effect on muscle both morphologically and functionally, but these changes are reversible. Once muscle becomes active again, it recovers. The neuromuscular junction (NMJ) is a site of neuromuscular signal exchange, and NMJs are sites that maintain neuromuscular function. The current study examined the effects of muscular atrophy on NMJ morphology. Inactivity, temporary denervation, and age were used to conduct an experiment to study muscular atrophy. **Methods:** Laboratory animals: The laboratory animals used were male Fischer 344 rats. 16week-old rats were used to study inactivity. Two groups of animals had their hindlimbs immobilized with a cast for 1 week or 2 weeks. A third group had its hindlimb immobilized with a cast. After two weeks of immobilization, to remove the cast, the animals were usually reared for two weeks. Temporary denervation was accomplished by freezing the sciatic nerve. Denervation was performed in 10weeks old rats. Changes in NMJ morphology were noted 3, 7, 14, and 21 days after freezing of the sciatic nerve. 17weeks old, 1year old, and 2years old rats were used to study aging. **Observation and Analysis of NMJ Morphology:** The muscle EDL was studied. The muscle was removed and then frozen. 50µm thick longitudinal sections were prepared in a cryostat. Then stained for ChE and stained with silver. Images were imported from a microscope camera to a PC, and the length of the motor endplate (LEL), the area of the motor endplate (EpA), the area of the nerve terminal (NTA), and the diameter of muscle fibers (FD) at NMJs were measured. NMJ morphology was analyzed using the methods described by Fahim et al. **Results:** Findings suggested that 1 week of inactivity caused muscle to atrophy. However, abnormalities in the morphology of axon terminals at NMJs were not noted in rats that were immobilized for 1 week. A decrease in the area of the NMJ was noted in rats that were immobilized for 2 weeks. FD returned to its previous value in rats that were reared normally after immobilization. FD diminished significantly as a result of 2 weeks of inactivity, but it returned to its previous value 2 weeks after activity resumed. There were no changes in the indices of NMJ morphology. NMJs were not affected by inactivity. A decline in NTA was noted in NMJs. There were no changes in EpA, FD, EpA, EPL, and EpA/FD were significantly smaller in 1year-old and 2year-old rats in comparison to the same indices in 16weeks old rats. Morphological abnormalities evident in old age were noted in atrophied muscle fibers at NMJs. **Conclusion:** Muscular atrophy in conjunction with increased or decreased muscle activity changed the morphology of the NMJ. However, morphological changes that occur in conjunction with muscular atrophy and the restoration of that morphology were found to differ early in life and in old age. This finding suggests that the mechanism of muscular atrophy early in life differs from that in old age.

## THE EFFECT OF LONG-TERM EXERCISE TRAINING AND HIGH-FAT DIET AND HIGH-CARBOHYDRATE DIET ON ENERGY SUBSTRATES UTILIZATION

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**Objectives:** Long-term exercise training with high-fat diet (HFD) feeding could lead to increase the fat oxidation, also high carbohydrate diet(HCD) feeding with long term exercise training increase the carbohydrate oxidation at rest and during exercise in rodents and humans. However, the effect of long-term exercise training with high fat and carbohydrate diet feeding on respiratory exchange ratio (RER) and energy substrate utilization in mice has not been clarified yet. Therefore, we investigated the effects of exercise training with HFD and HCD on RER and energy substrate utilization, also we measured MCT1, MCT4 and Glut4, CS mRNA expression in gastrocnemius muscle. **Materials & Methods:** ICR male mice were fed with high-fat(HF) and high-carbohydrate(HC) for 12 weeks. After the 12 weeks, these mice were divided into 4 groups; high fat diet with exercise (HFD-Ex), high-fat diet without exercise (HFD), high-carbohydrate diet with exercise (HCD-Ex), high-carbohydrate diet with exercise (HCD). Exercise mice performed running exercise on a motorized treadmill (1 h/d, 5 d/wk, 12 m/ min, 12% grade, 65~70% VO<sub>2</sub> max) for 12 weeks. mRNA expression in muscle was analyzed by using PCR method. **Results & Findings:** Final body weight and fat mass were significantly higher in both HF groups compared with both LF group. 24-h RER were significantly lower in HF groups compared with LF groups, but there were no significant differences between exercise groups. RER during a 1-h exercise were also significantly lower in both HF groups compared with LF groups. On the other hand, RER during a 1-h exercise was significantly lower in HFD-Ex than in HFD although the exercise effect was not observed in LFD groups. The expression of GLUT4 mRNA was significantly higher HFD in compared with HCD. CS mRNA expression was significantly higher both HF groups in compared with HCD and HFD-Ex significantly higher than HCD-Ex. Also, MCT4 mRNA expression tend to higher both exercise groups compare to the without exercise groups but not significant differences. **Conclusion:** We confirmed that long term high fat diet feeding increases fat oxidation both at rest and during exercise. Especially our results provide important information that long term exercise training can further enhance fat utilization during exercise under the exposure to a high-fat diet feeding. However, the effect of dietary in MCT1, MCT4 and Glut4 mRNA expression involved in substrate utilization of carbohydrate does not appear, but not MCT4 mRNA has shown that higher in both exercise groups. Therefore further studies are needed to examine the protein of mRNA expression in substrate utilization of fat.

## THE DIFFERENCE IN AGE IS NOT A KEY-FACTOR IN THE MODULATION OF ACUTE EXERCISE-INDUCED MUSCLE OXIDATIVE STRESS

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The difference in age is not a key-factor in the modulation of acute exercise-induced muscle oxidative stress **INTRODUCTION** The effects of exercise on ROS production and on the generation of reactive oxygen species and the response to muscle oxidative stress determines longevity. This study compares the effects of acute exercise with similar relative workload in rats with 3 and 18 months. **METHODS** The animals were divided into four groups (n = 6): control 3-months; exercise 3-months; control 18-months and exercise 18-months. Exercised groups underwent to a single bout of running with 60 minutes in the speed 0.8km/h (18 months) and 1.2 km/h (3 months). Metabolic parameters (lactate levels, glycogen content, succinate dehydrogenase levels, cytochrome c oxidase) and oxidative stress markers (activity of (superoxide dismutase, catalase and glutathione peroxidase). **RESULTS** Evidence in this study shows that changes in the glycolytic and oxidative metabolism are similar in both groups exercised, suggesting that acute exercise at a moderate intensity affect intensity affects the independent counsel age metabolism. In addition, the skeletal muscles (gastrocnemius) of animals from 3 to 18 months is similarly susceptible to oxidative damage, although age promote responses in different enzymatic antioxidant system. **DISCUSSION** The effects of exercise on the redox state are inconclusive because the literature have reported that exercise improves (Ghosh S), attenuates (Hatao H) or does not affect (Radak Z) redox homeostasis muscle. Our results show an increase in metabolic markers after acute exercise regardless of the age of the animals and similarity in oxidative damage despite the antioxidant enzymes present different modulation in older animals compared with young animals. These results suggest that the effects of acute exercise at moderate intensity affect the metabolism of aged groups, affects the independent counsel age metabolism, and the differential response in the enzymatic antioxidant system between groups did not promote greater protection against oxidative damage. **REFERENCE** Ghosh S et al. Diabetes. 2011; 60:2051–2060. Hatao H et al. Mech Ageing Dev. 2006; 127(4):384-90. Radak Z et al. Free Radic Biol Med 2011; 51:417–423. Niko-laidis MG et al. Exp Gerontol 2013; 48(8):734-43.

## EFFECTS AND EFFICIENCY OF AEROBIC TRAINING AROUND PUBERTY

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**Introduction** Monitoring maturation and development among young athletes is an essential factor to the adequate training. Aerobic capacity, progresses age dependently, sensitive period of development is between prepubertal and pubertal ages (9-13 years). Results regarding the efficiency of aerobic training in young age groups are controversial. The aim of our study was to examine physiological, hormonal changes, muscle force of young prepubertal female handball players after an 8 weeks training period in the preparatory season. **Methods** 18 young female handball players (11.50±0.56 yrs) participated in this study. Before and after the training period venous blood samples were collected (E, cortisol, T, GH levels were measured). Except two subjects players were before menarche. Anthropometric parameters were measured, the hand grip strength test and maximal concentric quadriceps and hamstring torque test were performed. All players took part in a spiroergometric treadmill exercise test (Bruce protocol) and changes in physiological parameters were monitored (e.g. HR, VO<sub>2</sub>max, RR variability, RER) during the test. Besides regular handball practice a specific endurance program (20-25 min continuous running, 3times/week) was evolved. Paired sample t-test and bivariate correlation were used to analyze data. Level of significance was set at p≤0.05. **Results** Significant differences were found in certain anthropometric parameters after 8 weeks of aerobic training. Improvement but no significant difference was detected in relative VO<sub>2</sub>max after the program (b: 43.32±5.68 ml/kg/min, a: 44.05±5.09ml/kg/min). Better results were also recorded in force parameters, mean maximal concentric quadriceps torque was significantly (p=0.022) higher after (84.39±15.35Nm) then before (76.38±15.93Nm). Significantly higher (p=0.033) level of cortisol was detected after the training program (b: 340.39±168.06nmol/l, a: 423.74±199.34nmol/l). **Discussion** In accordance with earlier data there was no significantly higher VO<sub>2</sub>max measured after 8 weeks of strong aerobic training, although young handball players



reached the ventilatory breakpoint later, while minute ventilation did not change. Suggesting that the quality of respiration is improved. Improvement in force parameters in prepubertal ages are the consequences of neuromuscular adaptation. To create efficient training programs, it is important to monitor the biological age/maturity parallel with physiological and anthropometric parameters of young athletes. Contact: cselkoa@gamma.ttk.pte.hu

## DOES VITAMIN D IMPROVE PERFORMANCE OF ATHLETES?

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**Introduction** Vitamin D can be synthesized endogenously by exposing the skin to UVB radiation of the sun (Deldicque & Francaux, 2015). Also, low vitamin D status has been linked to various cardiovascular diseases, hypertension and certain types of cancer (Halliday et al., 2011). Athletes have similar risk factors for vitamin D deficiency as the rest of the population. Its insufficiency results in increased risk of injury, poor health, and delayed recovery and therefore impacts athletic performance (Farrokhyar et al. 2015; Hamilton, 2011). Therefore, the aim of the present study is to investigate the effects of vitamin D on performance of athletes. **Methods** The following databases were searched: Pubmed, SPORTDiscus, Medline and CINAHL (Cumulative Index to Nursing and Allied Health Literature). In each database the title, abstract and keywords search fields were searched. The following keywords, combined with Boolean operators (AND, OR), were used: "vitamin D", "athletic performance", "antioxidants", "sports performance", and "muscle strength". **Results** There are only two studies in the literature showing beneficial effects of vitamin D supplementation on performance of athletes (Cannell et al., 2009; Yi et al., 2014). On the contrary, the majority of studies have shown no effect of vitamin D supplementation on performance (Close et al. 2013; Nieman et al. 2014; Shanely et al. 2014). **Discussion** These results indicate that there is uncertainty in regards to how vitamin D helps athletic performance. Also, there is little scientific evidence that vitamin D supplementation improves performance of athletes that are not vitamin D deficient. However, it is clear that vitamin D plays an important role in musculoskeletal health (stress fractures, viral respiratory tract infections) and in the prevention of chronic and acute diseases, such as: cancer, cardiovascular disease, type 2 diabetes and autoimmune diseases (Willis et al., 2013). **References** Cannell JJ, Hollis BW, Sorenson MB, Taft TN, Anderson JJ (2009). *Med Sci Sports Exerc*, 41(5), 1102-10. Close GL, Leckey J, Patterson M, Bradley W, Owens DJ, Fraser WD, Morton JP (2013). *Br J Sports Med*, 47(11):692-6. Deldicque L, Francaux M (2015). *Front Nutr*, 26, 2:17. Farrokhyar F, Tabasinejad R, Dao D, Peterson D, Ayeni OR, Hadioonazadeh R, Bhandari M (2015). *Sports Med*, 45(3), 365-78. Halliday TM, Peterson NJ, Thomas JJ, Kleppinger K, Hollis BW, Larson-Meyer DE (2011). *Med Sci Sports Exerc*, 43(2), 335-43. Hamilton B (2011). *Asian J Sports Med*, 2(4), 211-9. Nieman D, Gillitt N, Shanely R, et al. (2014) *Nutrients*, 6, 63-75. Shanely R, Nieman D, Knab A, et al. (2014). *J Sport Sci*, 32, 670-679. Yi M, Fu J, Zhou L, Gao H, Fan C, Shao J, et al. (2014). *J Int Soc Sports Nutr*, 11, 11. Willis KS, Peterson NJ, Larson-Meyer DE (2008). *Int J Sport Nutr Exerc Metab*, 18(2), 204-24. Contact grivasger@hotmail.com

## ENDOCRINE AND INFLAMMATORY RESPONSE TO RESISTANCE TRAINING AT DIFFERENT TIMES OF DAY

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**Introduction** The physiological response to resistance training (RT) has been well documented; however, the time of day to conduct RT in order to maximize adaptation is not well defined. This study investigated the effect of RT at different times of day on endocrine and inflammatory responses, and markers of muscle damage. **Methods** 18 healthy male subjects (age:  $27.8 \pm 4.7$  yrs; stature:  $179.6 \pm 6.4$  cm; body mass:  $80.1 \pm 9.1$  kg) with 6 months (2 to 3 times per week) RT experience were randomised to three conditions in a crossover design: no resistance training (NRT), morning resistance training (MRT) and evening resistance training (ERT); each separated by seven days. Blood samples were taken at rest (prior to RT), and at 2, 4, 8, 12, 16, 20, 24, 30 and 36 hours post RT and NRT. Samples were analysed for cortisol, insulin, interleukin 6 (IL-6) and testosterone in all conditions, and for creatine phosphokinase (CPK) and high sensitivity C-reactive protein (CRP) in MRT and ERT conditions. Values were expressed relative to the corresponding time-point in NRT and differences between MRT and ERT were analysed using mixed-model analysis of variance (ANOVA). **Results** There were condition main effects between MRT and ERT for cortisol ( $F=6.20$ ;  $P=0.016$ ) insulin ( $F=13.09$ ;  $P=0.0004$ ), testosterone ( $F=5.59$ ;  $P=0.019$ ), CPK ( $F=12.67$ ;  $P<0.001$ ) and CRP ( $F=17.4$ ;  $P<0.001$ ). There were time main effects for cortisol ( $F=5.08$ ;  $P<0.001$ ), insulin ( $F=19.19$ ;  $P<0.001$ ), IL-6 ( $F=2.14$ ;  $P=0.033$ ), testosterone ( $F=7.93$ ;  $P<0.001$ ), CPK ( $F=0.53$ ;  $P=0.833$ ) and CRP ( $F=1.02$ ;  $P=0.410$ ). Finally, there were condition by time interaction effects for cortisol ( $F=39.91$ ;  $P<0.001$ ), testosterone ( $F=16.09$ ;  $P<0.001$ ), and insulin ( $F=19.44$ ;  $P<0.001$ ). Post-hoc analysis showed cortisol was higher in ERT at 16 h ( $P=0.0037$ ); testosterone was higher in MRT at 4 h and 12 h ( $P=0.025$  and  $P<0.001$ , respectively); and insulin was higher in ERT at 16 h ( $P<0.001$ ) and higher in MRT at 24 h ( $P=0.046$ ). **Discussion** Whilst there were some differences in cortisol, testosterone and insulin between ERT and MRT, these were not consistent across time points following the RT at different times of day. Further research is required to elucidate the differences and relative benefits of resistance training at different times of day. In particular, optimizing the timing of RT aligned with individualized physiological response could provide longitudinal accrued benefits to training response and adaptation.

## PERIPHERAL RATHER THAN CENTRAL FATIGUE IS RESPONSIBLE FOR ROWING PERFORMANCE IMPROVEMENT WITH OXYGEN SUPPLEMENTATION

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**Introduction** Hyperoxic breathing may enhance rowing performance, presumably by restoring cerebral oxygenation (SCO<sub>2</sub>), and thus attenuating central fatigue. However, considering that hyperoxia also attenuates peripheral fatigue, the contribution of central and peripheral fatigue to rowing performance is not known. This study evaluated the effect of oxygen supplementation on cerebral and active muscle oxygenation together with central and peripheral fatigue indices, i.e., reduction in maximal voluntary contraction (MVC) and transcranial magnetic stimulated (TMS) force generation. **Methods** Six competitive rowers performed 2000 m all-out exercise on a rowing ergometer in normoxia and hyperoxia (30% O<sub>2</sub>) in a randomised double blind crossover design. Arm MVC was assessed with electromyography (EMG) of the m. biceps brachii and the m. brachioradialis. Voluntary activation of the elbow flexor muscles was assessed with TMS single pulses that were delivered to the motor cortex and evoked motor potential in the biceps brachii. SCO<sub>2</sub> and muscle (vastus lateralis) oxygenation were assessed with near infrared spectroscopy (NIRS). **Results** Arterial hemoglobin O<sub>2</sub> saturation was  $92.5 \pm$

0.2% during exercise in normoxia, while it was maintained at  $98.9 \pm 0.2\%$  in hyperoxia.  $\text{SCO}_2$  decreased by 11% from resting baseline during exercise in normoxia, while it was maintained during hyperoxia. Muscle oxygenation decreased equally during normoxia (-35%) and hyperoxia (-32%), while rowing performance tended to increase during hyperoxia ( $-3 \pm 4$  s, NS). Maximal rowing in normoxia resulted in a significant reduction ( $7.4 \pm 5.1\%$ ) in MVC, while there was no difference in the extra force produced by TMS. Following hyperoxic exercise the MVC and TMS were not different than at rest. Discussion These data indicate that following maximal rowing the force generating capacity of the elbow flexor muscles is attenuated but it is restored with hyperoxia and suggest that the associated performance improvement with oxygen supplementation is attributed to alleviation of peripheral fatigue. References Gandeia SC. Physiol Rev 81: 1725-89, 2001 Volianitis S et al. J Physiol 586: 107-12, 2008 Contact svolian@hst.aau.dk

### EFFECT OF HEAT EXPOSURE AND EXERCISE ON FOOD INTAKE REGULATION

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CONTEXT: Physical exercise might slightly increase energy intake but this compensation is far from completing the energy expended during exercise sessions creating therefore a negative energy balance. However, we still ignore whether living in a hot environment inhibits or stimulates exercise-induced weight loss. OBJECTIVE: The aim of the study was to determine the sole and combined (with exercise) effect of heat on acute energy intake (EI) and its hormonal regulation. METHODS: Ten healthy and physically active young men participated in four experimental sessions (40 min of rest and cycling at 60% of their  $\text{VO}_{2\text{max}}$  at 22 and 31°C in both conditions). This test period was followed by a 30-minute recovery period and then an ad libitum meal (ham and cheese sandwiches). Temperature was maintained until the end of the meals. Subjective ratings of hunger with visual analogic scales and plasma pancreatic polypeptide (PP), cholecystokinin (CCK) and ghrelin concentrations were determined. RESULTS: Subjective hunger scores and energy intake were not modified by exercise and/or heat. However, when energy expenditure during the 40-min sessions was subtracted to EI, relative energy intake was significantly decreased in the exercise session ( $P=0.004$ ). Exercise increase plasma PP ( $P=0.002$ , respectively). Postprandial levels of CCK were elevated only in the rest conditions. Heat did not alter plasma levels of these different hormones. CONCLUSIONS: Exercise induced a short-term energy deficit. However, modifications in the hormonal regulation of food intake in response to short-term heat or combined heat and exercise exposure seem to be minor. These results suggest that physical activity interventions designed to manage weight require no particular adaptation to a hot environment.

### THE EFFECT OF ONE BOTH ECCENTRIC EXERCISE FLEXORS ELBOW ON

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Introduction Skeletal muscle may develop adaptive chaperone and enhancement defense system through daily exercise stimulation. The present study investigated 3 types training alters the expression of chaperone proteins. These proteins function to maintain homeostasis, facilitate repair from injury and provide protection. Exercise-induced production of HSPs in skeletal muscle and peripheral leukocytes and, it may provide insight into the mechanisms by which exercise can provide increased protection against stressors. The aim of this study was to examine the effect of 3 types training on HSP70 expression and glucose. Methods Twenty training female performed one bout, 3 sets of 12 maximal eccentric actions of the elbow flexors of the nondominant arm. G-CSF, MPO, PGE2 and myoglobin (Mb) were measured before, immediately after, and for 2 hours after exercise. Results All data are expressed as means  $\pm$  SEM and analysis of variance (ANOVA) repeated measures and LSD test was used for post(P value was  $<0.05$ ). There were no significant differences among in the changes in MPO and Mb measures, but changes of G-CSF and PGE2 were significantly ( $p < 0.05$ ). Discussion In conclusion, although there was evidence of severe muscle damage after the eccentric exercise, this muscle damage was not accompanied by any large changes in plasma concentrations. The minor changes in systemic concentration found in this study might reflect more rapid clearance from the circulation, or a lack of any significant metabolic or oxidative demands during this particular mode of exercise. Our results suggest that the intensity of exercise affects the magnitude of muscle soreness and blood markers of muscle damage and inflammation.

### EFFECT OF INTERVAL HYPOXIC TRAINING ON EXERCISE PERFORMANCE OF JUDOISTS

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Introduction One of the methods for increasing an exercise performance (EP) of athletes is the interval hypoxic training (IHT). Though the IHT is widely being used in training of athletes, to date there are not still available optimum training regimens for different sports. Goal of the study – to assess the effect of IHT on EP of judoists. Methods Twenty four elite judoists (12 athletes – trial group, 12 athletes – control group) were involved in the study. During the entire assessment, the both groups were coached with the same training program. In addition, the trial group exercised the IHT every other day. Total 10 sessions of IHT were applied. The BIO-NOVA-20454 device was utilized for IHT sessions. Each IHT session lasted 60 minutes, during which there was provided the alternation of breathing for five minutes of air with normal and 10% lowered oxygen content. Prior to IHT and after the entire set of sessions the both groups of judoists were examined, with determination of lung vital capacity (VC), maximal breathing capacity (MBC),  $\text{VO}_{2\text{max}}$ , anaerobic threshold (AT) by blood lactate concentration, complete blood count, registration of ECG. There was made the assessment of EP on bicycle ergometer at a three-step discrete small, submaximal and maximal aerobic load (PWC130, PWC150, PWC170, PWCmax). Results VC and MBC did not change in both groups. The trial group showed growth of ET at heart rates (HR) 130 and 150 bpm by 16%, at HR 170 bpm by 7%, and at maximal HR by 4%. That is, there was noted the rise of ET mainly at the aerobic loads. In the control group, the EP virtually did not change at every HR regimen. The highest rise of EP was noted in athletes with a relatively lower initial level of it. No change of  $\text{VO}_{2\text{max}}$  was noted in both groups. The trial group demonstrated growth of AT from  $147.3 \pm 2.6$  to  $157.7 \pm 2.8$  bpm. No change of AT was noted in the control group. No change of red blood indicators was revealed in both groups. Conclusion The study findings demonstrate the positive effect of IHT on EP of judoists at heart rates 130 and 150 bpm. After the IHT the rise of AT was characteristic. The conclusion is that the IHT contributed to the increase of aerobic efficiency. The effect of IHT on EP showed substantial individual variations. sukhovsergey2004@mail.ru

## Psychology

**EXAMINING THE RELATIONSHIP BETWEEN JUNIOR ICE HOCKEY PARTICIPATION AND ALCOHOL CONSUMPTION**

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**Introduction** Research has shown how sport participants have higher rates of alcohol consumption than nonparticipants, with ice hockey having been identified as a sport where athletes are particularly involved in binge drinking (Ford, 2007). However, little is known as it relates to the psychosocial factors that influence alcohol consumption among ice hockey players within adolescence and emerging adulthood. **Methods** Using a case study approach (Yin, 2009), the purpose of this study was to examine alcohol consumption within a Canadian junior (17-21 years) ice hockey team over the course of an entire season. Semi-structured interviews were conducted at three different time points (beginning, middle, and end of season) with five male participants (two coaches and three players). All participants were of legal drinking age. The interviews lasted between 45 and 79 minutes ( $M = 55:45$ ). The researcher was granted full access to all team facilities (e.g., locker room), with observations occurring during training camp, regular season games, tournaments, and playoffs. **Results** During the regular season, the locker room and a local bar close to the arena were identified as the areas most conducive to alcohol consumption after games, with beer being the preferred choice. During tournaments, excessive alcohol consumption was prevalent amongst all team members, with some indicating that drinking superseded playing ice hockey as their main motivation for taking part in the tournament. While intoxicated, team members engaged in drunk driving, risky sexual practices, and hotel vandalism, all practices reinforced by the chauvinist climate that existed within the team environment. **Discussion** Interest in the alcohol-sport relationship is growing, as evidenced by the special issue (June 2014) in the *International Review for the Sociology of Sport*. The current study contributes to the literature in this area by exploring in-depth how and why alcohol consumption occurs in Canadian junior ice hockey. As the findings indicate, alcohol consumption is inherently engrained within the fabric of ice hockey, with players and coaches often engaging in binge drinking that leads to risk-related behaviors. Despite having provided rich insights into the intricate inner-workings of alcohol consumption in ice hockey, the findings are limited in the generalizability as data were collected within a single team. Further research is warranted in different contexts (e.g., women's ice hockey) to ascertain if/how alcohol consumption manifests itself differently. **References** Ford, J. A. (2007). Substance use among college athletes: A comparison based on sport/team affiliation. *Journal of American College Health*, 55, 367-373. Yin, R. K. (2009). *Case study research, design and methods* (4th ed). Thousand Oaks, CA: SAGE. Contact jroy127@uottawa.ca

**VALIDATION OF THE SPORT MULTIDIMENSIONAL PERFECTIONISM SCALE-2 FOR THE MEXICAN SPORT CONTEXT**

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**Introduction** Frost and cols. (1990) proposed six facets representing central aspects of perfectionist cognition, affect and behavior across life domains: personal standards; organization; concern over mistakes; perceived parental pressure; doubts about action; perceived coach pressure. An instrument designed to measure these aspects within the sporting context is the S-MPS-2 (Gotwals & Dunn, 2009). Thus, the ability to adequately evaluate perfectionism is a current need to the development of sport and sport psychology sciences in general, especially in Mexico where no such instrument has been validated. The aim of this study was to validate the factorial structure a Spanish version of the S-MPS-2 for the Mexican population. **Methods** Participated 192 sportsmen and women with a mean age of 20.63 years old ( $SD = 3.73$ ). To adapt the S-MPS-2 into Spanish, the strategy of reverse translation of Hambleton (1996) were used. Confirmatory factor analysis (CFA) was performed with the LISREL 8.80 program with the estimation procedure robust maximum likelihood. To evaluate the differences between the setting of alternative models, differences less than or equal of .01 between values of CFI indicates practical differences (Cheung & Rensvold, 2002). Analysis of reliability (Cronbach's alpha) were performed with the program SPSS 22.0. **Results** The CFA showed that six factors model had a close fit:  $2(687) = 1340.85$ ,  $p < .001$ ;  $RMSEA = .08$ ;  $CFI = .86$ ;  $NNFI = .85$ . Although the factors loadings of six items were below the criterion ( $> .40$ ). A second model in which these items were removed was tested:  $2(579) = 998.44$ ,  $p < .001$ ;  $RMSEA = .07$ ;  $CFI = .90$ ;  $NNFI = .90$ . In this second model all items load significantly ( $p < .01$ ) with factor loadings above criteria. Phi correlations matrix between latent factors were lower than .80. Comparing the indexes of incremental fit between the two models, the results showed better fit for the second model ( $CFI = .03$ ). The Cronbach's alpha coefficients of the factors were above the criterion value, except the perceived coach pressure factor. **Discussion** The adaptation to the Spanish spoken in Mexico of the S-MPS-2, has demonstrated adequate validity of its factorial structure, and adequate internal consistency for the factors. So can be used in the sporting context for the measurement of the six facets of perfectionism proposed by Frost and cols. (1990). However, the validity is confirmed after the elimination of six items; three of them are the same as those suggested by the results of Gotwals and cols. (2010) in the original version. **References** Cheung GW, Rensvold RB. (2002). *Struct Equ Modeling*, 9, 235-255. Frost RO, Marten P, Lahart C, Rosenblate R. (1990). *Cognitive Ther Res*, 14, 449-468. Gotwals JK, Dunn JG. (2009). *Meas Phys Educ Exerc Sci*, 13, 71-92. Gotwals JK, Dunn JG, Dunn JC, Gamache V. (2010). *Psychol Sport Exerc*, 11, 423-432. Hambleton RK. (1996). *Psicometría*, 207-238. *Universitas*, Madrid. Contact Antonio.pineda@uabc.edu.mx

**DEVELOPING A SCALE TO APPRAISE REQUIRED MENTAL SKILLS FOR REFEREES**

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**Introduction** Sports umpires, referees, and their assistants are responsible for ensuring that the competitive efforts of athletes take place within the rules of the game, and that match results are obtained fairly. Not only must referees continuously endure physical pressure, they should also be willing to psychologically endure various stressors. As the best performance cannot be expected from athletes and coaches who are under a great deal of stress, referees are, similarly, sometimes unable to demonstrate proper performance (Reilly and Eregson, 2006). One key factor in referees working to their capabilities in regard to performance is the use of appropriate mental skills. The purpose of this study, therefore, is to develop an appraisal scale for the required mental skills for referees, and to drive home the impact of mental skills on performance. **Methods** The statistical population of this study included all international and national referees in the fields of handball, soccer, tennis and baseball, which, according to the related federations, were 352 subjects. These subjects had arbitrated sporting events for 4 to 33 years, with a mean of  $12.5 \pm 8.51$  years of refereeing experience. We considered 6 dimensions of mental skills based on elite referees' practical experience, and used this to create a hypothetical model of required mental skills for

referees. Results To examine the internal consistency of the items, we calculated the correlation coefficient between the summation of item scores in the scale and the rated scores in each item. A significant correlation was obtained in the range of  $r = .39-.78$  for all items, which showed internal consistency. Factor analysis (principal factor solution, promax method) was employed to detect the factor structure of questionnaire items. For refereeing situations, 6 factors were derived from 24 items in the questionnaire and named as follows: emotional control, resolute attitude and look, motivation, confidence, communication, and concentration. High reliability coefficients were observed, and the validity of the structural concept reached the acceptable standard. Discussion Exploratory factor analysis of the mental skills for referees yielded a very clear factor structure. The findings of the factor analysis, together with the descriptive statistics presented for each subscale, clearly support previous studies (Weinberg and Richardson, 1990) in identifying motivation, confidence, communication, and emotional control strategies as an important feature of the qualities in a good referee. The information gathered from this work also provides insight into how we can better create training programmes for mental skills for this population. References Reilly, T. and Eregson, W. (2006) Special populations: The Referee and Assistant Referee. *J Sports Sci*, 24(7): 795-801. Weinberg, R. and Richardson, P. (1990) *Psychology of Officiating*. Champaign, IL: Leisure Press. Contact: kiso@rs.kagu.tus.ac.jp

## THE FACTORS AND METHODOLOGY TO BUILD UP THE FLOW STATE OF THAILAND TAEKWONDO'S ATHLETES

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Introduction This research is a qualitative research, aims to study realizing of flowing state, the factors and methodology to build up the flow state of Thailand Taekwondo's athletes who joined the 28th SEAGAMES at Singapore in both practical and competition state. Collected the data by using Semi - structured Interview, observation, critical incident, and questionnaire of the flow state. Methods The sample were 6 people of Thailand Taekwondo's athletes who joined the 28th SEAGAMES at Singapore, age of 18-24 years old, 5-13 years of competition experience. Analyzing data by constant comparing. Trustworthiness the data by member check, triangulation and peer debriefing. Results The result found that; 1.Score of flow state in practical state was 143, 145, 145, 130, 137, 131 points. Flow state score in competition state was 164, 161, 157, 142, 140 and 115 points (ranked from gold medal, silver medal and bronze medal) 2.Taekwondo's athletes recognized the flow state in practical state that is the practice as expected, pursued the goal, automatically, fun, practice with full performance, and has developing, for flow state in competition state is automatically play, continuously, full potentials, happy and quickly pass of time, thought controlled, confident and concentrate. 3. Factors effect to the flow state in practical state has 6 factors are practical goal, effectiveness of practical program, practical atmosphere, coach and staff, mental and physical readiness. In the other side, 6 competition state factors are automatically movement of body, concentrating to competition, self-confident, verbal form coach, thought and emotional well controlling, and good readiness preparation. 4. The method of building up of flow state in practical state has 5 methods, goal setting, mind concentrate, body readiness, mental readiness, and self-motivation. For the competition state has 6 methods are concentrating, relaxing and stress managing, imaging and warming up, thought controlling and self-encourage and building up self-confident. Discussion Result from research indicated the flow state is essential to Taekwondo's athletes to both practical and competition state, trainer and team and Taekwondo's athletes should be realized to factors of influencing flow state to meet high performance and effectiveness of practical and competition. References Bruce A. Larson and Evelyn Oregon. 2008. Flow and Sports: Gender differences between mens and womens soccer. Western Kentucky University. Jackson, S. A. 1996. Towards a conceptual understanding of the flow experience in elite athletes. *Research Quarterly for Exercise and Sport*, 1, 76-90. Tonsaitanin, Jeerattikul. B.E. 2557. The flow state of Volleyball player who join the University competition. Thesis of Master Degree, Kasetsart University.

## BASIC PSYCHOLOGICAL NEEDS AS A MEDIATOR BETWEEN MINDFULNESS AND ATHLETES' WELL-BEING: A LONGITUDINAL STUDY

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Introduction Mindfulness has been conceptualized as paying sustained attention to ongoing cognitive and emotional experience with a non-judgmental and non-elaborating attitude (Kabat-Zinn, 2003). Previous studies have demonstrated mindfulness positively contribute to individual's well-being (Brown & Ryan, 2003); however, the underlying mechanism is not fully understood. Therefore, based on self-determination theory, the present research conducted a longitudinal design to investigate the mediating role of basic psychological needs in the relationship between mindfulness and athletes' well-being. Methods Time-lagged design was used to collect data during two periods to examined mediation effect. The first data collection involved 104 athletes with a mean age of 20.66 years ( $SD = 1.68$ ). After five months later, we collected well/ill-being indicators again. The sample consisted of 104 athletes (49 male) with average sporting experience of 7.01 years ( $SD = 4.15$ ). The athletes reported that they spent 19.76 ( $SD = 5.79$ ) hours per week training. All participants read and signed the informed consent form indicating their ethical rights. Confidentiality and anonymity were ensured. Results The mediation analysis of basic psychological needs between mindfulness and well-beings indexes at Time 2 were conducted by PROCESS macro for SPSS using 10,000 bootstrap samples (Hayes & Preacher, 2013). Results revealed basic psychological needs mediated the relationship between mindfulness and both athletes' hedonic and eudaimonic well-being indicators. However, one exception was basic psychological needs fulfillment did not mediated the relationship between mindfulness and athlete burnout. Discussion The results correspond to the self-determination theory, which demonstrated that basic psychological needs mediated the relationship between mindfulness and athletes' well-beings. In this regard, we provide additional evidence to extend the scope of mindfulness from performance to well-being enhancement. These findings also provide important information for researcher and practitioners when they design programs which aimed at enhancing athletes' well-being. References Brown, K. W., & Ryan, R. M. (2003). The benefits of being present: Mindfulness and its role in psychological well-being. *Journal of Personal and Social Psychology*, 84(822-848). doi: 10.1037/0022-3514.84.4.822. Hayes, A. F., & Preacher, K. J. (2013). Statistical mediation analysis with a multicategorical independent variable. *British Journal of Mathematical and Statistical Psychology*, 67, 451-470. Kabat-Zinn, J. (2003). Mindfulness-based interventions in context: past, present and future. *Clinical Psychology: Science and Practice*, 10, 144-156.



## AFFECTIVE RESPONSES IN MOUNTAIN HIKING - A RANDOMIZED CONTROLLED TRIAL FOCUSING ON DIFFERENCES BETWEEN INDOOR AND OUTDOOR ACTIVITY

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**Introduction** Affective responses during and after physical activity may predict the motivation to engage in future physical activity. Although mountain activities, such as mountain hiking, show a high prevalence in alpine regions, the main body of literature is focussing on physical activity in flat environments. However, both the physiological and the environmental conditions of mountain hiking are different than walking in flat environments. Therefore, the aims of the present study were (1) to analyse affective responses of a single bout of mountain hiking and (2) to detect possible influences of the environment on affect during this activity. **Methods** Using a within-subject-design, 47 healthy participants were randomly exposed to three different conditions in small groups: outdoor mountain hiking, indoor treadmill walking, and sedentary control situation. Each condition lasted for 3.5 hours. Assessments included the Feeling Scale (Hardy et al. 1989), Felt Arousal Scale (Svebak et al. 1985) and a mood survey (Abele-Brehm et al. 1986). Results 42 participants completed the study. Compared to the control situation, the participants showed a significant increase in affective valence ( $\eta^2p = .43$ ), activity ( $\eta^2p = .21$ ), elation ( $\eta^2p = .31$ ), and calmness ( $\eta^2p = .25$ ), and a significant decrease in fatigue ( $\eta^2p = .37$ ), anxiety ( $\eta^2p = .28$ ) after mountain hiking. Outdoor mountain hiking also showed significantly greater positive effects on affective valence ( $\eta^2p = .12$ ), activity ( $\eta^2p = .11$ ), and fatigue ( $\eta^2p = .16$ ) than indoor treadmill walking. **Discussion** The results indicate, that a single bout of mountain hiking elicits higher positive and lower negative affective responses compared to a sedentary control situation. These changes in affect are believed to raise motivation to maintain exercise behaviour in futures situations (Williams et al. 2008). Additionally, the data suggest a synergetic effect of physical activity and being outdoors. Abele-Brehm A, Brehm W. (1986). Zur Konzeptualisierung und Messung von Befindlichkeit: Die Entwicklung der 'Befindlichkeitsskalen' (BFS). Diagnostica, 32: 209-228. Hardy C, Rejeski W. (1989). Not what, but how one feels: The measurement of affect during exercise. J Sport Exerc Psychol, 11(3): 304-317. Svebak S, Murgatroyd S. (1985). Metamotivational dominance: A multimethod validation of reversal theory constructs. J Pers Soc Psychol 48(1): 107. Williams D, Dunsiger S, Ciccolo T, Lewis B, Albrecht A, Marcus B. (2008). Acute Affective Response to a Moderate-intensity Exercise Stimulus Predicts Physical Activity Participation 6 and 12 Months Later. Psychol Sport Exerc 9(3): 231-245. Contact: martin.niedermeier@uibk.ac.at

## PERSPECTIVE OF PARTICIPATION IN SPORTS AND LEISURE ACTIVITIES AS AN AFFECTING FACTOR ON HEALTHY AGING IN ADULTS WITH OTHER PSYCHOSOCIAL FACTORS

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**Do notIntroduction** Healthy aging is a lifelong process of optimizing opportunities for improving and preserving physical, social and mental wellness, independence, and quality of life, as well as enhancing successful life-course transitions (Health Canada, 2004). Participation in sports and leisure activity relates to depression especially in old people and it influence on other psychosocial factors that were identified as influential factors in healthy aging. The purpose of this study is to identify the psychosocial factors influencing healthy aging and examining their socio-demographic characteristics. **Methods** More than 200 Korean adults aged between 45 and 80 years-old participated in the study. Self-reporting questionnaires were used, followed by descriptive statistics and multiple regressions as inferential statistical analyses. Results There were significant differences between participants' general characteristics: age, education, religion, housing, hobby, and economic status. Participant in sports and leisure activities and other psychological factors are correlated with health aging. The factors influencing healthy aging were depression, participant in sports and leisure activities, and other psychosocial factors in order. **Conclusion** As results, all individual psychosocial resources correlate to participation in sports and leisure activities. Old people strengthen and improve their psychological resources because participating in sports and leisure activities may provide them experiencing achievement, expanding their social and personal relationship, and increasing their physical health, and consequently old people have less depression leading to more vitality in life. **Reference** Health Canada. (2004). Workshop on healthy aging [www.hc-sc.gc.ca/seniors-aines/pubs/workshop\_healthyaging/pdf/workshop1\_e.pdf] Contact franzhan@yahoo.co.kr insert authors here

## OPTIMAL PHYSICAL ACTIVITY LEVEL TO PSYCHOLOGICAL WELL-BEING

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**INTRODUCTION** Psychological well-being has been recognized as a key factor to academic success (Osornio-Castillo, et al. 2010); however the college students are exposed to several physic and psychological stressors. One of the strategies to attend this problem is the physical activity, nevertheless there isn't clarity about the optimal intensity level to induce psychological benefits. The aim was to determine the relation between psychological well-being and physical activity level in college students, associated with academic performance. **METHODS** Participated 1,489 Mexican college students. The physical activity level was determined by IPAQ questionnaire identifying low, moderate and vigorous level. The psychological well-being was assessed by Ryff scale with six sub-scales: self-acceptance, positive relations with others, autonomy, environmental mastery, purpose in life and personal growth. Instruments were applied in computerized form. Academic performance was the school grades. **RESULTS** Students with vigorous intensity level had higher scores in self-acceptance ( $P<0.003$ ), environmental mastery ( $P<0.041$ ) and purpose in life scales ( $p<0.001$ ). Autonomy scale shows lower scores ( $P<0.004$ ) in students with low intensity. In all cases, the academic performance co-variable was significant ( $p<0.01$ ). **DISCUSSION** Three sub-scales were related with the vigorous activity level, different to the study of Abu-Omar, R. et al. (2004) who refers moderate level. In concordance with Cerin, L. et al. (2009) who claim that vigorous level produce higher mental well-being. While autonomy scale doesn't differ between moderate and vigorous level, similar to studies of Mutrie N. (2007) and Hawker C. (2012) who found results in both intensity levels. The relation between physical activity and psychological well-being is clear; seems that vigorous level is the optimal intensity. The link between educational performance and well-being is evident, although the causality direction can't be clarified in this study. **REFERENCES** Abu-Omar, K., et al. (2004). Mental health and physical activity in the European Union. Sozial-und Präventivmedizin 49(5): 301-309. Cerin, E., et al. (2009). Associations of multiple physical activity domains with mental well-being. Mental Health and Physical Activity, 2(2): 55-64. Hawker, CL. (2012). Physical activity and mental well-being in student nurses. Nurse education today 32(3): 325-331. Mutrie, N. and Hannah, MK. (2007). The importance of both setting and intensity of physical activity in relation to non-clinical anxiety and depression. International Journal of Health Promotion and Education 45(1): 24-32. Osornio-Castillo, et al. (2010). El bienestar psicológico, predictor del

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### RELATIONSHIPS BETWEEN BODY DISSATISFACTION, COGNITIVE BODY IMAGE, AUTHENTICITY, AND CONTINGENT SELF-ESTEEM FOR FEMALE ATHLETES

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1: GSHS-RU (Saitama, Japan), 2: RFJS-PS (DC2), 3: DSWCCH-RU (Saitama, Japan) Introduction This study investigates the body image of female athletes and shows a correlation with authenticity and contingent self-esteem. Method The subjects were 119 female university students (aged  $19.8 \pm 1.3$  years) belonging to athletic clubs or teams and participating in sports activities at high frequencies (>5 times a week for 3 h). We have given attention to their privacy concerns and taken their consent for the investigation. The contents of the investigation were as follows: 1) personal data (age, height, weight, ideal weight, type of sports); 2) authenticity criterion (Ito and Kodama, 2005); 3) contingent self-esteem criterion (Ito and Kodama, 2006); and 4) Contour Drawing Rating (CDR) Scale (Thompson and Gray, 1995). Subjects were categorized into three groups based on the extent of body dissatisfaction (calculated by CDR results); no body, normal body, and strong body dissatisfaction. Subjects were categorized into three groups according to cognitive body image distortion: no distortion, light distortion, and obesity distortion. We analyzed the factor of variance of scores of contingent self-esteem criterion and authenticity criterion as the dependent variable. For statistical analysis, we used IBM SPSS statistics version 2.1. Results Here 16.6% subjects had cognitive body image disturbance based on the height distribution of cognitive body image disturbance. Moreover, based on the result of factor analysis of variance, scores of contingent self-esteem criterion and authenticity criterion analysis showed no significant difference between the three groups of cognitive body image distortion. For contingent self-esteem criterion and authenticity criterion analysis, there was no significant difference between the three groups of cognitive body image disturbance. Discussion This study showed that female athletes have accurate cognitive body images. This study showed that the main factor of body dissatisfaction for female athletes is not dissatisfaction as much as the desire to raise contingent self-esteem. These results suggest that contingent self-esteem and authenticity are not correlated with cognitive body image. Hereafter, correlations with other factors, such as competitive ability, competitive scores, and social support, such as relationships with friends, must be studied. Reference Masaya I, Masahiro K. (2005). Japanese Association of Education Psychology, 53, 74-85 Masaya I, Masahiro K. (2006). Japanese Association of Educational Psychology, 54, 222-232 Teru M, Ikue M, Masaru H. (2014). The Bulletin of Shizuoka Eiwa Gakuin University & Shizuoka Eiwa Gakuin University Junior College, 12, 133-140 Thompson M, James G. (1995). J Personality Assessment, 64, 258-269 Contact 15vd006c@rikkyo.ac.jp

### RELATIONSHIPS AMONG COACHING EVALUATION, COLLECTIVE EFFICACY AND TEAM ADAPTATION OF HIGH SCHOOL BASEBALL ATHLETES

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Introduction Baseball is one of the most popular sports in school club activities from elementary to college levels in Japan. The purpose of this study was to develop Coaching Evaluation Scale for Baseball Manager and Coach (CESBMC), Collective Efficacy Scale for Baseball Athletic Teams (CESBAT), Team Adaptation Scale for Baseball Athletes (TASBA) and to examine relationships among factors of CESBMC, CESBAT and TASBA. Methods The subjects of 94 athletes (mean age=16.27, SD=1.01, mean baseball experience=8.17, SD=2.23) in high school baseball teams were asked to answer a questionnaire on coaching evaluation, team adaptation and collective efficacy. The question items of the first two were developed from our preliminary survey in 2010 and those of the last derived from Collective Efficacy Scale (Kuniyoshi & Shimizu, 2009). Exploratory factor analyses and reliability analyses were conducted to develop CESBMC, CESBAT and TASBA. In order to examine relationships among CESBMC and CESBAT, TASBA, stepwise multiple regression analyses were conducted. Results The results of exploratory factor analyses identified that CESBMC has a 5-factor model with 32 items ("Psychological Support," "Understanding and Trust," "Team Building and Administration," "Friendly Attitude," "Game Analyses and Strategic Planning"), CESBAT has a 7-factor model with 28 items ("Efficacy for Practice," "Efficacy for Performance," "Efficacy for Social Support," "Efficacy for Goal Achievement," "Efficacy for Cooperation," "Efficacy for Emotional Expression," and "Efficacy for Loyalty"), and TASBA has 2-factor model with 25 items ("Team Adaptation" and "Team Maladaptation"). Reliability analyses and confirmatory factor analyses confirmed that all the scales had satisfactory Cronbach's alpha coefficient reliabilities and structural validities. Multiple regression analyses showed that "Team Building and Administration" was positively associated with CESBAT ( $\beta=0.66$ ,  $p<0.001$ ), "Psychological Support" was negatively associated with "Team Maladaptation" ( $\beta=-0.29$ ,  $p<0.01$ ), and "Understanding and Trust" was positively associated with "Team Adaptation" ( $\beta=0.30$ ,  $p<0.01$ ). Discussion The results of this study indicate that CESBMC, CESBAT and TASBA can be useful tools to assess team adaptation of high school baseball athletes. The findings also imply that coaches' higher awareness and team building skills enhance collective efficacy in teams and that psychological support from coaches and relationship based on trust are most likely to facilitate athletes' adaptation to their team. References Kuniyoshi D & Shimizu Y. (2009). Development of Coaching Evaluation Scale and Collective Efficacy Scale for Soccer Athletes. Kyusyu Journal of Sport Psychology. 21:38-39. Contact syasuo@icu.ac.jp

### THE EFFECT OF 8 WEEKS OF TRAINING IN WATER, HAPPINESS AND SELF-ESTEEM OF WOMEN WITH MULTIPLE SCLEROSIS

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Introduction : The purpose of this study was to the effect of 8 weeks of training in water, life expectancy and self-esteem of women with multiple sclerosis. Today's multiple sclerosis is a suffering patient from poor movement and physical disability is increasing in the world and it is a disease of the century now. Physical education has a special place in the sciences and as a complementary therapy help to many patients such as diabetes, cardiovascular disease, multiple sclerosis, arthritis and so on. For many years. Methods : Research method of this study is half-experimental. The population of this study was included women who were diagnosed with multiple sclerosis therapy for multiple sclerosis patients in Tehran referred to Association, based on Morgan scale the sample size determined 30 people. The instrument for collecting the data includes two questionnaires: Oxford Happiness of Argyle et al (1989) and Coopersmith Self-Esteem (1967). Validity of the questionnaires determined by 8 professors of sport management and reliability by using the Cronbach's alpha coefficient that ordinarily are: 0.77, 0.72, 0.93. For the data analyzing, descriptive and inferential statistics (Pearson correlation coefficient

and regression). Result : Result showed there is not a positive and significant in meaningful Happiness index before and after exercise ( $p < 0.05$ ). But there is a positive in self-esteem observed . Conclusion : Water-therapy is a main factor in increasing self-esteem in these patients . in other words that water-therapy and doing exercise will have a meaningful effect on self-esteem .

### CLUSTERS OF MENSTRUAL DISTRESS AND THEIR ASSOCIATION WITH SPORT-CONFIDENCE IN JAPANESE FEMALE COLLEGE ATHLETES

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Background Sport-confidence is an important factor for sport success; however, the association of menstruation symptoms with sport-confidence is unclear. Moreover, few studies have focused on individual differences in menstrual distress among female athletes. Purpose To clarify the relation between menstrual distress and sport-confidence, and to identify clusters of menstrual distress for different phases of the menstrual cycle (i.e., menstruation and the late follicular and luteal phases) and examine associations of these clusters with sport-confidence among Japanese female college athletes. Method Participants were 198 female college athletes, from which we collected data once per week over seven weeks. Participants completed questionnaires on demographic characteristics, the Moos Menstrual Distress Questionnaire (MDQ; Moos, 1968; 1986), and the Sport- Confidence Inventory (Vealey & Knight, 2002) Results We found no difference in sport-confidence between menstrual cycle phases. However, there were significant relationships between menstrual distress and sport- confidence. Using cluster analysis of the MDQ, we found five clusters spanning the phases of the menstrual cycle, as follows: Cluster 1, consistently low menstrual distress and high energetic arousal during a menstrual cycle (27.3% of total sample); Cluster 2, consistently high menstrual distress during a menstrual cycle (9.1%); Cluster 3, consistently low menstrual distress during a menstrual cycle (36.9%); Cluster 4, slight fluctuations in menstrual distress during a menstrual cycle (12.6%); and Cluster 5, large fluctuations in menstrual distress during a menstrual cycle (14.1%). Athletes in Cluster 5 showed greater sport-confidence during the late follicular phase than during the menstruation phase; athletes in other clusters showed no significant changes in this sport-confidence across the different phases. Conclusion Greater menstrual distress was related to lower sport-confidence. Furthermore, those with large fluctuations in menstrual distress during a menstrual cycle may experience changes in sport-confidence according to the phase. References Vealey, R. S. & Knight, B. J. (2002, September). Multidimensional sport-confidence: A conceptual and psychometric extension. Paper presented at the Association for the Advancement of Applied Sport Psychology Conference, Tucson, AZ. Moos, R. H. (1968). The development of a menstrual distress questionnaire Psychosom Med. 30 (6): 853-67. Moos, R. H. (1986). Menstrual Distress Questionnaire Manual. Los Angeles: Western Psychological Services. Contact Email: swakui@junendo.ac.jp

### THE INTERACTIVE EFFECT OF PHYSICAL FITNESS AND ALZHEIMER'S DISEASE RELATED GENOTYPE ON COGNITIVE FUNCTION IN ADOLESCENCE: AN EEG COHERENCE STUDY

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Purpose: The purpose of the study is to examine the difference of nonverbal intelligence and cortical networking according to physical fitness in adolescents carrying Alzheimer's disease related genotype(ApoE e4). Methods: Participants were middle school students consisting of ten high-fit and eight low-fit e4 carriers and fourteen high-fit and ten low-fit non-carriers. K-CTONI-2 was used to measure nonverbal intelligence, and cortical activation at F3, F4, C3, C4, P3, P4, T3, T4, O1, O2 has been recorded during intelligence test. Inter- and intra-hemispheric coherences were calculated to examine cortico-cortical communication. Results: There were no significant fitness, genotype main effects and fitness x genotype interaction effect on the score, accuracy and reaction time of the nonverbal intelligence test. However, the result of EEG coherence revealed that significant fitness x genotype interaction effects were observed and those effects were focused on right hemisphere pairs highly related to task-relevant visual-spatial processing. Specifically, coherence in low-fit e4 carriers was lower than high-fit e4 carriers but such difference between low and high fit group was not observed in non-carriers. Importantly, cortical networking in e4 carriers with high physical fitness was not discriminated by non-carriers. Conclusion: The results imply that carrying e4 allele appears to decrease neural efficiency 50-60 years before onset of AD but physical fitness seems to compensate the negative impact of carrying AD related genotype.

### THE EFFECT OF PROGRESSIVE MUSCLE RELAXATION ON SPINAL POOL EXCITABILITY

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THE EFFECT OF PROGRESSIVE MUSCLE RELAXATION ON SPINAL POOL EXCITABILITY 1: Kokushikan University Graduate School of Sport System (Tokyo, Japan) Purpose The purpose of this study was to examine the effect of Progressive muscle relaxation (PMR), on spinal motoneuron pool excitability during movement immediately after performing PMR. Methods Participants were male university students of high performance athletes ( $n = 4$ , mean age 21.8 years,  $SD = 1.0$ ). All subjects reported any medications they were taking and it was verified that none took any medications that affected the muscular or nervous systems. They practiced the simplified version of progressive muscle relaxation (Wolpe, 1954), daily for three weeks and assessed on the three weeks of practice. As a experimental, Before and after engaging in PMR in the left-foot phase, 20% maximal voluntary contraction (MVC) ankle dorsiflexion (6sec) and 70% MVC plantarflexion (6sec) of the right foot( $\times 10$ set : motor task) was performed, and spinal motoneuron pool excitability was assessed by measuring the H-reflex of the soleus during the dorsiflexion part of the motor task. Electrical stimulation The tibial nerve was electrically stimulated with square pulses 1.0 sec in duration delivered through a constant voltage stimulus isolation unit on 70% MVC plantarflexion (6sec) of the right foot. The anode, a metal plate (5 $\times$ 13 cm) covered in gauze and moistened with saline, was placed on the opposite side of the leg above the patella. The stimulus intensity setup to elicit H reflexes was on average 10% of maximum M wave. Electromyographic recording Soleus EMG was recorded using disposable 10-mm Ag/AgCl electrodes 1 cm apart positioned immediately below the division of the two heads of the gastrocnemii in the midline over the soleus muscle. EMG was amplified ( $\times 5$ Hz–2KHz) and digitized at 10 kHz. (AD Instruments Lab Chart v7.2.2) Results The result indicated that H-reflex amplitude value decreased during the motor task of the right foot before and after performing PMR in the left-foot phase. Conclusion Facilitatory effect on the excitability of the spinal motoneuron pool excitability was observed in movement immediately after performing PMR in the left-foot phase. Trimble and Harp(1998) reported that post-muscle activation effects on segmental reflexes reveal divergent results dependent upon the manner in which the muscle is activated. Therefore, PMR has the potential to influence the excitability of soleus motoneurons. References Wolpe, J. (1954) Reciprocal inhibition as the main

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### THE RELATIONSHIP BETWEEN STATE ANXIETY AND COPING WITH EXTERNAL PRESSURE WHILE OFFICIATING: THE MODERATING ROLE OF MENTAL TOUGHNESS.

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Johansen & Haugen (2013) found that Norwegian top-class referees are self-confident in their officiating and that they have coping strategies designed to deal with anxiety and stress provoked by others' aggressive behavior. Mental toughness (MT) is a widely employed concept in the context of sport and there seems to appear a general consensus that MT includes important individual characteristics related to successful performance and outcomes in sport (Sheard, Golby, & Wersch, 2009). The aim of this study was to examine the potential moderating role of MT in the relationship between state anxiety and coping strategies in officiating among Norwegian top class soccer referees. 109 soccer referees (100 males, 9 females) with a mean age 30.8 (sd = 6.98) ranked in Norwegian Premier League (NPL) and OBOS League (second league level) reported in a questionnaire their level of MT (SMTQ, Sheard et al., 2009), level of anxiety (CSAI-2, Martens et al., 1990), and their officiating behavior (Johansen & Haugen, 2013). Results revealed that somatic anxiety predicted negative perceptions of social pressure in the decision-making process ( $r = .21, p < .05$ ), whereas cognitive anxiety did not ( $r = -.15, p = .12$ ). When assessing the MODERATE-macro for SPSS (Hayes & Preacher, 2014), no moderating role of mental toughness was evident. Based on the preliminary analyses there are indications that soccer referees with more somatic anxiety are more disposed for anticipating external social pressure and the reason may be that they feel lack of coping strategies dealing with this pressure. Whether mental toughness among these soccer referees do not play a moderating role are still early days in concluding and our finding may be due to this specific sample of top-class soccer referees. References Hayes, A. F., & Preacher, K. J. (2014). Statistical mediation analysis with a multicategorical independent variable. *British Journal of Mathematical and Statistical Psychology*, 67(3), 451-470. Johansen, B. T., & Haugen, T. (2013). Anxiety level and decision-making among Norwegian top-class soccer referees. *International Journal of Sport and Exercise Psychology*, 11(2), 215-226. Martens, R., Burton, D., Vealey, R.S., Bump, L.A., & Smith, D.E. (1990). Development and validation of the Competitive State Anxiety Inventory-2. In R. Martens, R.S. Vealey, & D. Burton, *Competitive anxiety in sport* (pp. 117-190). Champaign, IL: Human Kinetics. Sheard, M., Golby, J., & Van Wersch, A. (2009). Progress toward construct validation of the Sports Mental Toughness Questionnaire (SMTQ). *European Journal of Psychological Assessment*, 25(3), 186-193.

### RELATIONSHIP BETWEEN SELF-ESTEEM AND REGULAR EXERCISE IN THE JAPANESE ELEMENTARY SCHOOL CHILDREN

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**Introduction** It is well known that lower physical fitness, exercise dislike and insufficient exercise in children are a serious problem for healthy growth and development of physical and mental. In particular, self-esteem is essential in exercise and sports activities. However, there are also unclear points such as the relationship of exercise habit and/or lifestyle and self-esteem in the growth and development period. **Purpose** The purpose of this study was to evaluate the relationship between self-esteem and regular exercise in the Japanese elementary school children. **Methods** This study was conducted among 3,680 children (1,805 boys, 1,875 girls), 4th-6th grade elementary school children (aged 9-12 years old), from 21 elementary schools in south district in Miyagi, Japan. All participants were asked to fill out self-report measures of habitual of exercise and self-esteem questionnaire. Self-esteem was investigated using Self-esteem Scale (Tokyo edition, 2011). This scale contains 22 items or phrases to measure individuals' worth and attitudes toward a real emotion concerning each item on a four-point Likert's scale (absolutely agree, agree, disagree, absolutely disagree) with scores of 1-4 and an average score of 1-4 points. Also, we evaluated three category of self-acceptance, that is, self-assertion and self-determination using by this scale. Participants were divided into four groups for each grade and gender from habitual of exercise questionnaire; high regular exercise (HE: more 3days/wk), middle regular exercise (ME: 1~2 days/wk), low regular exercise (LE: 1~3days/month), and no exercise (NE). And we compared self-esteem with self-acceptance, self-assertion and self-determination among four groups. **Results** Regardless of the gender, self-esteem of HE in each grade was higher than any other group. And, Self-acceptance, assertion and determination also tended to be higher due to the frequency of exercise habits, respectively. Self-acceptance, assertion and determination of girl in each grade were higher than that of boy. Self-esteem has become a low value with the upper grades. **Conclusion** Our results indicate that regular exercise would be enhanced and/or improved self-esteem in elementary school children. Further studies needed to confirm whether relate to the physical fitness level and lifestyle and self-esteem could be suggested as a new exercise intervention or clinical strategy for the health growth of children. **References** Pope, A. W. et al. : Self-esteem enhancement with children and adolescents, Pergamon, New York, 1998. Fox, K. R. and Corbin, C. B., *Journal of Sport and exercise Psychology*, 11, 408-430, 1989. Yamamoto, S. et al., *Bull. of Tokyo Metropolitan School Personnel in service training Center*, 8, 3-26, 2010 Contact: jn-uchimaru@sendai-u.ac.jp

### ATTITUDE OF BASKETBALL AND BADMINTON PLAYING STUDENTS TOWARDS OBESITY

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**Introduction** Obesity is serious consideration among youth. A team game like basketball and an individual game like badminton both promote fitness. Students playing these games are often physically fit. Their attitude towards obesity assumes significance in university settings. Therefore, the present study examined the attitude of basketball and badminton playing students towards obesity. **Methods** Hundred eight students from King Fahd University of Petroleum and Minerals were selected as participants for the present study. All participants were enrolled in freshmen course of academic year 2012 -2013. Group one (n = 51) consist of basketball players and group two (n = 57) consists of badminton players. The attitude towards obese people scale (Allison et al 1991) was used as a tool to measure the attitude towards obesity. ATOP is tool widely used to measure the anti-fat attitude and biasness which consist of twenty items and based on likert rating scale. The ATOP score indicates the negative or positive attitude. Descriptive statistics was used to compute means and standard deviation. Independent sample t test was employed to find the significance difference between the attitudes of two groups towards obesity. The data obtained were analyzed with the help of statistical software (SPSS 16 version). The level of statistical significance was set at 0.05 levels. **Results** T Test revealed highly significant difference between ATOP scores for basketball (M=58.11, SD  $\pm$  9.25) and badminton (M=54.08, SD  $\pm$ 10.50) groups;  $t(106) = 2.10, p = .038$ . Combined ATOP score of the two groups was (M=55.99, SD $\pm$  10.09).



Discussion Results suggest that basketball playing students are more positive in their attitude towards obesity compare to badminton playing students. Badminton playing students seems to have more anti-fat attitude towards obesity. Anti-fat bias occurs when overweight individual are negatively judged because they are assumed to possess negative traits such as being lazy, unattractive, self-indulgent (Phul and Brownell 2001). Rukavina et al 2008, also found that kinesiology undergraduates indicated anti-fat bias toward obese individuals on the lazy/motivated scale. References Allison DB, Basile VC and Yunker HE. (1991). International Journal of Eating Disorder, 10, 599 - 607. Puhl R and Brownell KD. (2001). *Obes Res*, 9, 788 - 805. Rukavina PB, Li W and Rowell MB. (2008). *Social Psychology of Education*, 11, 95-112. Contact rtat@rediffmail.com

## GENDER DIFFERENCE IN ACUTE EXERCISE AND NEUROCOGNITIVE PERFORMANCE IN CHILDREN

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**Introduction** The executive attention networks and the efficiency of inhibitory control are important in motor-skill learning in developing children. Previous studies have demonstrated that cognitive function can be improved by the physical exercise and gender differences could influence behavioral inhibitory control, with girls outperforming boys in behavioral self-control (Chen & Sang, 2002; Kochanska, Murry, & Harlan, 2000). However, there have been no proceeding studies investigating the influence of gender on the inhibitory control in children after an acute bout of moderate aerobic exercise. The present study thus examined the effects of such an exercise mode on behavioral (i.e., RT and accuracy) and electrophysiological (i.e., P3 amplitude) performance using a modified Flanker task in boys and girls. **Methods** Twenty healthy elementary school children were recruited and then randomly assigned into both acute exercise (AE) and seated rest (SR) sessions with a counterbalanced order. Behavioral and Event-related potentials (ERPs) performances were collected in 20 children during a modified flanker task at baseline and after either an acute bout of 20 minutes of moderate intensity aerobic exercise or a control period at least one week apart. All independent variables (e.g., accuracy rate, reaction time, and P3 amplitude) from the acute bout of moderate aerobic exercise were separately analyzed with repeated-measures ANOVA. **Results** The results revealed that, although the accuracy rate in congruent and incongruent conditions and the reaction times (RTs) in the congruent condition did not significantly improve after SR and AE sessions in all children, they showed significantly shorter RTs in the incongruent condition after AE when compared to SR. In terms of ERPs performance, P3 amplitude increased following AE when compared to SR in all children. However, only the boys displayed greater P3 amplitude in the incongruent condition after the acute exercise. **Discussion** The current findings replicate prior research reporting the beneficial effects of acute aerobic exercise on neurocognitive performances (e.g., RTs and P3 amplitudes) in children. The children could gain response-related (i.e., RTs) benefits in the higher inhibitory control (i.e., incongruent) condition. Only boys could obtain particular cognition-process-related efficiency with regard to attentional resource allocation (i.e., P3 amplitude) after acute exercise, implying that the mechanisms underlying the effects of such exercise on neural functioning may be gender dependent. **Keywords:** Executive function, Flanker, P3 amplitude, acute exercise, attention Supported by MOST Grant 103-2410-H-320-010 and 104-2410-H-320-009

## Rehabilitation and Physiotherapy

### ASSOCIATIONS BETWEEN SITTING TIME AND MUSCULOSKELETAL PAIN IN DIFFERENT BODY REGIONS AMONG WORKERS ACCORDING TO BLUE AND WHITE COLLARS

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FADEUP

**Studies** on the association between sitting time and musculoskeletal pain have found contrasting results. The aim of this study is investigate the association between sitting time (daily total, and occupational and leisure-time periods) and musculoskeletal pain in different body regions among workers by blue-collar and white. **Methods:** The sample comprised 205 workers. Musculoskeletal pain and related symptoms was assessed with the Nordic Questionnaire of Osteoarticular Symptoms, and the sitting time was assessed with IPAQ – Short Version. The association of sitting time and musculoskeletal pain and related symptoms was analyzed with logistic regression, adjusted for BMI, age, gender and Moderate to Vigorous Physical activity. **Results:** The white collars participants had lower level of moderate to vigorous Physical Activity than Blue collars. The participants were more likely to have less musculoskeletal pain and related symptoms in the ankles/feet with higher sitting time (odds ratio [OR] = 0.995, p = .032). **Conclusion:** Sitting time is negatively associated with musculoskeletal pain in the ankles/feet intensity only among white collars workers. Future studies using a prospective design with objective measures of sitting time are recommended. Our results emphasize the need of worksite interventions to prevent musculoskeletal pain and related symptoms.

### INFLUENCE OF MOVEMENT SPEED ON MUSCLE SWELLING DURING STEP-UP EXERCISES IN HEALTHY YOUNG MEN

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**Introduction** It has been reported that skeletal muscle swelling immediately after training may be due to muscle architecture changes needed to generate muscle hypertrophy (Brancaccio et al, 2008; Yasuda et al, 2015). We examined muscle swelling, defined as the increase in the muscle thickness obtained from ultrasound images, immediately after step-up exercises and investigated the effects of movement speed during step-up exercises on muscle swelling in the lower extremities of healthy young men. **Methods** Twenty healthy young men (mean age 22.6 years) participated in this study. A step-up exercise, using a step of 30 cm, was performed at two different speeds (fast and slow). The fast speed group [1s for concentric phase, 1s for eccentric phase] performed the step-up exercise for 12 sets of 30 repetitions. The slow speed group [3s for concentric phase, 3s for eccentric phase] performed the exercise for 12 sets of 10 repetitions. Therefore, the total time of the step-up exercise was standardized to 720 s. The increase in muscle thickness immediately after the step-up exercise, was used as an index for muscle swelling. Ten muscle thicknesses in the lower limbs were examined using B-mode ultrasound imaging with an 8-MHz transducer: right rectus femoris and vastus lateralis, bilateral gluteus maximus, gluteus medius, semitendinosus, and gastrocnemius. **Results** Both groups (fast and slow speeds) showed significant increases in the thickness of all the examined muscles immediately after the step-up exercise. A two-way, repeated measures ANOVA using two factors — movement speed and muscle — indicated that both factors significantly affected the rate of change in the muscle thickness. The rate of change in

the muscle thickness was significantly greater in the fast speed group than in the slow speed group. The increase in muscle thickness was greatest for the vastus lateralis among the lower limbs muscles. Discussion The increases in muscle thickness on the ultrasonography images immediately after the step-up exercise indicate muscle swelling, which is caused by damage to the skeletal muscle. We found that there was a greater degree of muscle swelling in the fast speed group than in the slow speed group during the step-up exercise standardized by the total training time. This result suggests that step-up exercise at fast speeds may cause greater damage to the muscles in the lower extremities. References Brancaccio P, et al (2008). Changes in skeletal muscle architecture following a cycloergometer test to exhaustion in athletes. *J Sci Med Sport*.11:538–541. Yasuda T, et al (2015). Effect of low-load resistance exercise with and without blood flow restriction to volitional fatigue on muscle swelling. *Eur J Appl Physiol*. 115(5):919–926. Contact: E-mail: ike-zoe.tome.4u@kyoto-u.ac.jp

## EFFECTS OF REHABILITATION IN MULTIPLE SCLEROSIS ANIMAL MODEL

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**Introduction** Multiple sclerosis (MS) is an autoimmune-mediated inflammatory disease which leads to cognitive deficit, visual disturbances, abnormal muscle tone, and impaired ambulation (Stevens et al., 2013). Rehabilitation is frequently used clinical strategies for improving or maintaining functional status (Kraft 1999; Stevens et al., 2013). However, molecular mechanism about effects of rehabilitation is poorly unknown. In this study, we investigated effect of rehabilitation in hippocampus and spinal cord on animal model with MS. **Methods** The mice (10 weeks) were randomly divided into three groups (n = 10 in each group): sham group, experimental autoimmune encephalomyelitis (EAE) group, and EAE-exercise group. For induction of EAE, the mice were injected with 100 µg myelin oligodendrocyte glycoprotein (MOG) 35-55 in complete Freund's adjuvant. The mice in the exercise groups were put on the treadmill to run for 30 min/day. To check motor function, we carried out rota-rod test, bridge test, step down avoidance task. We confirmed spinal cord and hippocampus by using molecular analysis. **Results** We found that EAE-exercise group showed good motor function compared with EAE group. We found that EAE-exercise group increased expression of myelin basic protein (MBP), CNPase, DCX, 5-bromo-2'-deoxyuridine (BrdU), Bcl-2, brain-derived neurotrophic factor (BDNF), and tropomyosin receptor kinase B (TrkB) than EAE group in the spinal cord and hippocampus (p<0.05). However, expression of low density lipoprotein receptor-related protein1 (LRP-1), neurotrophin-3 (NT-3), bax, caspase-3, and TUNEL decreased in the EAE-exercise group than EAE group in the spinal cord and hippocampus (p<0.05). **Discussion** Exercise training represents a promising behavioral approach for managing cognitive dysfunction in person with MS (Sandroff et al., 2015). Enriched environment provides beneficial conditions to promote the mobilization of neural progenitors into demyelinating lesions (Magalon et al., 2007). We found that exercise applied to EAE animal model reduced demyelination and axonal injury in the spinal cord. As well as, it increased cell proliferation and prevented apoptosis in the hippocampus. Based on the present results, it can be suggested that rehabilitation may give beneficial effects to patients with MS by helping motor function and cognition ability. **Acknowledgement** This research was supported by Basic Science Research Program through the National Research Foundation of Korea(NRF) funded by the Ministry of Science, ICT & Future Planning(No. 2014R 1A 1A 3052861) **References** Stevens V, Goodman K, Rough K, Kraft GH. (2013). *Phys Med Rehabil Clin N Am*, 24:573-592. Kraft GH. (1999). *Lancet*, 354:2016-2017. Sandroff BM. (2015). *Neurosci Biobehav Rev*, 59:173-183. Magalon K, Cantarella C, Monti G, Cayre M, Durbec P. (2007). *Eur J Neurosci*, 25:761-771. Contact sungpt97@kyungnam.ac.kr

## EFFECT OF MANIPULATION AND CORRECTIVE CORE EXERCISES ON THE SPINAL DEFORMATION IN GOLFERS: A CASE STUDY

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**[Purpose]** As noted previously, only a few exercise programs can help correct spinal vertebral distortion and strengthen surrounding muscles in golfers. Several theory-oriented and formalized rehabilitation programs have been applied in both athletes and non-athletes. Against this background, this study examined spinal shape in two professional golfers with chronic back pain, and analyzed the effects of a 4-week regimen of semi-weekly manipulation therapy and corrective core exercises on spinal shape. **[Subjects]** Two golfers were selected as study subjects. Subject A was 43 years old, 174 cm tall, weighed 78.30 kg, had a body mass index (BMI) of 25.9 (kg/m<sup>2</sup>), and a 24-year career. Subject B was 46 years old, 171.40 cm tall, weighed 73.40 kg, had a BMI of 25.0 (kg/m<sup>2</sup>), and a 28-year career. **[Methods]** The pelvis and spinal vertebrae were corrected using the Thompson "drop" technique. Angle and force were adjusted to place the pelvis, lumbar spine, and thoracic vertebrae in neutral position. The technique was applied twice weekly after muscle massage in the back and pelvic areas. The golfers performed corrective, warmup stretching exercises, followed by squats on an unstable surface using the Togu ball. They then used a gym ball for repetitions of hip rotation, upper trunk extension, sit-ups, and pelvic anterior-posterior, pelvic left-right, and trunk flexion-extension exercises. The session ended with cycling as a cooldown exercise. Each session lasted 60 minutes. **[Results]** The difference in height was measured on the left and right sides of the pelvic bone. The pelvic tilt changed significantly in both participants after the 4-week program. **[Conclusion]** In golfers, core muscles are critical and are closely related to spinal deformation. Core strengthening and spinal correction play a pivotal role in the correction of spinal deformation.

## EFFECTS OF ACCELERATION TRAINING AFTER ANTERIOR CRUCIATE LIGAMENT RECONSTRUCTION ON DYNAMIC BALANCING FUNCTIONS

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**[Purpose]** The present study aimed to investigate whether the effects of rehabilitation exercise performed after anterior cruciate ligament reconstruction on dynamic balancing functions differ between males and females. **[Subjects]** Eighteen subjects aged between 20–30 years enrolled in this study. The ages did not significantly differ between the males and females. **[Methods]** The rehabilitation exercise program was performed three times per week for 12 weeks (3 months), and was initiated immediately after anterior cruciate ligament reconstruction. Thereafter, the patients visited the hospital once per week to perform rehabilitation exercise during weeks 12–24 (3–6 months), and education on self-exercise and assessments were conducted during the visits. Self-exercise was performed two times per week according to the determined program. **[Results]** The extension active joint position sense, extension passive joint position sense, and flexion passive joint position sense of the affected and unaffected knees did not show any interaction effects between the measurement periods or between the groups. In the case of the affected knee, the results of two-way repeated-measures analysis of variance

showed no significant difference between the measurement periods or between the groups; moreover, no, interaction effects were observed between the measurement periods or between the groups. In the case of the unaffected knee, although no significant difference was observed between the measurement periods, significant differences were observed between the groups. [Conclusion] In conclusion, this study revealed that most knee rehabilitation exercise training programs can be applied to both genders during the recovery period after ACL reconstruction, except for the knee rotational feedback/feedforward function exercise that may exhibit different effects based on the gender.

### **OUTCOMES FOLLOWING THE INTERVENTION OF THE MULTIDISCIPLINARY APPROACH FOR A PATIENT WITH SNAPPING HIP SYNDROME IN TAIWAN: A CASE REPORT**

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**Introduction :** Snapping hip syndrome was the common problem of in the hip joint. The imbalance tension of soft tissue around the hip joint caused the audible snapping or popping noise as the hip moved from flexion to extension. It also caused increased stress in the joint and produced the uncomfortable symptom. Pain relief and soft tissue stretch were very important principles in conservative management. The purpose of this study was to describe the outcomes from the multidisciplinary approach for a patient with snapping hip syndrome in Taiwan. **Methods:** A 40-year-old female presented the pain over R't hip joint. She also complained that she heard the popping sound over R't hip joint when she walked. The sound was more obvious in the mid-stance phase in the gait cycle. The X ray finding showed that no abnormal sign was noted. The examination of standing posture showed that sway back posture was noted. No limitation of range of motion in the hip joint was found. R't sacroiliac joint hypomobility was examined. Treatment consisted of the mobilization for R't sacroiliac joint. The training of core muscle of the low back corrected the standing posture. Finally, the strengthening exercise of hip joint was instructed especially in deep hip external rotators. This case accepted 8 treatment visits over 4 weeks. **Results:** The pain scale and the scores of Iowa functional hip evaluation showed significant improvement. The pain scale decreased from 3 to 0. The scores of Iowa functional hip evaluation improved from 78 to 89 after treatment. She also responded that the popping sound was not obvious when she walked. **Discussion:** The sacroiliac joint mobilization improved the alignment of the pelvis and decreased the abnormal stress in the joint. In addition, the core muscle training provided the stability of low back and maintained the ideal posture. The strengthening exercise of the deep hip external rotators improved the stability of the hip joint. The contraction of the deep external rotators provided the motor control of femur head to the acetabulum in weight bearing phase of gait cycle. Appropriate alignment of lower quarter and the stability of the hip improved the snapping hip syndrome. **Reference** Konczak CR, Ames R. (2005) J Manipulative Physiol Ther, 28(1) Macadam P, Cronin J, Contreras B. (2015) Int J Sports Phys Ther, 10(5) Dello Iacono A, Padulo J, Ayalon M. (2016) J Sports Sci, 34(7)

### **EFFECTS OF PROGRESSIVE RESISTANCE EXERCISE ON BODY COMPOSITION AND PHYSICAL FUNCTION IN ELDERLY FEMALE ADULTS WITH SARCOPENIC OBESITY\_A RANDOMIZED CONTROLLED TRIAL**

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**Background:** Obesity is associated with an increased risk of knee osteoarthritis (KOA), which had been addressed to higher fat mass and lower lean muscle mass. The incidence of receiving a total knee replacement (TKR) among obese patients increased in recent years. The limited functional mobility after TKR, which had been addressed to the deficits of muscle function and balance ability, can be improved by postoperative rehabilitation. However, it was noted that obesity exerted negative impacts on leg muscle function and postural balance control. Furthermore, it remains unclear whether post-TKR rehabilitation improves the postoperative body composition of obese patient with KOA. **Purpose:** To identify the training effects of postoperative rehabilitation, using elastic resistance exercise combined with balance training, on body composition of obese patients with KOA after TKR; and the relationship between changes of body composition followed post-TKR active rehabilitation and outcomes of functional mobility. **Methods:** Eligible participants who are overweight and obese with a body mass index  $\geq 24$  kg/m<sup>2</sup>, older than 45 years old and received a primary TKR were randomly assigned to either experimental group or control group. The experimental group received elastic resistance exercise combined with balance training 3 times a week for a total of 12 weeks, while the control group received only functional training in each admission. All outcome measures, including analysis of body composition using dual energy X-ray absorptiometry and bioelectrical impedance method, distance of functional forward reach, duration of single leg stance, timed sit-to-stand test, timed up-and-down stair test, timed 10-m walk; timed up-and-go test, and the Western Ontario and McMaster Universities Osteoarthritis Index score, and SF12, will be collected before rehabilitation, at the end of rehabilitation and 3 months after the end of rehabilitation. **Results:** Statistically significant improvement of all measures was observed in both experimental group and control group after intervention ( $p < 0.001$ ). Study group got significant improvement ( $p < 0.001$ ) for all measures over control group after ANCOVA with the pre-test of both groups as the covariate. **Conclusion:** Postoperative rehabilitation with a complex exercise regime exerts benefits on function outcome in obese patients KOA after TKR. Based on the fact that obesity is a risk of post-TKR function outcome and the need for obese patients with KOA to receive a TKR is gradually growing, further study should identify the training effects on body composition of obese patients with KOA after TKR. It is also important to identify the relationship between changes of body composition and outcomes of functional mobility in obese patients with KOA followed post-TKR active rehabilitation, which will help clinicians to develop post-TKR intervention models specified to obese subgroup in KOA population after TKR and enhancing the function outcome.

### **LOWER LIMBS STRENGTH, BALANCE, MOBILITY AND RISK OF FALLING IN COMMUNITY-DWELLING OLDER ADULTS**

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**INTRODUCTION** During the last decades there has been a rapid ageing of the Portuguese population. The ageing process involves several changes namely a decreasing in lower limbs strength, mobility and balance which contributes to increase the risk of falling and the likelihood to suffer fractures or traumatic brain injuries among other injuries. Physiotherapy can develop an important intervention in identifying the factors that potentiate the risk of falling and can provide strategies to prevent or reverse this risk. The purpose of this study was to characterise the risk of falling and related factors in a sample of Portuguese community-dwelling older adults. **METHODS** Cross-sectional study. 74 subjects participated in the study (50 women, 24 men), aged 65-97 years, apparently healthy, independent and living in the community. The following tests were used: to assess lower limbs strength the 30s chair stand test; 8-foot up and go test to assess

mobility and the Berg Balance Scale (BBS) to assess balance. The risk of falling was determined based on BBS. RESULTS The results of our study showed that for 30s chair stand test the mean value was 11 repetitions and for 8-foot up and go test was 8.63 seconds. For BBS the median was 53 points. 36.5% of the participants reported at least one fall during the previous year. Negative correlations have been found between 8-foot up and go test and 30s chair stand test ( $R=0.664$ ;  $p=0.00$ ) and between 8-foot up and go test and BBS ( $R=0.653$ ;  $p=0.00$ ). A weak positive correlation was also found between 30s chair stand test and BBS ( $R=0.475$ ;  $p=0.00$ ). DISCUSSION The results of the 8-foot up and go test ( $>8.5$  seconds) indicate that this population was at risk of falling (Rose et al, 2002). In addition, BBS scores showed that the risk of falling was 11% (Muir et al, 2008). Lower limbs strength was decreased compared with reference values for Portuguese population (Marques et al, 2013). Assessment of these factors seems to be recommended in order to develop and implement strategies directed to increase lower limbs strength, balance and mobility and decrease the risk of falling. References Marques EA, Baptista F, Santos R, et al (2014). Normative functional fitness standards and trends of Portuguese older adults: cross-cultural comparisons. *J Aging Phys Act*, 22(1):126-137. doi:10.1123/japa.2012-0203. Muir SW, Berg K, Chesworth B, Speechley M (2008). The use of the Berg Balance Scale for predicting multiple falls in community-dwelling elderly people: a prospective study. *Phys Ther*, 88: 449-459 Rose DJ (2010). Fallproof - A Comprehensive Balance and Mobility Training Program. Champaign: Human Kinetics beatrizdfernandes@gmail.com

## THE EFFECTS OF KINESIO TAPING IN PROPRIOCEPTION FOR PITCHERS WITH GLENOHUMERAL INTERNAL ROTATION DEFICIT

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Introduction Throwing movement that performed by pitchers is a kind of overhead sports. According to previous studies, repeated throwing often resulted in increased external rotation and decreased external rotation of pitchers' shoulder and anterior capsule laxity which may cause shoulder problems such as impingement, instability, labrum lesion etc. Proper movement control by improving proprioceptive sense has become an important issue for pitchers to prevent injuries. Therefore, the purpose of this study was to exam the effects of Kinesio taping in shoulder proprioception among pitchers with glenohumeral internal rotation deficit. Methods Twenty-one Right handed male pitchers (age from 18 to 22) with right shoulder internal rotation limitation and regular training were recruited and randomly relocated to control (n=10) and Kinesio taping (n=11) group (KT group). Participants in KT group were taped by using Kinesio tape which aimed to improve shoulder internal rotation limitation. All subjects received joint position sense error (JPS error) test and force sense error (FS error) test before and after taping to detect proprioceptive difference between groups. Results Kinesio taping showed no significant effect in joint position sense and force sense for pitchers with glenohumeral internal rotation deficit ( $p>.05$ ). Discussion The findings of this study indicated that a superficial stimulation e.g. Kinesio taping may not enhance proprioception for pitchers with glenohumeral internal rotation deficit. A possible explanation is that proprioception is a complex sensory system, the receptors scattered in cutaneous, muscle, capsule etc., but taping is only applied on skin that may not have enough stimulation for proprioception. References Aarseth LM, Suprak DN, Chalmers GR, Lyon L, Dahlquist DT. (2015). *J Athl Train*, 50(8), 785-91 Bigliani LU, Codd TP, Connor PM, Levine WN, Littlefield MA, Hershon SJ. (1997). *Am J Sports Med*, 25(5), 609-13. Lin JJ, Hung CJ, Yang PL. (2011). *J Orthop Res*, 29(1), 53-7. Zanca GG, Mattiello SM, Karduna AR. (2015). Kinesio taping of the deltoid does not reduce fatigue induced deficits in shoulder joint position sense. *Clin Biomech*, 30(9), 903-7. \*Contact Hsiao-Yun Chang, email: yun1130@csmu.edu.tw

## THE EFFECT OF AROMATHERAPY ON DELAYED ONSET MUSCLE SORENESS

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Delayed onset muscle soreness describes muscle pain and tenderness that typically develop several hours post-exercise and consist of predominantly eccentric muscle actions, especially if the exercise is unfamiliar. The purpose of this study was to examine the effects of plain carrier oil massage and aromatic massage on delayed onset muscle soreness using a within-subjects cross-over design. Nine healthy young males performed an exercise protocol designed to induce delayed onset muscle soreness on their non-dominant arms on 3 separate occasions; each occasion was separated by at least two weeks. The protocol consisted of 3 sets of 10 maximal eccentric repetitions of the elbow flexors exerting isokinetic dynamometry. Subjects were randomly assigned to a carrier oil massage group, aromatic massage group or control group and received treatments 20 minutes post-exercise, 24 and 48 h post-exercise. Creatine kinase (CK), lactate dehydrogenase (LDH), myoglobin (Mb), range of motion (ROM), limb girth and muscle soreness index were measured pre, 20 minutes post, 24, 48 and 72 h post-exercise. Significant time effects were observed for CK, Mb, ROM, limb girth and muscle soreness index ( $P < .05$ ). There were no significant differences between treatments. Compared with control group, carrier oil massage and aromatic massage are also ineffective in reducing CK, LDH, Mb or muscle soreness index. In addition, no significant effects of carrier oil massage and aromatic massage on recovery of ROM or limb girth were found within 72 hours. Conclusion: both carrier oil massage and aromatic massage have no significant effect on the symptoms of delayed onset muscle soreness.

## INFLUENCE OF HIP ABDUCTOR FATIGUE ON TRUNK AND LOWER EXTREMITY MECHANICS DURING SINGLE-LEG LANDING IN FEMALES

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Introduction Because hip abductor strength is associated with lower extremity mechanics, especially knee adduction angle during weight-bearing activities, weakness of hip abductor is thought to increase the risk of anterior cruciate ligament (ACL) injuries (Jacobs CA, 2005; Chaudhari AM, 2006). However, there are a few studies that have investigated the influence of reduced hip abductor strength on trunk and lower extremity mechanics during single-leg landing in the experimental setting. The present study aimed to examine the changes in trunk and lower extremity mechanics during single-leg landing occurring due to hip abductor fatigue. Methods Fifteen young females participated (age,  $21.5 \pm 0.7$  years). Single-leg landing mechanics was examined in the subjects before and after a hip abductor fatigue protocol. This protocol comprised repetitive isokinetic hip abduction using a dynamometer. During this protocol, hip abduction was repeated until the hip abduction torque decreased to less than 50% of the maximal strength, 5 times in a row. A 3-dimensional motion capture system with 8 cameras and a force plate were used to record a single-leg landing. Reflective markers were attached to the trunk, pelvis, and lower extremity of the subjects based on the Vicon plug-in-gait marker placement protocol. Each subject performed



3 single-leg landings from a 30-cm height before and immediately after the hip abductor fatigue protocol. The maximal value of trunk, hip, and knee kinematics and kinetics, and vertical ground reaction force during the initial contact to maximal knee flexion were analyzed. A paired t test was performed to compare the pre- to post-hip abductor fatigue protocols for each dependent variable of interest. Results The maximal hip abductor strength decreased by 27% due to the hip abductor fatigue protocol. The peak external hip adduction moment decreased and peak trunk ipsilateral bending angle increased during the landing trials after the hip abductor fatigue protocol. No other significant kinematic and kinetic changes were observed between the pre- and post-hip abductor fatigue protocols. Discussion Increase in trunk ipsilateral bending due to hip abductor fatigue transfers the center of gravity of the upper body close to the hip joint, which might contribute to decreasing the external hip adduction moment and preventing an increase in the knee abduction angle. In an actual sports situation, it is thought that the risk of ACL injury associated with knee abduction increases if compensatory motion such as trunk lateral bending is restricted. References Jacobs CA, Mattacola CG. (2005). J Sport Rehabil, 14, 346-355. Chaudhari AM, Andriacchi TP. (2006). J Biomech, 39, 330-338.

### THE IMPACT OF COLD WATER IMMERSION ON BRAIN DERIVED FACTOR AND ABILITY TO CONCENTRATE AMONG HIGH TRAINED ATHLETES.

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**Introduction** Cold water immersion (CWI) is applied in order to support regeneration after training. The effect of this procedure on "mental" recovery, however, has not been studied. Thus we investigated the impact of CWI on ability to concentrate after a high-intensity randori judo training (RT). We hypothesized, that the improvement in mental concentration will be associated with changes in irisin and BDNF level. Basing on the observation that the axis between irisin and BDNF is present in response to exercise (Wrann, White et al. 2013), we assumed that the coldness will be additional factor stimulating irisin release. **Methods** Fourteen professional judoists performed a randori training (RT) followed by a coldness exposure-supported recovery or a simple rest in case of the cold water treatment (CWG; 8°C, 4-min immersion) and control group (CG), respectively. Group assignment was a randomized controlled crossover. After one week the groups swapped and repeated the whole experiment. Each time, after 1h of recovery the ability to concentrate was tested using the Grid Exercise Test by Harris. Blood samples were collected at rest, 1h and 12h after training. **Results** The recovery supported by CWI did not significantly influence the scores in Grid Exercise Test. Interestingly, CWI induced the anti-inflammatory response (increase IL-10), however, the effect dissipated within 12h. The values of BDNF recorded 1h after training and CWI slightly dropped in comparison to the baseline ( $9.20 \pm 3.2$  vs  $8.46 \pm 2.8$  ng·mL<sup>-1</sup>). Its concentration was reduced among 12h after RT ( $5.07 \pm 3.0$  ng·mL<sup>-1</sup>). The similar tendency was observed in control group, however the drop was much more pronounced ( $10.8 \pm 3.02$  at rest vs  $4.09 \pm 1.9$  12h after RT,  $p < 0.05$ ). Directly after training and CWI significant correlation between BDNF and HSP27 was noted ( $r = 0.87$ ,  $p < 0.05$ ). The high-intensity randori judo training caused the rise of blood HSP27, but CWI treatment had any effect on it. **Discussion** Obtained results did not confirm our assumption that CWI improves the ability to concentrate. Moreover, despite the exhausting exercise, we did not observe "mental" fatigue. CWI slightly changed the irisin concentration but significantly diminished the BDNF level. Interestingly in CWI, those athletes, who were characterized by an elevated concentration of HSP27 after the RT had the highest concentration of BDNF. In conclusion these data indicate that although the lack of influence of CWI on ability to concentrate, this procedure may have positive impact on proteins responsible for "mental" fatigue. Wrann, C. D., J. P. White, et al. (2013). Cell Metab 18(5): 649-659. jaworska.joanna12@gmail.com

### NAVICULAR DROP IS ASSOCIATED WITH FLEXOR HALLUCIS BREVIS THICKNESS IN COMMUNITY-DWELLING OLDER ADULTS

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**Introduction** Excessive foot pronation and flat foot are common foot problems in older adults (Pita-Fernández et al., 2015). Generally, navicular drop is associated with these foot problems, so its mechanism should be clarified to prevent the progression. It is thought that intrinsic foot muscles may play an important role in the mechanism, but its role is poorly understood. The purpose of the present study was to investigate the relationship between the thickness of intrinsic foot muscles and navicular drop in older adults. **Method** Ninety-three adults from the community aged over 65 participated in the present study. The navicular height was measured on the right foot with three-dimensional foot scanner at sitting and standing positions. Using this data, the navicular drop was calculated as the change ratio in navicular height from sitting to standing position. The thickness in the potential contributing intrinsic foot muscles, which are flexor hallucis brevis and flexor digitorum brevis were measured on the right foot using ultrasonography, as previously described (Mickle et al., 2013). The multi-regression models were applied to examine the navicular height at sitting and standing positions, and the navicular drop in relation to the thickness of both intrinsic foot muscles. **Results** The flexor hallucis brevis thickness was significantly associated with the navicular drop and the navicular height at standing position but not at sitting position after adjusting for potential confounders. On the other hand, the flexor digitorum brevis thickness was not significantly associated with the navicular drop in the all multiple regression models. **Discussion** Our results indicate that the function of flexor hallucis brevis may have a strong link to navicular drop in foot in older adults. Thus, flexor hallucis brevis may have an important role for preventing excessive foot pronation or flat foot. **References** Pita-Fernández S, González-Martín C, Seoane-Pillado T, López-Calviño B, Pêrttega-Díaz S, Gil-Guillén V (2015). Validity of footprint analysis to determine flatfoot using clinical diagnosis as the gold standard in a random sample aged 40 years and older. J Epidemiol. 25(2):148-54. Mickle KJ, Nester CJ, Crofts G, Steele JR (2013). Reliability of ultrasound to measure morphology of the toe flexor muscles. J Foot Ankle Res. 6(1):12. Contact Yoshihiro Fukumoto, Email: fukumoto@reha.kobegakuin.ac.jp

### THE INTERDISCIPLINARY BETWEEN OCCUPATIONAL THERAPY AND PHYSICAL EDUCATION

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Occupational therapy (OT) works with human life and acts in daily life and quality of life of the subject as well as Physical Education (EF), has human life as a performance target and make use of various tools. Among the tools the Activities of Daily Living (ADLs) deals with the individual-activity-environment, and the way in which the subject meets their basic and personal needs and how to organize their daily routine (sanitize, dress, food). Moreover, it is relevant to mention the psychomotor development with the technical working autonomy and independence of the subject, which directly affects the quality of life. You are talking about two professions united by one work object:

human life. Because it is something unique, each person is unique, this jobs created to care for human life. It is making you reach satisfaction and quality of life, as are professionals who develop the human's science health and all your senses. Therefore, the OT and PE relate when they treat the human considering its peculiarities, economic factors, psychological, social, religious, cultural and especially biological / physical. Thus, from the link, they are professionals who build on their potential great skills. Specifically, the rehabilitation, the OT has the particularity of activity analysis as a tool, because from it you can categorize with purpose and method which must be submitted to greater objectivity and quality, to the subject. Considering rehabilitation as the improved performance of the functional capabilities of the human body by permanent or temporary reasons is unable to carry out their activities, among them, ADLs, work and leisure, we have that is the health care that instrumentalizes relationship / interaction of the individual and their role / environment (1). With everything, it can be concluded that the OT and the PE should work as a team, because they have the same object of work and both of them use of additional working tools. Like this, there are immeasurable gains for people who enjoy and / or need these professionals. Thus, as to the actual advancement of professions, since the more the sciences communicate higher are launched flights for evidence-based practice. Reference: 1. Neistadt ME, Crepeau EB. Occupational Therapy. Traduzido por Willard & Spackman. Terapia Ocupacional. Nona edição, Rio de Janeiro, 2002.

## DEVELOPMENT OF AIR INJECTABLE HARNESS FOR IMPROVED COMFORT AND LOADING PRESSURE DISTRIBUTION

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1. Introduction The harness supports body primarily for fall prevention and it typically consists of a hip belt and shoulder straps with only minimal padding. They are 'one size fits all' and not truly customizable to fit the individual body. Therefore, the need for a more comfortable harness has been indicated through previous studies because current harnesses have many problems such as activity restriction and insufficient support of wearer's body. In the development of the harnesses for performance, entertainment and rehabilitation, the distribution of the load pressure, wearing sensation and convenience are an important research theme. The object of this study is to develop and evaluate a more comfortable harness. It was hypothesized that advanced design, using the air injectable pads would reduce loading forces. 2. Methods Three types of harnesses were newly designed based on generally used harness. In the new-type of harnesses, multi-layer air injectable pads developed using hollow fibers and the 3D spacer fabrics were applied. The size, number and position of the pads can be chosen depending on the type of the harness. The load pressure exerted from the harness to the body was measured by sensor strips (Pliance sensor S2148, Novel GmbH, Sensing area 160x40mm<sup>2</sup>, Pressure range 15~600kPa, Number of sensors 64ea) which were placed under both sides of wearer's thigh. A comparison of force and peak pressure between the different type of the harnesses with or without air injectable pads was made. 3. Results and Discussion The mean pressure and peak pressure were significantly reduced with the air injectable pads inside the harness. Loading pressure of the new -type harness decreased considerably when the air injectable pads were placed on thigh and abdomen. Peak pressure reduced by 55% and mean pressure reduced by 12% with the air injectable pads. The sensor loading area increased because the air injectable pads properly fitted to the body shape. 4. Conclusions Distribution of the load pressure exerted from the harness is the decisive factor that has great impact to the conventional harness. The general harness appears too much loading on hip belt and shoulder straps and this can become uncomfortable, and should make every endeavor to reduce discomfort and potentially damaging forces. In this study air injectable pads were applied to solve the fitting problems of existing harnesses. The air injectable pads individually fit along the wearer's body by multi-layer structure consisted of polyester foam and 3D spacer fabric at first. Additionally, injection of air can provide enough cushioning and support body. Therefore the pain by pressure concentration can be reduced and improved comfortable wearing sensation. It is expected that ergonomic design of the harness will possible to ensure comfort and support to the wearer's body. 5. References Novotny, Sara C., et al. 'A harness for enhanced comfort and loading during treadmill exercise in space.' Acta Astronautica 89 (2013): 205-214. \*Contact happyknh@kitech.re.kr

## RESEARCH IN THE FIELD OF PHYSIOTHERAPY

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Introduction The field of Physiotherapy (PT) has gone through major changes in the recent years. Some countries followed Australia and adopted direct access (DA) others allow DA only in a private setting and finally, other countries do not allow DA at all (1, 2). Although experience appears to show an overall benefit for patients and health care systems in terms of care and cost effectiveness (3, 4) intense discussions about DA are still enduring. This study provides an important new argument to the debate by measuring the productivity of science and research based on the output of research papers in PT and related fields. Methods The database SJR (5) was used to extract the amount of globally published papers in PT, Sport Science and other disciplines from 1999 to 2014. The rate of citations per article was analyzed and the contribution of over 10 western countries evaluated and compared. Results In PT related research the rate of published papers steadily increased from approximately 4000 to 12000 and in "Sport Science" from 7000 to 16000 from 1999 to 2014. Thus, these fields outnumber medical disciplines and importantly increase at a faster pace. Similar results were obtained regarding the impact evaluated by number of citations each article generated. This hints overall to a large innovative potential within PT and Sport Science, respectively. Remarkably, corresponding numbers of "Molecular Biology" remained almost unchanged from 1999 to 2005 to then increase almost exponentially. These data demonstrate that molecular biology is representing a growing part within the life sciences and will most likely impact PT related research progressively. The country comparison revealed that in terms of quantity and impact countries with DA, such as Australia, Sweden and the Netherlands outperformed others with limited DA, such as, Austria, Spain and Germany manifold. Evaluations of other disciplines suggest that the low contribution appears to be specific for the field of PT. Whether the level of college education and status of DA are causative for these differences remains speculative. Discussion The data imply that the growing body of knowledge within PT necessitates highly trained professionals to maintain clinical care. The data support the hypothesis that countries allowing DA outperform countries still banning DA in PT related research and advocate, in line the WCPT, the introduction of DA. Hence, these data provide helpful arguments in a complex discussion about the status of DA and physiotherapist education. References 1. Galley et al. 1977 2. Bury et al. 2013 3. Holdsworth et al. 2007 4. Ojha et al. 2013 5. SCImago, 2007 SJR, SCImago Journal & Country Rank. Retrieved November 16, 2015 from <http://www.scimagojr.com> Contact Gerd.Bungartz@hs-fresenius.de

## CAN MCCONNELL TAPING OR SERF STRAP AFFECT PLANTAR LOADING PATTERNS OF THE REARFOOT IN ADULTS DURING WALKING AND JOGGING?

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**Introduction** Patellofemoral pain syndrome (PFPS) is a common pathology of the knee accounting for 30% of all knee injuries (Anloague, 2011) and can be found in both athletic and nonathletic population (Kowall et al., 1996). There are limited research studies assessing effects of McConnell taping (medial patellar taping) and the stability through external rotation of the femur (SERF) strap (Don Joy Orthopedics Inc, Vista, CA) on rearfoot plantar loading patterns. The aim of this study was to investigate effects of McConnell taping and SERF strap, which are treatment methods for PFPS, on rearfoot plantar loading patterns in healthy adults during walking and jogging. **Methods** Twenty-three participants (12 males and 11 females, age: 26.52(6.43) years) were recruited in the study. All participants were tested in 2 functional activities which were walking and jogging under 3 conditions: 1) no tape, 2) McConnell taping, and 3) SERF strap randomly. Data (maximum pressure of medial (MH) and lateral heel (LH), contact area of MH and LH, initial heel contact, foot axis angle, and center of pressure (COP)) were collected using a 2 m footscan pressure plate (RScan International, Belgium). During the study, each participant was instructed to walk and jog on the pressure plate at their own natural pace. **Results** There was a statistically significant difference of maximum pressure of LH during walking ( $p = 0.011$ ) which the SERF strap condition had higher maximum pressure than the no-tape condition (SERF: 7.46(2.14) N/cm<sup>2</sup>; no tape: 7.01(1.23) N/cm<sup>2</sup>,  $p = 0.006$ ). However, significant differences of other variables were not found. **Discussion** Excessive rearfoot pronation is frequently associated with PFPS development (Barton et al., 2011). In the present study, maximum pressure of LH while wearing the SERF strap was significantly higher than one of LH with the no-tape condition ( $p = 0.011$ ) during walking. The possible reason was that the SERF strap pulled the femur and the tibia laterally so it reduced pronation of the foot and the lateral loading of the rearfoot increased. The further study should focus on the SERF strap and McConnell taping on plantar pressure in patients with PFPS compared to healthy people. **References** Anloague PA. (2011). J Appl Res, 11(2), 97-104. Kowall MG, Kolk G, Nuber GW, Cassisi JE, Stern SH. (1996). Am J Sports Med, 24(1), 61-66. Barton CJ, Levinger P, Webster KE, Menz HB. (2011). Gait Posture, 33, 286-291. Contact sp620@kent.ac.uk

## STEPPING EXERCISE ON PHYSICAL PERFORMANCE IN THAI ELDERLY: A RANDOMIZED CONTROLLED TRIAL

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**Introduction** Elderly people are increasing continuously in several countries. Anatomy and physiology of the elderly may change and reduce physical performance. This study was investigated the effect of stepping exercise and physical performances in Thai elderly. **Methods** Forty-two subjects were divided into two groups. The control group ( $n=21$ ) did not undergo stepping exercise but received health education and remained their activity daily livings. The experimental group ( $n= 21$ ) received stepping exercise program for 3 times per week, 60 min per time for 8 weeks. All subjects were measured baseline characteristic and physical performance before and immediately after the program. **Results** Six minute walk test (6MWT), functional reach test (FRT), time up and go test (TUGT), and five times sit to stand test (FTSST) in the control group were not significantly different after program. In contrast, the subjects in the experimental group showed significantly increased of the scores of 6MWT ( $p<0.001$ ), FRT ( $p=0.004$ ) and also showed significantly decreased of the scores of TUGT ( $p<0.001$ ) and FTSST ( $p<0.001$ ). **Discussion** This study showed that stepping exercise improves physical performances (6MWT, TUGT, and FRT) in healthy elderly subjects with a shorter period of intervention at 8 weeks. Similarly to other aerobic exercises, 6MWT was significantly increased from the baseline after stepping exercise and also significantly different from the control subjects. Female subjects with average age of 65 had longer 6MWT with a 6-week course of Thai dance compared with control subjects (416 vs 345 m), while COPD patients also had longer walking distance after training exercise (381 to 487 m) (Janyacharoen et al., 2011; Janyacharoen et al., 2013). These 6MWT improvements were explained by aerobic exercise in the elderly and also COPD patients (Borghi et al., 2009). At the end of study, both TUGT and FRT in control subjects were significantly worse than the baseline. These data indicated that mobility and stability were improved by stepping exercise and worsen without exercise in the duration of 8 weeks. We had unexpected results of the non significant improvement of FTSST. This may not conclude that stepping exercise did not improve physical fitness of lower extremities because the improvement had a trend of improvement when compared with the control subjects ( $p$  value  $< 0.08$ ). Further studies with longer study duration may be needed. In conclusion, stepping exercise is appropriate for the healthy elderly subjects. Physical performance significantly improved after the 8 week-course of stepping exercise. **References** Janyacharoen T, Chaichanawongsa J, Namsiri S, Thongduang Y, Arayawichanon P. (2009). Chula Med J, 55(1), 29-38. Janyacharoen T, Laophosri M, Kanpittaya J, Sawanyawisut K, Auvichayapat P. (2013). Clin Intervention in Aging, 8, 1-6. Borghi SA, Arena R, Castello V et al. (2009). Respir Med, 103(10), 1503-1510. Contact taweesak@kku.ac.th

## VALIDITY AND RELIABILITY OF THE FRENCH TRANSLATION OF THE PATIENT-RATED TENNIS ELBOW EVALUATION QUESTIONNAIRE

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**Background:** The lateral elbow tendinopathy is a common injury in tennis players and physical workers. The Patient-Rated Tennis Elbow Evaluation (PRTEE) questionnaire was created to measure pain and functional disabilities specifically reported in patient with lateral epicondylitis (tennis elbow). Developed in English, this questionnaire has since then been translated into several languages but not in French. **Objectives:** The aims of the study were to translate and cross-culturally adapt the PRTEE questionnaire into French and to evaluate the reliability and validity of this new version of the questionnaire (PRTEE-F). **Methods:** The PRTEE was cross-culturally adapted into French according to the international guidelines. To assess the reliability and validity of the PRTEE-F, 115 participants filled in the PRTEE-F twice, and the Disabilities of Arm, Shoulder and Hand questionnaire (DASH) and the Short Form Health Survey (SF-36) once. Internal consistency (with Cronbach's alpha), test-retest reliability (with intra-class correlation (ICC)), convergent and divergent validity (by calculating the Spearman's correlation coefficients with the DASH and some sub scales of the SF-36, respectively) were assessed. **Results:** The PRTEE was translated in French without problem. PRTEE-F showed a good test-retest reliability for the overall score (ICC 0.83) and for each items (ICC 0.71-0.9) and a high internal consistency (Cronbach's alpha = 0.98). The correlation analyses revealed high correlation coefficients between PRTEE-F and DASH (good convergent validity) and, as expected, a low or moderate correlations with the divergent subscales of the

SF-36 (discriminant validity). There was no floor or ceiling effect. Conclusions: The PRTEE questionnaire was successfully cross-culturally adapted into French the PRTEE-F is reliable and valid for evaluating the French-speaking patient with lateral elbow tendinopathy.

### THE ASSOCIATION BETWEEN LOWER LIMB FORCE GENERATION AND STRENGTH PRODUCTION IN ANTERIOR CRUCIATE LIGAMENT RECONSTRUCTED PATIENTS

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Background: Muscular power has been considered as one of the essential elements of dynamic athletic performance, especially in sporting occasions that involve high force generation in a short period of time (1). Moreover, Lower extremity muscular strength is often assumed to reflect and affect overall performance. One example of this is that there is a positive relationship between isokinetic muscle strength and hop performance during single-leg hop tests (2). However, there is lack of literature exploring the relationship of lower limb force generation with muscles strength tests which might have a role in overall performance. This will inform the specialists about what are the suitable tests should be used to explain lower limb function. Therefore, the aim of this study is to investigate the association between lower limb force generation tests using FT 700 and knee muscles strength test (quadriceps & hamstring) using Biodex System 4 in ACLR patients. Design & Setting: A correlation study undertaken in the Human Performance Laboratory at the University of Salford. Participants: 16 ACL reconstructed (6-9 post-operative) patients, 9 males and 7 females, were recruited (age  $22.31 \pm 3.37$  years; height  $179 \pm 9.71$  cm; and mass  $78.31 \pm 11.83$  kg). Interventions: Two different tests have been undertaken on both legs (injured & non-injured): 1- Force tests: include ten consecutive vertical jumps and the unilateral stance isometric mid-thigh pull (IMTP). 2-Isokinetic muscle strength tests: of quadriceps and hamstring muscle testing. All of strength tests were performed in concentric muscle action only. Main Outcome Measurements: 1-Force tests: six variables (in concentric phase) for ten jumps test which were: maximum rate of force development (RFD), peak force, peak power, peak velocity, time to peak force, and time to peak power. While six other variables (in concentric phase) for IMTP test which were: maximum RFD, peak force, impulse 0-100ms, impulse 0-200ms, impulse 0-250ms, and impulse 0-300ms. All force tests were undertaken using FT 700. 2-Isokinetic muscle strength tests: three different variables were collected in concentric phase, peak torque, peak torque to body weight, and the total work to body weight using Biodex System 4. Results & Conclusion: The majority of quadriceps strength parameters relate to peak force during 10 jumps test. Hamstring strength would appear to relate to peak force, peak velocity, time to peak force, and time to peak power during 10 jumps test. Strength in both quadriceps and hamstring does not appear to correlate to any force parameters during isometric mid-thigh pull test for either injured and non-injured limbs.

### Sociology

### CHANGING DISCRIPTIONS OF THE CONCEPT OF SPORT FOR PEOPLE WITH DISABILITIES: A COMPARISON BEFORE AND AFTER A DISABILITY-INCLUSIVE SPORT CLASS

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Introduction In the fields of education, sport and social work in Japan, the concept of sport has often been discusses. Over the past several years, although many researchers have shown an interest in disability sport, little studies have been conducted to explore the view-point of sport for people with disabilities. Therefore, the aim of this study is to examine the change descriptions of sports for people with disabilities. Methods The subjects of this study were ninety university students who participate in disability-inclusive sports. The purpose of this investigation is to ascertain factors of sports for people with disabilities (physical, intellectual and mental). Questionnaire were prepared to investigate this, and were administered to students at the start and end of each disability-inclusive sports class. Their sentence data were analyzed by using language analysis software (KH Coder). The whole picture and relationships among the factors were visualized using a co-occurrence network and correspondence analysis. Results The results showed that attitudes changed about which sports the students believed were suitable for people with disabilities (physical, intellectual and mental). Discussion At the start of the classes, the language used for talking about sports for people with intellectual disabilities were similar to those for people with mental disabilities. However at the end of the classes, it appeared that there were differences in the language used to talk about sport for people with intellectual disabilities and people with mental disabilities. The words used when referring to sport for intellectual disabilities changed from "health" and "difficult" to "power," "grow," and "change"; and those for mental disabilities from "mood" and "difficult" to "rehabilitation," "affirmation," and "positive". Furthermore, those for people with physical disabilities changed from "physical," "enjoyment," and "recreation" to "life" and "win." Considering these matters, before the classes there was a description concerning extrinsic value, and after the classes concerning intrinsic value. It is necessary to consider integrating their shift in response toward the intrinsic value of a disability sport curriculum. Japanese researchers have tended to distinguish the concept of sport between "lifelong sport." To evolve, the sports for people with disabilities must place emphasis on intrinsic value of sport. A further study of how people with disabilities replied to the questionnaire should be conducted. It is hoped that the outcome of the present study would be of some use to develop a curriculum of sport trainers for disabled people.

### INVESTIGATION OF JAPANESE GIRLS' NONPARTICIPATION IN SPORTS AND PHYSICAL ACTIVITY

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Introduction Recently, Japanese female athletes have begun to actively participate in national level sports. For instance, the female soccer team won their first gold medal in the 2011 FIFA Women's World Cup, and the female volleyball team won a bronze medal in the London Olympics for the first time in three decades. However, female sports in Japan are currently encountering various problems, a major one being that many girls give up sports and physical activity citing a long list of reasons such as relationships, dieting, intense training, etc. (Yumiko, 2012; Michio, & Kazuyoshi, 2012; Mayumi, 2001). The objective of this study was to examine nonparticipation rates, involvement, and interest in female sports and physical activity. Methods The study's research was based on a focus group of adolescent girls, aged 13-17 years (n=477), and investigated their perspective of sports and physical activity (e.g., interest, involvement, and frequency) and self-efficacy. Boys were also included in the study as was convenient for the analysis, though the girls were the main focus. The data were statistically analyzed using SPSS version 19 for the students' t-test and Chi-square test. Results 1) A number of girls give up sports and



physical activity (excluding physical education) when transferring to high school (from 14 to 15 years old). 2) Girls do not participate in sports and physical activity because they dislike it. 3) Many girls have never performed sports and physical activity because they did not like it. 4) Self-efficacy had a significant relationship with nonparticipation and participation (e.g., items such as confidence and positive attitude). Participation was significantly higher than nonparticipation (e.g., confidence,  $t=4.47$ ,  $P<.01$ ). 5) Boys' participation in sports and physical activity was significantly higher than that of girls, and a number of boys were trying to continue participation after transferring to high school ( $\chi^2=23.9$ ,  $P<.000$ ). Conclusion We found that many girls gave up sports and physical activity or had never done either, the most common reason being that girls did not like them. It is important that girls gain some experience in sports and physical activity, some interest, and parental advisement in childhood. On the other hand, many boys have experience in at least one sport or physical activity, and girls' experience was significantly lower than that of boys. Reference Mayumi, N. (2001). Comparison of Knowledge and Behavior of Health Among Female High School Students in 1992 with Those in 2000, Bulletin of Japanese Red Cross College of Nursing, 15, 60-69 Michio, A., Kazuyoshi, S. (2012). A Study of Negative Attitudes towards Physical Activity, Bulletin of Shukutoku Junior College, 42, 17-31 Yumiko, S. (2012). A Study of A Place Where One Psychologically Fits in or Belongs Among Japanese High School Girls, Japan Academic Association of Socio-Education and Service Learning, 20, 107-115 Contact sato@bss.ac.jp

## Sport Management and law

### THE IMPLEMENTATION OF THE ADVANCED APPRENTICESHIP IN SPORTING EXCELLENCE IN THE UK

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**Introduction** It is increasingly recognized that helping talented student-athletes to cope with their educational/career development and sporting performance is one of the most commonly encountered issues in different countries. In the UK, the Advanced Apprenticeship in Sporting Excellence (AASE) which is a sports performance program established in 2004, is a government backed partnership between talented young athletes (aged 16-19), families, coaches, educational institutes, NGBs. It is recognized as an exemplar model of families' support which contributes to student-athlete training and competing support to develop and reach their maximum potential, whilst at the same time continuing their education/career development. **Objectives** This discussion is about elite sport and primarily about how the UK provides lifestyle support for the talented young athletes with a concern of major contributions of implementing the AASE. **Materials & Methods** The empirical research was conducted between November 20th to 29th, 2014 and November 5th to 17th, 2015. It consisted of eight in-depth interviews including AASE administrators, college teachers, parents, coaches, athletes. The interview data are supplemented by analyses of British government policy documents, academic articles, media publications etc. **Results & Discussion** In 2004, the SkillsActive, NGBs and industry experts administered an AASE program which serves talented young athletes as an initiative to receive the support and training for pursuing the success in elite sport. Athletes can complete the AASE through one of two pathways (Pathway one, Pathway two) and four requirements (Functional skills, Personal learning and thinking skills, Employee rights and responsibilities, Exemption from the mandatory employment). The major services/units were provided through the AASE program, namely, technical skills, tactical skills, physical capability, nutrition psychological skills, lifestyle management, career planning, health and safety, communicating as an athlete (SkillsActive, 2016). In our study, it shows that AASE administrators, college teachers, parents, coaches, and athletes acknowledged the implementing AASE aids athletes to achieve excellence in their sport as well as to prepare academic/career development. **Conclusions** The AASE introduced in 2004 has been formalized and extended. To some extent, delivery of the AASE has met those 'needs' of government, NGBs, schools, families, coaches and talented young athletes in some elements. From the relevant stakeholders' perspectives, this implies that such a scheme is able to assist talented young athletes balance other aspects of their sport training and competing with counting education/career development. And, the major contributions/implications of the AASE are concluded as the followings: well-equipped facilities, parent's support, quality coaching, and athlete education/career development. **References** SkillsActive. (2016). AASE. Retrieved from: <http://www.skillsactive.com/standards-quals/apprenticeships/aase>

## Sport Statistics and Analyses

### SURVEY ON AWARENESS ABOUT SPORTS AND IMPLEMENTATION STATUS OF SPORTS ACTIVITY AMONG VISUALLY IMPAIRED PEOPLE IN JAPAN

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**Introduction** Continuation of sports and exercise is paramount in maintaining and improving the health of individuals with visual impairments, and also in maintaining their quality of life. The purpose of this study is to prepare basic data for ascertaining the attitudes of individuals with visual impairments toward sports activities, and understanding the extent to which such individuals are carrying out these activities. **Methods** The Participants in this study were 515 individuals (40.1±13.8 ages) who have visual impairments. We conducted an anonymous questionnaire survey. We delegated the implementation of the survey to an online survey company. We recruited the participants from a list of monitors owned by the online survey company. The survey items included Participants of the attribute, awareness of sports activities, implementation status of sports activities. **Results** 53.2% of the participants had a severe visual impairment. Of the total participants, 78.0% answered that sports activity is essential, or essential to some extent. 30.1%, the highest proportion, answered that they participated in sports/exercise once or twice a week. The type of activity with the largest proportion of responses was walking at 65.8%. Most of the participants (71.6%) cited "to build health/physical strength" as the reason for participating in sports or exercise. As for the reasons for not participating in sports or exercise, "because of eyesight issues" had the largest proportion of responses at 35.9%. Most of the participants (57.0%) answered that they rely on their family or relatives for getting to the venue. **Discussion** Previous studies have investigated the sport implementation rate of adult and disabled people. This result suggests that the rate of sports engagement among individuals with visual impairments is lower than that of the general adult population, but higher than that of adults with a disability. The reason for participating in sports or exercise that was most frequently cited by the individuals with visual impairment was "to build health/physical strength." This finding suggests that those with or without disabilities alike share an interest in health, and that people with visual impairments engage in relatively simple sports like walking and calisthenics to a similarly frequent extent as those in the general adult population. As for the reasons for not participating in sports or exercise, "eyesight issues" was the most frequently

cited reason. Other than "eyesight issues," the reasons for not participating in exercise were the same as the top reasons in the results of the survey conducted on adults. This finding suggests that when it comes to sports and exercise, the visual impairment factor is both particular to individuals with visual impairments and is also the greatest factor inhibiting them from engaging in sports and exercise.

### DIFFERENCES IN DIETING METHODS BETWEEN GENDERS AND JAPANESE AND ASIAN OVERSEAS STUDENTS

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**Introduction** These days, many young people are overly obsessed with being slim. This had caused the issue of excessive or inappropriate dieting behaviors. How an individual diets depends on their gender and nationality, which also affects cultural norms and thoughts related to the body and health. This study aimed to investigate the differences in dieting methods between young men and women and between Japanese and Asian overseas students. **Methods** Based on Matsumoto et al. (1997), a questionnaire survey consisting of 22 items about dieting methods was conducted with 1003 Japanese and Asian overseas students at N-university in January 2015. The 463 students (162 Japanese and 301 Asian overseas students; 293 males and 170 females) who indicated that they had previous dieting experience were included in the analyses. Students were asked to choose one response out of the following four options: "I am doing it now (now)," "I did it in the past (past)," "I have never done it but I am interested in it (interest)" and "I am not interested in it (never)." After the responses were categorized into Japanese males, Japanese females, Asian overseas male students and Asian overseas female students, cross tables were created. The tendency was investigated using significantly greater adjusted residuals in the cross table. **Results** Significant differences were found in all items except for two items. Japanese males had the greatest number of significant adjusted residuals with 15 responding "never" among four options, Japanese females with seven responding "past," Asian overseas males with seven responding "Interest," and Asian overseas females with 11 responding "now." If we assume that interest in dieting decreases in descending order of "now," "past," "interest," and "never," it can be said that Asian overseas females had the highest interest in dieting, followed by Japanese females, Asian overseas males, and Japanese males. Greater differences in the interest in dieting method were detected in gender than nationality in seven items, such as "I do not eat sweets or high calorie foods", indicating female predominance. More noticeable differences based on nationality were discovered in three items, such as "I take laxatives in order to lose weight", than those based on gender. Gender difference not found in overseas students but found in Japanese students was detected in three items, such as "I do not eat the recommended foods and drinks because I have become fat." In contrast, gender differences among Asian overseas students were observed in two items including "I restrict my calorie intake", indicating that females had higher interest in dieting method. Contact: aoyagi@cis.fukuoka-u.ac.jp

### RELATIONSHIP BETWEEN KNEE ANGLE IN SQUAT TEST AND DEFENCE OR RECEPTION EFFICACY IN AMATEUR VOLLEYBALL PLAYERS

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**Introduction** Defending and receiving successfully in volleyball is necessary to produce good attacks. The most used technique of defence and reception is dig. It was found that performance of dig influences the performance of spike (Palao et al., 2006). Key points for the effectiveness of dig are anticipation, decision-making, and movement speed. However, it is legit to hypothesize that knee joint angle (KJA) in the starting position of the dig may have an influence on defence and reception efficacy. Therefore, we aimed to investigate the relationship between KJA during an overhead squat test and both defence efficacy (DE) and reception efficacy (RE) in amateur volleyball players. **Methods** Fifteen amateur volleyball players were recruited (20.27±3.08 yrs, 76.60±9.27 kg, 184.53±6.63 cm). Players performed three trials of the NASM overhead squat test (Clark 2001) aimed to detect the minimum knee angle value just before losing inverting the normal lumbar lordosis. The KJA was assessed using Microsoft Kinect™. After that, DE of each player was assessed in response to 15 test spikes performed by the same player, as well as RE was assessed in response to 15 test services performed by the same player (Palao et al., 2015). After checked for the normality of the distributions, Pearson correlation coefficient was calculated between KJA and both DE and RE. A p-value lower than 0.05 was considered statistically significant. Data are presented as means ± SD. **Results** The KJA in the squat test was 103.9±13.4 deg; DE was -41.3±22.9 % and RE was 46.6±20.9 %. Correlations between KJA and DE and KJA and RE were -0.7 (p=0.004) and -0.14 (P>0.05), respectively. **Discussion** The significant inverse correlation between KJA and DE suggests that the players with knee angle lower just before losing the normal physiological lumbar curve had a better efficiency during the defence position. From a speculative point of view, the major depth reached the quality of movement in the squat test reflects a better technical performance the quality of movement in the defensive stance; generally, the squatting depth positively influences the lower-body jumping and postactivation potentiation (Esformes & Bampouras 2013). Conversely, the non-significant correlation of KJA and RE was probably due to the more time from the service to the dig, allowing the receivers more time to prepare the reception. **References** Palao JM, Santos JA, Urena A. (2006). J Hum Mov Stud 51(4), 221-238. Palao JM, Giménez-Ibarra MI (2015). Cent Eur J Sport Sci Med 12(4), 25-34. Clark M. A. (2001). National Academy of Sports Medicine. Thousand Oaks, Ca. Esformes JI, Bampouras TM. (2013). J Strength Cond Res 27(11), 2997-3000. Do not insert authors here

### SCALING OF DEFENSIVE TACTICAL PERFORMANCE FROM TRACKING DATA OF SOCCER GAME

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**Introduction** Game analysis using tracking data in soccer has become popular in the world. However, soccer defensive tactical performance (SDTP) measurements has not analysed sufficiently. The purpose of this study was to construct SDTP variables by using tracking data of a soccer game. **Methods** An official game of J-league in 2015 season in Japan was analysed to measure SDTP. The SDTP variables with content validity were consisted from pressing defence (PDF), retreat defence (RDF) and shoot defence (SDF), using the causal-effect analysis and Delphi method with five experts qualitatively. The SDTP variables were measured from x-y coordinates of all field players during ball lost through ball gain or opponents shoot extracted from the tracking data. Total number of SDTP was 102 plays in a game (44 in PDF, 37 in RDF, and 21 in SDF). PDF and RDF were defined as successful defence, and SDF was defined as unsuccessful. SDTP variables were analyzed using descriptive statistics. Binomial logistic regression analysis was used to analyse the effective correlation of SDTP variables to defensive performance (successful or unsuccessful). The statistical significant level P< .05 was set. SPSS 22 (SPSS Inc., Chicago, USA) was used for analysis. **Results** Distance between ball and the 1st and the 2nd defenders (DFs) at the beginning of defen-

sive play, distance covered by from FW player, distance covered by bottom DF player from the beginning to the end of defensive play, velocity and position of final DF line which distance from own goal line from the beginning to the end of defensive play, area of front five players and area of back 5 players at the end of defensive play were investigated as SDTP variables by Delphi method. Distance between ball and the 1st defender (odds ratio (OR) = 1.502,  $p = .41$ ), and the 2nd DF (OR = .672,  $p = .49$ ) at start of defence, distance covered by FW player (OR = .844,  $p = .48$ ), distance covered by DF player (OR = 1.428,  $p = .007$ ), and position of final DF line (OR = 1.600,  $p = .004$ ) were correlated with the defensive performance, respectively. Discussion The distance between ball and the 1st and the 2nd DFs at the start of defensive play is a key factor of defensive tactical play. Availability of the 1st DF to reduce the opponent attacking speed is one of key component of defensive tactical skill of soccer (Suzuki & Nishijima, 2007). The distance covered by FW and DF, and position of final DF line directly relate with control of opponent attack such as decreasing opponent attacking space. In conclusion, these SDTP variables are statistically valid to use for defensive performance analysis in soccer games. Reference Suzuki, K., & Nishijima, T. (2007). Sensitivity of the soccer defending skill scale: a comparison between teams. *European Journal of Sport Science*, 7(1), 35-45.

## DEVELOPMENT OF A NEW METHOD USING SEQUENCE ANALYSIS FOR CLARIFICATION OF THE ATTACKING TACTICS IN HANDBALL

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Introduction Notational analysis quantifies for tactical actions as "When", "Where", "Who", "What" and "How" and can be used for evaluation of game performance. In general, a notational analysis can assess the total tactical behavior and the important aspects of the game to evaluate single actions. In order to gain deeper insight into the tactical behavior of the individual and team, it is necessary to record the multiple tactical actions and to analyze the sequence of continuous attacking actions in time-series. Thus, we considered a new method to analyze the multiple tactical actions using sequence analysis in the ball game, like a sequence analysis of nucleotide of DNA. Methods We analyzed the offense set-plays of 42 games in 2012 European Women's Handball Championship in Serbia. In total, 21381 single attacking actions were recorded. The single attacking action were classified according to a definition and encoded for these attacking actions. The classification definitions of attacking action were (1) the direction of passing the ball and attacking action of player 1, (2) The timing which starting a movement of player 2, and (3) The attacking direction of the player 2 against the passed direction from player 1. The classified attacking actions were arrayed from opening to terminating play in time-series. The one attacking sequence was defined as the continuous attacking actions from opening to terminating play. The definition of terminating attacking action was "shooting", "technically miss", "technical fault" and "foul by defender". In this study, we examined the useful combination of attacking actions in opening phase, terminating phase and continuous phase. Results We could classify the 15 kinds of single attacking actions according to the classification definition. These classified attacking actions were encoded to a letter of alphabet as T, W, X, Y, H, P, D, F, R, I, Q, E, G, S and C. The numbers of attacking sequence were 1983. In comparing among attacking phase, the kinds of four combinations attacking action were 190 in opening phase, in 312 in terminating phase, 300 in continuous phases, respectively. In opening phase, "T-T-W-T", "T-T-F-T", "T-T-F-W", "T-W-T-R", "T-W-T-W" and "T-W-P-R" of four combinations of attacking actions were more used compared to other phases. In terminating phase, "F-T-H-D", "H-P-P-F", "H-T-H-D", "T-F-P-F", "T-F-R-F", "T-H-T-P" and "W-T-H-D" of those were higher observed than other phases. In continuing phase, "F-R-R-T", "F-T-H-T", "H-T-H-T", "H-T-T-W", "P-R-T-H", "R-P-H-T", "R-P-R-T", "T-H-T-T", "W-P-H-T", "W-P-R-W", "W-T-F-W", "W-T-H-T", "W-T-R-T", "W-T-R-W", "W-T-T-T", "W-T-T-W", "W-T-W-T", "W-T-W-W", "W-W-T-W" and "W-W-W-T" of those were well observed. These results demonstrated that the more useful combination attacking actions differed among the attacking phase. Conclusion We found the difference of attacking tactics among attacking phases. This result indicated a potential of our new analysis methods using sequence analysis. Contact shiro@rs.noda.tus.ac.jp

## Sport Technology

### ANALYSIS OF ANTICIPATION BY INTEGRATION OF EYE TRACKING IN VIRTUAL REALITY – AN INNOVATIVE APPROACH

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Introduction It is commonplace to analyze anticipation in sports by usage of eye tracking and occlusion techniques to study foveal and peripheral perception in combination for anticipatory cue detection. Most studies exploring anticipation in sports used video screens for stimulus presentation. A virtual environment provides conditions close to reality due to depth information and standardized conditions. An additional advantage is that for training or investigations in virtual reality (VR) there is no dependence on other athletes. However, eye tracking, occlusion techniques and VR have never been combined. The aim of this project is to describe preparatory work in the field of eye tracking in 2D and in the field of occlusion techniques in VR and to give an outlook to combine all three technologies. Methods Reactions of expert karate athletes ( $n=5$ ) were analyzed via high-speed video (200Hz) while responding to occluded attacks shown on a life-size video screen and in a virtual environment. Furthermore visual search behavior of karate experts ( $n=7$ ) was investigated using a head-mounted eye tracker (SMI ETG1) while responding physically to occluded attacks shown on a life-size video screen. Results Statistical data analysis revealed a significantly ( $p < .05$ ) higher number of correct responses in the virtual environment compared to 2D video presentation. Also first anticipatory cues could be determined. Analyzing the data of the eye tracking experiment the opponent's head and upper torso were found to be main fixation regions (e.g. 58% head and 22% upper torso under non occluded condition). Discussion and Recommendation Better reactions in VR are caused by depth information which evokes a more realistic feeling in the environment and higher immersion than 2D video presentation. In future approaches eye tracking and occlusion techniques shall be implemented in virtual reality to gain the advantages from all technologies. Wearing a head mounted eye tracker in a CAVE (Cave Automatic Virtual Environment), eye movements can be detected in VR but spatial limitations inhibit sport specific applications. Hence the integration of an eye tracker in a head mounted display (SMI Oculus Rift Integration) appears to be the most suitable solution. This provides immersive stimulus presentation with high mobility enhancing natural movements. To allow natural interaction between an avatar and a real athlete in VR it would desirable to develop an autonomously interacting environment for studying anticipation in sports. Contact: kerstin.witte@ovgu.de

## Sports Medicine and Orthopedics

### THE EFFECT OF ACUTE EXERCISE MODALITY ON INTRADIALYTIC BLOOD PRESSURE IN HEMODIALYSIS PATIENTS

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**INTRODUCTION AND AIMS:** Blood pressure (BP) in hemodialysis patients is a modifiable risk factor for long-term mortality and its alteration during dialysis such as symptomatic intradialytic hypotension is a poor prognostic marker. Exercise has been known to have influences on BP in these patients. The purpose of this study is to investigate the effect of acute aerobic, resistance exercise on the BP during dialysis. **METHODS:** During hemodialysis, 11 patients were performed 2 sets of aerobic or resistance exercise with 1 hour rest in between sets. All patients were conducted aerobic, resistance exercise and no exercise for three consecutive weeks. Each intervention was separated by at least 7 days, to avoid a training effect. BP was measured during 4 hours of dialysis every 10 to 30 minutes. Paired t-tests or a repeated measure ANOVA and post hoc test were used to compare each time point within or among three exercise modalities, respectively. **RESULTS:** Two exercise programs were well tolerated, with no complications during the study. In both aerobic and resistance exercise systolic BP increased during exercise and fell after exercise except for during 1st set of aerobic exercise. In each time period, only resistance exercise significantly increased systolic BP compared with untreated among three individual modalities ( $P < .05$ ). The patterns of diastolic BP were similar with those of systolic BP during intradialytic period. **CONCLUSIONS:** During dialysis period, both acute aerobic and resistance exercise increased BP during exercise and decreased BP after exercise in hemodialysis patients. Both aerobic and resistance exercise deserve future investigations on the effects of acute intradialytic exercise on BP and symptoms when applied in intradialytic hypotensive patients.

### GENDER RELATED DIFFERENCES OF ACHILLES TENDON CROSS-SECTIONAL AREA AT REST AND MAXIMAL VOLUNTARY CONTRACTION AMONG CHILDREN

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**Introduction:** Larger Achilles tendon cross-sectional area (AT-CSA) yields a reduced average tendon stress for a given force (Westh et al., 2008). At a given force a compliant tendon CSA reduces more from rest to contraction (Muraoka et al., 2005). Females tend to have smaller CSA and more compliant AT than males (Maganaris et al., 2008). This difference is more obvious in adults however in children this phenomenon is not clear. **Purpose:** To investigate gender related differences of AT-CSA at rest and maximal voluntary contraction (MVC) among children. **Methods:** Left AT-CSA of 14 healthy adolescent athletes (7 boys, 7 girls;  $13 \pm 2$  yrs;  $158 \pm 12$  cm;  $49 \pm 16$  kg) was sonographically assessed during rest and MVC under 5s. Subjects were positioned prone on an isokinetic dynamometer with knee extended and ankle placed at  $90^\circ$  in a footplate. AT-CSA (4 cm from distal attachment on the calcaneus) was measured using a custom-made cast over 3 trials and the average was taken. Data was analyzed descriptively (mean  $\pm$  SD) for each group. Differences between groups were analyzed using independent t-test ( $\alpha = 0.05$ ). **Results:** Mean AT-CSA for boys was  $55 \pm 10$  mm<sup>2</sup> at rest and  $50 \pm 9$  mm<sup>2</sup> during MVC, for girls the values were  $44 \pm 11$  mm<sup>2</sup> at rest and  $39 \pm 7$  mm<sup>2</sup> during MVC. Mean CSA difference between rest and MVC was  $-4 \pm 4$  mm<sup>2</sup> for boys and  $-5 \pm 4$  mm<sup>2</sup> for girls. AT-CSA was found to be statistically significant larger in boys at rest ( $p = 0.007$ ) and at MVC ( $p = 0.003$ ) compared to girls. Muscle torque during MVC for boys reached  $65 \pm 23$  Nm and for girls  $60 \pm 24$  Nm. No statistical significant differences were found for AT-CSA from rest to MVC ( $p = 0.713$ ) as well as for muscle torque ( $p = 0.701$ ) between the groups. **Conclusion:** The larger CSA in boys compared to girls during rest and MVC is already visible at an average age of 13 years. AT-CSA reduction from rest to MVC showed no gender-related differences; implying no differences in tendon compliance at these ages. Further research including other methodological approaches and higher sample sizes are necessary to understand the properties of AT among children. **References:** Westh, E., Kongsgaard, M., Bojsen-Moller, J., Aagaard, P., Hansen, M., Kjaer, M., & Magnusson, S. P. (2008). Effect of habitual exercise on the structural and mechanical properties of human tendon, in vivo, in men and women. *Scandinavian journal of medicine & science in sports*, 18(1), 23-30. Muraoka, T., Muramatsu, T., Fukunaga, T., & Kanehisa, H. (2005). Elastic properties of human Achilles tendon are correlated to muscle strength. *Journal of Applied Physiology*, 99(2), 665-669. Maganaris, C. N., Narici, M. V., & Maffulli, N. (2008). Biomechanics of the Achilles tendon. *Disability and rehabilitation*, 30(20-22), 1542-1547.

### EPIDEMIOLOGY OF FEMALE COLLEGIATE FOOTBALL TEAM INJURIES FOR TWO YEARS

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**Introduction:** Football is played worldwide by more than 265 million players, of whom 26 million are female players (Astrid et al., 2007). The popularity of female football players in Japan has been rising since the winning of FIFA World Cup championship in 2011. The number of population continues to increase every year and exceeds approximately 30,000 today. Football requires physical contact, and therefore associates with a large number of injuries in both sexes. Injuries in male football have been the subject in many studies. However, the number of reports regarding female football injuries in adults is low and epidemiologic data in Japanese collegiate female football players is very rare. The aim of this study was investigating the injuries in Japanese female collegiate football players in two seasons (2014-2015) using definitions established by the Federation International de Football Association (FIFA). **Methods:** A total of 32 female collegiate football players (mean height =  $159.3 \pm 7.1$  cm, mean weight =  $57.0 \pm 7.3$  kg) participated in the study. We investigated the injured situation (game or practice, contact or non-contact), type of injury (traumatic or overuse), location, severity, days until return to play, and a month that the injury occurs. Injuries were classified into the following three categories according to FIFA severity. **Results:** Overall, 76 injuries were documented in 25 players (78.1%). 82.9% of injuries were traumatic and 17.1% were overuse injuries. 31.6% of injuries were occurred during games and 68.4% were during practices. 36.2% of injuries were caused by the contact play and 65.8% were non-contact play. Most injuries (85.5%) were located in the lower extremities with affecting thigh (32.9%), ankle (23.4%), and knee (17.1%). The days taken until return to play with injuries during game and practice were  $46.9 \pm 69.4$  and  $17.1 \pm 19.8$  respectively. April was the predominant month for injuries (25.0%). **Discussion:** As with other studies, our results show that the most injuries occurred in lower extremity. However, the days taken until return to play was longer in our study than its other studies (K. Söderman et al 2001). The results suggest that, in addition to the rehabilitation that focuses on early recovery, reducing severity of injuries by applying the preventive intervention of lower extremity injuries is the crucial strategy to shorten the return to play in female football players. **References:** 1.Junge A, Dvorak J.



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## MRI FEATURES OF THE TRUNK MUSCLES IN MALE COLLEGIATE SPRINTERS WITH LUMBAR DISK DEGENERATION

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**Introduction** Lumbar disk degeneration (LDD) is a common cause of low back pain (LBP) in athletes. Previous studies have reported higher prevalence rates of LDD among athletes (Hangai et al., 2009). However, despite the high prevalence among athletes, the predictive factors of LDD have not been fully clarified. Many studies have reported a direct correlation between LBP and cross-sectional areas (CSAs) of the trunk muscles in the general population. We hypothesized a significant relationship between LDD and CSAs of the trunk muscles in athletes. The purpose of this study was to investigate the association between LDD and the CSAs of the trunk muscles in Japanese male collegiate sprinters. **Methods** The subjects were 48 Japanese male collegiate sprinters. LDD and CSAs were evaluated by using T1- and T2-weighted magnetic resonance imaging (MRI). LDD was defined as reduced signal intensity of the intervertebral disks from L1/L2 through L5/S1. The grading system for the assessment of LDD was based on the Pfirrmann classification, with grades 3–5 indicating degeneration (Pfirrmann et al., 2001). According to this evaluation, we assigned the sprinters into 2 groups, namely the LDD group (n = 8) and non-LDD group (n = 40). The CSAs of the trunk muscles at the L3/L4 and L4/L5 disk levels were measured on MRI. We calculated the CSAs of the following muscles: rectus abdominis, obliques, psoas, quadratus lumborum, and erector spinae. All the CSAs were normalized by the CSAs of the corresponding intervertebral disk. **Results** The LDD group had larger CSAs of the trunk muscles than the non-LDD group (obliques:  $p < 0.01$ ; psoas:  $p < 0.05$ ) at level L4/L5 of the intervertebral disk. Furthermore, the CSAs were significantly asymmetrical between the left and right sides at the L4/L5 disk level in the LDD group (obliques:  $p < 0.05$ ). **Discussion** In this study, we found that the LDD group had a significantly larger CSAs of the trunk muscles (both the oblique and psoas) than the non-LDD group. Arbanas et al. reported that patients with LBP had larger CSAs of the psoas major muscles. The CSAs of the trunk muscles (size and asymmetry) might affect not only LBP but also LDD. In conclusion, the CSAs of the trunk muscles is a predictor of LDD in Japanese male collegiate sprinters. **References** Hangai M, Kaneoka K, Hinotsu S, Shimizu K, Okubo Y, Miyakawa S, Mukai N, Sakane M, Ochiai N. (2009). Am J Sports Med, 37(1), 149-155. Pfirrmann C. W, Metzendorf A, Zanetti, M, Hodler J, Boos N. (2001). Spine, 26(17), 1878-2001. Arbanas J, Pavlovic I, Marijancic V, Vlahovic H, Starcevic-Klasan G, Peharec S, Bajek S, Miletic D, Malnar D. (2013). Eur Spine J, 22(9), 1965-1971. Contact y-tahara@nittai.ac.jp

## DIFFERENCES IN QUADRICEPS MUSCLE THICKNESS IN JAPANESE JUNIOR HIGH SCHOOL AND COLLEGE BASKETBALL PLAYERS

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**Introduction** Quadriceps muscle thickness (MT) is associated with sprint and jump performance. Prior studies have reported that bilateral differences in muscle architecture are related to lower extremity injuries. However, the difference in quadriceps MT among different age groups of athletes is unclear. This study investigates differences in quadriceps MT between elite Japanese junior high school and college basketball players. **Methods** Nineteen male junior high school (JHS; age  $13.8 \pm 0.7$  yrs, height  $168.0 \pm 11.8$  cm, body mass  $56.5 \pm 13.4$  kg, history of competition  $5.2 \pm 1.7$  yrs) and college basketball players (CS; age  $19.7 \pm 1.1$  yrs, height  $190.9 \pm 4.5$  cm, body mass  $86.0 \pm 7.9$  kg, history of competition  $9.4 \pm 1.8$  yrs) volunteered for this study. Quadriceps MT of the vastus medialis oblique (VMO), vastus medialis (VM), rectus femoris (RF), vastus intermedius (VI), and vastus lateralis (VL) was measured using real-time ultrasonography (Giles et al., 2015). Images were analyzed by software after being classified as dominant leg (DL) or non-dominant leg (NDL). The ratio of MT to body mass<sup>1/3</sup> (MT/BM<sup>1/3</sup> ratio) was calculated to normalize morphological differences. Independent t-tests were used to compare MT and MT/BM<sup>1/3</sup> ratio between JHS and CS. To evaluate differences in MT between DL and NDL of each player within an age group, paired sample t-tests were performed. The significance level was set at 0.05. **Results** CS had greater MT of DLVM ( $p=0.006$ ), NDLVM ( $p=0.001$ ), DLRF ( $p=0.017$ ), NDLRF ( $p=0.006$ ), DLVI ( $p=0.031$ ), and NDLVL ( $p=0.023$ ) compared with JHS. For the MT/BM<sup>1/3</sup> ratio, NDLVMO in JHS was significantly greater than in CS ( $p=0.038$ ). The MT of VMO and VI in DL was significantly greater than the MT in NDL for CS (VMO:  $p=0.014$ , VI:  $p=0.047$ ). **Discussion** Muscle growth velocity corresponds with peak mass velocity between 7-17 years of age (Malina et al., 2004). Quadriceps muscles in CS are thicker than in JHS, except for VMO; this difference between the groups is the effect of aging on muscle growth. However, the MT/BM<sup>1/3</sup> ratio of VMO was recognized less than JHS and laterality of quadriceps MT was found in CS. History of competition and injury may affect the laterality of quadriceps MT in CS. Muscle imbalance is a risk factor for lower extremity injury (Mangine et al., 2014). The results of this study indicate the importance of improving the laterality of quadriceps muscle thickness in CS. **References** Giles LS, Webster KE, McClelland JA, Cook J. (2015). J Orthop Sports Phys Ther, 613-619 Malina RM. (2004). Growth, Maturation, and Physical Activity-2nd Edition. Human Kinetics. Mangine GT, Hoffman JR, Gonzalez AM, Jajtner AR. (2014). J Athl Train, 49: 794-799 Contact y-sekine@nittai.ac.jp

## CARDIORESPIRATORY FITNESS AND NEUROCOGNITIVE PERFORMANCE IN THE ELDERLY WITH MILD COGNITIVE IMPAIRMENT

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**Introduction** Thus far, no studies have yet been conducted that explore the potential correlation between cardiorespiratory fitness and neurocognitive (i.e., neuropsychological and neurophysiological) performance in elderly individuals with mild cognitive impairment (MCI). Therefore, the aim of this study was to investigate the role of cardiorespiratory fitness in the relationship between neurocognitive performance and MCI. **Methods** Fifty-six participants were classified into MCI (n=28) and control (n=28) groups, and were monitored with regard to their behavioral performance (e.g., accuracy rates and reaction times) and event-related potential measures (e.g., P3 latency and amplitude) during a variant of the task-switching paradigm, and also underwent a cardiorespiratory fitness test. All independent variables were separately analyzed with a repeated-measures ANOVA. **Results** Although no significant difference was observed in accuracy rates between the two groups, the MCI group showed slower reaction times in the heterogeneous condition and larger global switching costs when performing the task-switching paradigm. Additionally, the MCI group exhibited significantly longer P3 latencies in the homogeneous and heterogeneous conditions, and a smaller P3 amplitude only in the heterogeneous condition. The MCI group relative to the control group showed poorer VO2max values. The level of cardiorespiratory fitness was significantly associated with P3

amplitude, particularly in the heterogeneous condition of the task-switching paradigm, in the MCI group. Discussion The MCI group showed abnormalities in neurocognitive performance when performing the cognitive task, and this extends the body of research exploring the neuropsychological performance of people with MCI (Belleville et al., 2008). Such a deficit (e.g., P3 amplitude) was likely correlated with poorer cardiorespiratory fitness. A physical exercise intervention leading to improved cardiorespiratory fitness may thus have non-pharmacological protective effects on the functional integrity of the MCI patients' brains and cognition (Colcombe and Kramer, 2003). However, the cross-sectional research design does not allow us to address the issue of directionality or causation, and such a correlative approach cannot sufficiently explain the potential mediating effects of cardiorespiratory fitness on the neurophysiological problem. References Belleville S, Bherer L, Lepage E, Chertkow H, Gauthier S. (2008). *Neuropsychologia*, 46, 2225-2233. Colcombe S, Kramer AF. (2003). *Psychol Sci*, 14, 125-130. Contact Tsai, Chia-Liang: andytsai@mail.ncku.edu.tw

### ALIGNMENT OF TRUNK AND LOWER LIMBS DURING STAR EXCURSION BALANCE TEST MIGHT BE USEFUL TO CATEGORIZE ACL INJURY RISK

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**【Introduction】** Some reports have indicated that categorization of ACL risk during sports movement among athletes is important to reduce ACL injuries. ACL injuries are occurred during sports, especially jump landing and cutting movements with knee valgus alignment. Because ACL injuries were occurred during movements toward to various directions, we considered that alignment of trunk and lower limb during Star Excursion Balance Test (SEBT) might be useful to categorize ACL risk of supporting leg. Therefore, the purpose of this study was to clarify the relationship of knee valgus alignment during single leg drop landing (SDL) and alignment of trunk and lower limb during SEBT. **【Methods】** 28 healthy females (age = 20.6±1.2 years old, height = 159.3±4.7 cm, weight = 51.3±4.3 kg) volunteered to participate in this study. All of them gave written informed consent before this study. The 3D motion analysis system was used to measure trunk, hip and knee angles during SDL and SEBT. All participants were divided into the knee valgus group (more than 5 degrees in knee valgus displacement) and the control group (less than 5 degrees in knee valgus displacement) during SDL. Trunk, hip and knee angles of right leg (supporting leg) were analyzed from the starting position to the maximum reach during SEBT. Independent t-test was used to identify differences of trunk, hip and knee angles during SEBT between two groups. **【Results】** The knee valgus angles in knee valgus group were greater than those in control group during reach direction of anterior (A), anterior medial (AM), anterior lateral (AL), medial (M), and posterior medial (PM;  $p < 0.05$ ), respectively. In addition, the hip internal rotation angle in knee valgus group was less than those in control group during reach direction of AM and AL ( $p < 0.05$ ). Furthermore, the knee flexion angle in knee valgus group was less than that in control group during reach direction of M ( $p < 0.05$ ). The trunk right rotation in valgus group was also less than that in control group during reach direction of PM ( $p < 0.05$ ). **【Conclusion】** In addition to an increase of knee valgus, increase of hip internal rotation, decrease of knee flexion and trunk rotation to supporting leg were reported as a risk factor of non contact ACL injury during landing and cutting movements. It was considered that decrease of hip internal rotation might be one of ACL injury risk found as a characteristic influenced by the SEBT. Our results indicate that reach direction of A, AM, AL, M and PM during SEBT would be useful to detect ACL injury risk.

### HEAT STIMULATION-INDUCED INCREASE IN HSP70 EXPRESSION ENHANCES TOLERANCE OF HUMAN ARTICULAR CHONDROCYTES

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**Introduction** Thermo-therapy has been applied to various joint diseases and injuries to alleviate their symptoms. Indeed, heat stimulation (HS) to an articular cartilage increased expression of cartilage matrix genes and heat shock protein 70 (Hsp70) gene, suggesting a protective effect in chondrocytes (Hojo et al., 2003; Tonomura et al., 2007). Although one of HSP70's roles is to protect cells against changes in the external environment, it is unknown whether chondrocytes gain higher tolerance to external stress after HS. Therefore, the purpose of this study was to evaluate the influence of HS-induced increase in HSP70 expression on human articular chondrocytes' tolerance to heat stress. **Methods** Cultured normal human articular chondrocytes (NHAC-kn, Lonza) were subjected to the 1st HS in a thermal bath (37, 39, 41, or 43 °C for 20 min) after 48 h of differentiation. Then, 24 h after the 1st HS, half of them were exposed to fatal stress (2nd HS at 45 °C) for 15 min. Cell viability and lactate dehydrogenase (LDH) activity were measured 8 h after 2nd HS. Twenty-four hours after each HS, Hsp70, proteoglycan, and type II collagen mRNA expressions were quantified by real-time PCR, and HSP70 protein level was measured by western blotting. Moreover, human articular chondrocytes were transfected with HSP70 small interfering RNA (siRNA) to determine whether knockdown of HSP70 led to decrease in the cells' tolerance. **Results** After the 1st HS, Hsp70 expression gradually increased with increase in temperature of the HS. Proteoglycan and type II collagen gradually increased until HS at 41 °C, whereas HS at 43 °C did not increase expression level of proteoglycan and type II collagen. Thus, the optimal temperature condition of the 1st HS was 41 °C. HSP70 expression level significantly increased 24 h after the 1st HS at 41 °C compared with that in untreated human articular chondrocytes. Moreover, human articular chondrocytes pretreated at 41 °C showed increased cartilage matrix gene expression and the most tolerance to the 2nd HS. The Hsp70 knockdown due to siRNA transfection attenuated the tolerance of articular chondrocytes to heat stress. **Discussion** Appropriate HS caused increase in HSP70 expression, leading to enhancement of articular chondrocytes' tolerance to heat stress. These results suggest that appropriate heat applications before physical activity could be useful for prevention of cartilage disorder and degeneration. **References** Hojo T, Fujioka M, Ostuka G, Inoue S, Kim U, Kubo T. (2003). *J Orthop Sci*, 8, 396-399. Tonomura H, Takahashi K, Mazada O, Arai Y, Shinya M, Inoue A, Honjo K, Hojo T, Imanishi J, Kubo T. (2007). *J Orthop Res*, 26, 34-41. Contact tho-jo@mail.doshisha.ac.jp

### THE NEW STANFORD 12-ELEMENTS VERSUS THE 12- ELEMENT AHA RECOMMENDATIONS AND ELECTROCARDIOGRAPHIC SCREENING IN PREPARTICIPATION CARDIOVASCULAR EVALUATION OF COMPETITIVE ATHLETES

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**Introduction.** Preparticipation Cardiovascular (PPCV) examination: To compare the athletes' responses obtained by two questionnaires, the new Stanford 12-Elements (1) and the 12-Element AHA(2) regarding the athletes' personal, family history, suggestive for the CV diseases

responsible for unexpected sudden cardiac death. To compare the positive responses with the electrocardiograms according to the Seattle, European Society of Cardiology 2010, "Refined" criteria (3,4,5). Methods. PPCV in 2015: 357 athletes (285 M, 79.8 %),  $21 \pm 3$  yo. Caucasians. Sports: rowing, canoeing, football, athletics. All athletes responded the 12- Stanford (questions: 11, personal; 1 physical exam) and 12-AHA (questions: 8, personal; 4, physical exam). ECG athletes, interpreted using the 3 criteria sets. The Stanford, AHA positive responses, analysed and compared with the ECGs data. Physical exams all athletes. Specific tests when required. Results. 357 athletes responses. 45 (12.6% positive): Stanford 35 (77.7%), AHA 10 (22.2%; of which, 6 Stanford positive). 22 (48.8%) of 45 positive responders had CV diseases (cardiomyopathy, 2; anomalous origin coronary artery, 1; Brugada tip1, one; WPW, 3; complex premature ventricular contraction, 15). Training unrelated ECG: Seattle, 22 (100%); ESC 10 (45.5%), Refined criteria 22 (100%) athletes. Discussion. The Stanford 12-Elements questionnaire is more specific compared to 12- Element AHA, pointing questions regarding the athletes' symptoms and past medical records. The ECG Seattle and Refined criteria support the Stanford questions. References 1. Tim P Dunn et al. The Stanford 12-Elements for Preparticipation Cardiovascular Screening of Competitive Athletes in Limitations of Current AHA Guidelines and Proposal of New Guidelines for the Preparticipation Examination of Athletes. *Clin Journal of Sport Med* 2015;25:472-477. 2. B. J Maron et al. The 12-Element AHA Recommendations for Preparticipation Cardiovascular Screening of Competitive Athletes in AHA. Recommendations and Considerations Related to Preparticipation Screening for Cardiovascular Abnormalities in Competitive Athletes: 2007 Update. *Circulation* 2007; 115:1643-55. 3. J A Drezner et al. Electrocardiographic interpretation in athletes: the "Seattle" Criteria. *Br Journal Sports Med* 2013;47:122-124. 4. D Corrado et al. Recommendations for interpretation of 12-lead electrocardiogram in the athletes. *Eur Heart Journal* 2010;31:243-259. 5. N R Riding et al. Comparison of three current sets of electrocardiographic interpretation criteria for use in screening athletes. *Heart* 2015;101:384-390. Contact: ioanamarinastoian@yahoo.com

## THE INFLUENCE OF SLOW JOGGING AT WALKING SPEED ON THE SALIVARY AMYLASE ACTIVATION AND EXERCISE INTENSITY

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**Introduction** The slow jogging at walking speed is one of the beneficial methods for preventive help of lifestyle-related diseases. (Kitajima Y, Sasaki Y, Tanaka H, 2014) The slow jogging also is known as safety exercise for middle-aged and aged. The salivary amylase has been known as one of the stress biomarker (Yamaguchi, 2007) The purpose of this study were to compare with the exercise intensity, rating of perceived exercise (RPE), blood pressure, and saliva amylase activation between slow jogging and walking with same speed. **Methods** This study comprised 23 healthy male volunteers. All volunteers performed 30min of treadmill walking and jogging with 5km/h speed. The slow jogging and the walking practiced at interval of a week. The exercise intensity was calculated from heart rate with Karvonen Formula during treadmill walking and jogging. The RPE was measured every 2min during treadmill walking and jogging. The blood pressure, salivary amylase activation were measured at time of pre-exercise, immediately after exercise, and 30 minutes after exercise. The salivary amylase activation after exercise was quantitated by the amount of change from pre-ex value. **Result** The exercise intensity and the RPE on the slow jogging showed high value from the walking significantly ( $p < 0.05$ ). The salivary amylase activation of the slow jogging and the walking had mean amount of change of  $8.6 \pm 26.0$  KU/L and  $6.5 \pm 24.3$  KU/L respectively, before immediately after exercise. The salivary amylase activation after 30min after exercise of both exercise also showed mean amount of change of  $29.4 \pm 45.5$  KU/L and  $13.3 \pm 23.7$  KU/L respectively. These values of the amounts of changes of salivary amylase activation were statistically significant different between the slow jogging and the walking. On blood pressure were no significant different between the slow jogging and the walking. **Discussion** Although the RPE of the slow jogging showed a high value from the walking significantly, the scale of RPE was under "very light". Therefore this result suggested the slow jogging was an exercise that was easy to continue. In addition, exercise intensity of the slow jogging showed effective aerobic exercise level for health. Therefore this result suggested the slow jogging could be a promising exercise method to prevent of lifestyle-related diseases. However it was necessary to pay attention to a stress biomarker. **Reference** Kitajima Y, Sasaki Y, Tanaka H. (2014). *Journal of Running Science*, 25(1), 19-27. Yamaguchi M. (2007). *Folia Pharmacologica Japonica*, 129, 80-84.

## THE EFFECTS OF ACUPUNCTURE ON ISOKINETIC EXERCISE

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**Introduction** Previous review reported that acupuncture has recently emerged as alternative medical enhancer of human physical performance (Ahmedov, 2010). The aim of this study was to examine the effects of acupuncture stimulation on isokinetic exercise of knee extensors. **Methods** Subjects were thirteen competitive triathletes (age:  $22 \pm 3$  yrs, height:  $173.0 \pm 5.3$ , weight:  $64.5 \pm 3.0$ ). They performed repetitive isokinetic knee extension/flexion exercise (5 sets of 30 repetition, angular velocity:  $60^\circ/\text{s}$ , 3 min rest between each set) after 1) no stimulation as control (Cont), 2) acupuncture stimulation on quadriceps (WHO-SP10, ST34) (acuQ), and 3) acupuncture stimulation on lumbar region (WHO-BL24, BL26) (acuL). Electromyographic (EMG) activities of the rectus femoris (RF), the vastus lateralis (VL), and the vastus medialis (VM) muscles were collected and integrated (iEMG). Peak torque and total work were also observed. Rate of changes of those indexes from the first set were evaluated. **Results** There were no significant differences on iEMG, Peak torque and total work among groups at the first set of exercise. In Cont group, RF was significantly decreased at fourth and fifth set compared to the first set ( $-39.35$ ,  $-53.6\%$ , respectively;  $p < 0.05$ ) and VL was also decreased at fourth set ( $-61.7\%$ ;  $p < 0.05$ ) while no significant change of iEMG was observed in acuQ group. Peak torque of each group did not change significantly. There was a significant difference in total work between Cont and acuL at the fifth set ( $-9.6\%$ ,  $6.2\%$ , respectively;  $p < 0.05$ ). **Discussion** These results suggested acupuncture stimulation on the muscles prior to the isokinetic exercise affected neuromuscular function. Moreover, it was suggested that acupuncture stimulation did not influence on the change of peak torque, but was effective when applied on lumbar region, to prevent the fatigue caused by repetitive heavy exercise and sustain generating the power on knee extensor. These results partly agree with previous studies (Hübscher et al., 2010; So et al., 2007; Toma et al., 1998) although they examined the data detected by isometric exercise and the acupuncture points varied. Acupuncture stimulation increases oxygenation at both local (stimulated) and distant (not stimulated) area in the same innervation (Kaneko et al., in press). It is considered that the acupuncture stimulation lead more appropriate delivery of arterial blood flow into deoxygenated muscles so that it could help the recovery during resting period between the repetitive isokinetic exercises. **References** Ahmedov S. (2010), *J Strength Cond Res* 24(5), 1421-1427. Hübscher M, Vogt L, Ziebart T, Banzer W. (2010), *Eur J Appl Physiol* 110:353-358 So Raymond CH, Joseph K-F Ng, Gabriel YF Ng. (2007). *Eur J Appl Physiol*, 100(6), 693-700. Toma K, Conatser Jr RR, Gilders RM, Hagerman FC.

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### AMETROPIA/VISUAL DEFICITS IN COMPETITIVE SPORTS – AN UP-TO-DATE STOCK TAKING

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**Introduction** Former investigations showed that about 20% of all elite athletes who have been examined in the context of visual performance diagnostics exert their sport ametropic/with visual deficits (Jendrusch, 2008), although it is known that considerable visual reductions are leading to uncoordinated movement, even if motion sequences are automatized. Nevertheless regular and meaningful visual tests for the analysis of the multidimensional visual performance and the detection of ametropia are only integrated in the health or performance diagnostics of few sports. Aim of the present study was to analyze current data of German elite athletes concerning ametropia or different parameters of visual performance; especially considering parameters that are also tested by optometrists or ophthalmologists. **Methods** The Vision Test Battery includes visual parameters like visual acuity, refraction error (nearsightedness/myopia or astigmatism), contrast sensitivity, stereoscopic perception of depth and color perception. The study focusses on a retrospective analysis of cross-sectional eye test data from different German national teams or first division athletes (n=553; age: 21.0±4.0 years) which were collected in the annual routine health check during the last three years (2013-2015). **Results** About 27.5% of athletes use glasses or contact lenses in their daily life. 33.3% of athletes (women=29.3%; men=37.7%) with ametropia are practicing their sports without an optical correction. On one hand, there was a lack of awareness about the effect of visual performance on sporting performance, on the other hand the correction used was unsuitable to go in for sports or correction was poor in relation to wearing comfort. The median of the (monocular) visual acuity is about 1.85 for men and 1.80 for women (with maximum-values considerably above 2.50). Altogether 22.6% of athletes (women=21.8%; men=23.0%) are detected as ametropic and thus in need of correction. 7.0% of the athletes tested (women=4.3%; men=8.8%) had deficits in depth perception; 7.5% of the men showed a color asthenopia (red-green). **Conclusion** Vision has a crucial importance for movement control and balance regulation and helps anticipating fast movements in ball games as well as potential accident risks, e.g. in one-on-one-situations in football. The rate of ametropia is still high and shows that regular eyesight tests are necessary in competitive sports and should be an inherent part in health diagnostics in order to be able to detect and – subsequently – correct visual deficiencies at an early stage. **References** Jendrusch, G. (2008). Leistungen des visuellen Systems im Sport. Zeitschrift für praktische Augenheilkunde & Augenärztliche Fortbildung (ZPA) 29(6): 239-247.

### CHANGE IN THE MUCOSAL IMMUNE FUNCTION ON A SINGLE WATER POLO GAME.

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**Introduction** In the field of athletics, the risk of upper respiratory tract infection (URTI) is one of the most important problems in athletes. Salivary human beta-defensin 2 (hBD2) have anti-virus activity, thereby preventing URTI. However, there is no information on the response to hBD2 after the game. The aim of this study was to examine salivary hBD2 and secretory immunoglobulin A (SIgA) responses to a single water polo game. **Methods** 9 college water polo players (20.6 ± 0.4 years) participated in this study. They played a single water polo game. Saliva samples were collected pre game (pre), post game (post), post 2 h, and post 4 h after the game. hBD2 and SIgA concentrations were measured by the enzyme-linked immunosorbent assay. The total protein concentration was determined by the Pierce 660nm Protein Assay. The hBD2 and SIgA data were expressed as relative to total protein concentration (hBD2/TP, SIgA/TP, respectively). The visual analogue scale for subjective fatigue was used at the same points as sample collections. **Results** Mean salivary hBD2/TP at pre, post, post 2h, and post 4h were 4.5 ± 0.8, 2.6 ± 0.4, 3.1 ± 0.6, 3.1 ± 0.6 pg/mg respectively (p < 0.05; pre vs. post). Mean salivary SIgA/TP at pre, post, post 2h, and post 4h were 122.9 ± 12.3, 99.53 ± 14.0, 78.7 ± 11.3, 88.1 ± 7.4 ng/mg respectively (p < 0.05; pre vs. post 2h). Subjective fatigue significantly increased after the game until post 4h compared with pre (p < 0.05; pre vs. post, post 2h, post 4h). **Discussion** In this study, mucosal immune system mediated by hBD2 and SIgA might be impaired by a single water polo game. These findings might contribute to development of markers to oral immunity in other athletes or in different environment. However, further study is required to determine relationship between variation in immune markers and susceptibility to URTI in athletes. In conclusion, a single water polo game could impair oral immunity, particularly salivary hBD2/TP and SIgA/TP.

### LOW BACK PAIN INCIDENCE AND RELATIONS TO MOTIVATION AND PERSONALITY TRAITS IN CROATIAN ROWERS

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**Introduction** Low back pain (LBP) is a common complaint in the rowing population (Gilchrist, 1983; Leo, 2015; Searge et al., 1990). There is a high prevalence of LBP in rowers at all training levels. However, very few studies have reported an effective management strategy to reduce LBP in these athletes (Leo, 2015). This may be due to the multidimensional nature of LBP that ranges from physical, psychological, social and lifestyle. The aim of this study was to determine whether personality traits, identified by the Eysenck personality questionnaire (EPQ) and level of motivation, identified by two test General achievement motivation (GAM) and Sport achievement motivation (SAM), in rowers with LBP are similar to those of a rowers without LBP. **Methods** The medical interview were performed on a group comprised of 19 rowers (age: 18,2±2,6 years; height: 184,3±6,3 cm; weight: 80,9±8,86 kg), members of the Croatian national team during spring preparation camp. All rowers were asked to complete three test: two test which measure level of motivation for general (GAM) and sport (SAM) achievement and one test which measure personality traits (EPQ). Rowers were divided in two groups according the incidence of low back pain. Descriptive analysis as well as univariate analysis were processed using the statistical package Statistica 13. **Results** Incidence of LBP divided rowers in two groups. One group with incidence of LBP included 10 (52,6%) rowers. Univariate analysis didn't show differences in any variable within these two groups. **Discussion** Incidence of LBP among this group of Croatian rowers is found to be at level usually reported in numerous studies. Konative aspect of rowers as well as motivation are not characteristics which differ rowers according to LBP incidence. Taimela et al (1999) demonstrated that lumbar fatigue significantly impaired the ability of subjects to sense the position of their trunks when in flexion. For rowers, this may mean that, as they become fatigued, they may not be aware that they are moving into a more flexed posture. Beside all modalities and time spending in specific rowing work, with aim of prevention of low back pain relevance should be paid to metabolic intensities as the body reacts on mechanical work intensity. **References** Gilchrist IC (1983). J Roy



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## THE EFFECTS OF MAXIMAL EXERCISE INTENSITY ON FREE RADICAL, ANTIOXIDANT CAPACITY AND EPOC

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The purpose of this study was to investigate of maximal exercise intensity on free radical, Antioxidant Capacity, oxygen consumption and EPOC(excess post-exercise oxygen consumption) in Judo Players of different weight class. For this study, participants were divided into two groups, lightweight group(n=8) and heavyweight group(n=8). The analyzed data brought about the following results by using independent t-test with SPSS 16.0. The results of the research were as follows. First, according to the Free radical test, lightweight group was increased higher than heavyweight group at pre-exercise, post-exercise and 30 minutes of recovery time. And lightweight group and heavyweight group show statistical significant difference at 10 minutes of recovery time. Second, according to the Antioxidant Capacity, lightweight group and heavyweight group show statistical significant difference at post-exercise and 10 minutes of recovery time. Third, lightweight group and heavyweight group show statistical significant difference at post-exercise and 10 minutes of recovery time. Fourth, EPOC, lightweight group and heavyweight group show statistical significant difference. From these results, heavyweight judo player's EPOC period longer than lightweight judo player. However, antioxidant capacity was lightweight judo player higher than heavyweight judo player. Therefore author deems that judo player of different weight class have need to different rest way and exercise treatment.

## CHANGES IN LOWER LIMB MUSCLE ACTIVITY IN SOCCER PLAYERS WITH FUNCTIONAL ANKLE INSTABILITY DURING A DIAGONAL SINGLE-LEG DROP LANDING

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Introduction Ankle sprain is one of the most common injuries in soccer players. Functional ankle instability (FAI) is residual symptom often develop as a result of ankle sprain. Patient with FAI has postural control deficits at ankle joint. Time to stabilization (TTS) that is used to evaluate the postural control is the time it takes for an individual to regain to single-leg stability after landing. Reduction in peroneus longus (PL) activity was accompanied by inverted position of the ankle joint from pre landing period (Delahunt et al. 2006). This can cause that patient with FAT take longer TTS than healthy people (Ross et al. 2005). However, peroneus brives (PB) activity is not clear during landing period. Methods Twenty-one male collegiate soccer players participated in this study. They were classified into 2 groups using Cumberland ankle instability tool Japanese version (CAIT-J)(Kunugi et al. 2016). 11 FAI group (age  $18.2 \pm 0.4$  years, CAIT-J  $21.0 \pm 3.1$ ) and 10 control group (age  $18.7 \pm 0.8$  years, CAIT-J  $30.0 \pm 0.0$ ) were instructed to land from a box of 30-cm high into anterolateral direction, stabilize as soon as possible, and remain as motionless as possible in a single-leg stance for 20-s. We calculated TTS mediolateral (TTSML) using a force plate. We recorded the muscles activity from the PL, PB, tibialis anterior (TA), gastrocnemius medialis (GM) during drop landing. Data relating to the period 500-ms pre-initial contact (IC) and 500-ms post-IC were analyzed to compare to difference between FAI and healthy group using independent two-sided t-test.  $\alpha$  was set at 0.05. Results There was significant difference for TTSML between FAI group (mean  $4626.3 \pm 347.4$ -ms) and control group (mean  $4282.1 \pm 282.4$ -ms). Reduction in PL, PB, and TA activity was founded in FAI group during the time 1-ms–11-ms post-IC, from 214-ms–31-ms pre-IC, and 68-ms–85-ms post-IC, respectively ( $p < .05$ ). Discussion Male collegiate soccer players with FAI had postural control deficits and low muscle activity in PL, PB, and TA during single-leg landing. This reduction in muscle activity may be caused by proprioceptive deficit at ankle joint. It is clear that PB activity has reduced in participants with FAI during pre-IC. References Shun Kunugi, Akihiko Masunari, Byungjoo Noh, Toshio Mori, Naruto Yoshida, Shumpei Miyakawa. (2016) Disabil Rehabil, 1–9. Eamonn Delahunt, Kenneth Monaghan, Brian Caulfield. (2006) J Orthop Res, 24(10), 1991–2000. Scott E. Ross, Kevin M. Guskiewicz, Bing Yu. (2005) J Athl Train, 40(4), 298–304.

## MYOELECTRICAL IMPEDANCE SYSTEM FOR ASSESSING MUSCLE INJURY

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Bioelectrical impedance analysis produces phase angle, resistance, reactance and impedance, which can be used in assessing whole body composition and segmental body composition. We design myoelectrical impedance system based on the segmental bioeletical impedance parameters for assessing muscle injury and muscle health status. We investigated the effects of degree and prognosis of muscle injury on bioelectrical impedance parameters. Phase angle and reactance decreased after muscle strain and these parameter increased according to the regeneration and healing process. These findings imply that changes in R reflect fluid accumulation, and fluctuation in Xc and PA highlight disruption of cellular membrane integrity and injury. Therefore, segmental BIA (or myoelectrical impedance system) may provide a powerful outcome measure for assessing the healing process of muscle injury

## EXCESSIVE EXERCISE HABITS IN MARATHONERS AS NOVEL INDICATORS OF MASKED HYPERTENSION

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Although appropriate levels of exercise have been found to improve vascular endothelial function and decrease blood pressure, an excessive amount of exercise increases arterial stiffness and the cardiovascular risk. Here, we aimed to assess whether the exercise characteristics of amateur, middle-aged marathoners with high blood pressure can be used as a novel indicator of masked hypertension. The subjects comprised healthy, middle-aged ( $\geq 40$ -years-old) marathoners, who had participated in marathons for at least 3 years, and regularly trained 2 times per week. A total of 571 subjects were assigned to a high blood pressure group (HBPG;  $n=214$ ), with a resting systolic blood pressure (SBP)/diastolic blood pressure (DBP) of  $\geq 140/90$  mmHg, or a normal blood pressure group (NBPG;  $n=357$ ), with a resting SBP/DBP of  $< 140/90$  mmHg. A graded exercise test was used to examine the hemodynamic response and cardiac events, and the personal exercise characteristics were also recorded. Although no difference in the personal characteristics were observed between the groups, the frequency of alcohol consumption was significantly higher in the NBPG than in the HBPG ( $p < 0.001$ ). No difference in the inHRrest, HRmax, Re-HR 1–2 min, ST depression, or arrhythmia, were observed between the 2 groups, although the SBPrest

( $p < 0.001$ ), DBPrest ( $p < 0.001$ ), SBPmax ( $p < 0.001$ ), DBPmax ( $p < 0.001$ ), VO2max ( $p < 0.05$ ), MTE ( $p < 0.05$ ), PPrest ( $p < 0.001$ ), and PPmax ( $p < 0.001$ ) were significantly higher in the HBPG than in the NBPG. The number of marathons completed and exercise frequency were not significantly different between the groups. However, the marathon history was significantly longer in the NBPG than in the HBPG ( $p < 0.01$ ), and the exercise intensity and time were also significantly greater in the NBPG than in the HBPG ( $p < 0.01$ ,  $p < 0.05$ , respectively). The marathon completion duration was significantly shorter in the HBPG than in the NBPG ( $p < 0.05$ ). Among middle-aged amateur marathoners, despite the presence of a shorter history of exercise, individuals with high blood pressure showed a higher frequency of alcohol consumption and more excessive exercise characteristics than individuals with normal blood pressure. If the individuals exhibit high blood pressure during rest as well as exercise, the exercise characteristics could be used as a novel indicator for masked hypertension.

## SURVEY OF OBSTRUCTIVE SLEEP APNEA IN JUDOISTS

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Obstructive sleep apnea (OSA) are caused by collapse of the pharynx during sleep<sup>1</sup>. OSA symptoms include excessive daytime sleepiness, aggressiveness, inattention, headache, poor memory and difficulty in socialization. Previous study reported that sleep quality relate to sports performance. These OSA symptoms may drop athlete conditions and performance because OSA reduces sleep volume and quality. In judoists, especially in heavy weight class, their physical feature may be a high risk of OSA. However, it was unknown their sleep condition of judoists. We investigated that sleep condition of judoists with questionnaire and polysomnography. Purpose The purpose of the present study was to examined the state of OSA in judoists Methods Subjects were men of 28 judoists member in university. They belonged to 5 weight categories in judo. We distributed 28 questionnaires to ask the sleep conditions, epworth sleepiness scale (ESS), which is index of OSA in judoists. Then we collected 28 question papers from judoists, and collected 100% questionnaire. Afterward we analyzed questionnaire and picked 8 judoists. To confirm the OSA, 8 judoists were measured with the polysomnography (PSG) during sleeping. Results 4 judoists were more than 11 ESS scores. 2 judoists answered that they snored during sleeping every night. And 14 judoists answered that they sometimes snored at night. 8 judoists had an experience of arousal during sleeping. 8 judoists were measured sleeping state with PSG. 2 judoists showed reduction of oxygen desaturation, and more than 5 apnea hypopnea index. Discussion OSA incidence rate of judoists was 7%. This incidence was higher than general investigation, which was found in about 2% of the Japan population. Although one judoist of OSA belong to heavy weight class, and the other judoist didn't belong to it. The judoist might have facial characteristics that are associated with OSA. Some judoists had factors of sleep disorder. We need further research on the sleep conditions in judoists, since we couldn't investigate the reason why judoists had factors of sleep disorder. Conclusion In judoists, rate of OSA prevalence might be high compared with other player and general people. References 1. Bradley TD, Floras JS. Sleep apnea and heart failure: Part I: obstructive sleep apnea. 107:1671-8 (2013)Circulation.

## FE ANALYSIS OF KINETICS AND KINEMATICS OF POSTERIOR CAPSULAR CONTRACTURE DURING SHOULDER ABDUCTION

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Introduction Posterior capsular contracture of shoulder was reported as a significant source of shoulder pain and restriction to shoulder kinematics including internal rotation and abduction. In our previous study, we investigated the effects of posterior capsular contracture during passive abduction of an intact cadaveric shoulder through a simulated plication for 6 cadaveric cases. In the current study, we carried out a finite element (FE) analysis to deduce the stress field and contact path during the passive abduction of shoulder in normal and posterior contracture (plicated) statuses. Method In our previous study, we described the posterior capsular contracture was simulated through plication and drawing the humeral head closer to the glenoid. Then, the glenohumeral motion was measured for 6 cadaveric cases during shoulder abduction. In the current study, using computational tomography (CT) images, the geometry of glenoid and humeral head for all cadaveric cases was prepared and meshed for FE analysis. In the FE analysis, the previously detected motion data of humeral head on the glenoid joint was the model input. Contact path and stress field in the contact region of glenohumeral joint were analyzed by conducting a dynamic explicit FE analysis. Result As the kinematic results, the contact path in x, y and z direction were compared for both normal and plicated states which no significant difference can be seen in the kinematics of two states. In the kinetic perspective, the joint reaction forces and stress field of humeral head and glenoid were calculated and compared for both normal and plicated groups. The results showed that in the humerus axis direction, the joint reaction force direction and magnitude changed as more compression applied to the glenohumeral joint. However, in normal direction to the humerus axis, there were no significant changes in the reaction forces. Discussion As an important outcome of this study, the experimental methods and FE analysis were combined together to analyze the kinematics and kinetics of posterior capsular contracture through a simulated plication. The FE analysis helped us to understand better the differences of shoulder kinetics and kinematics including contact path, stress field, reaction forces and joint compression and stability under both normal and plicated conditions. References DeAngelis, J.P., et al., Orthopaedic journal of sports medicine, 2015. 3(8): p. 2325967115599347 Bach, G.H. and B.A. Goldberg, Journal of the American Academy of Orthopaedic Surgeons, 2006. 14(5): p. 265-77

## THE SYNERGISTIC EFFECT OF ACUPUNCTURE USING PRESS TACK NEEDLES AND RESISTANCE TRAINING IN YOUNG ADULTS: A RANDOMIZED, DOUBLE-BLIND, PLACEBO-CONTROLLED TRIAL

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Introduction The efficacy of acupuncture in clinical studies is difficult to evaluate using double-blind tests (Streitberger et al., 1998). Press tack needles (PTNs) are small needles that are fixed with adhesive plaster and have the advantage of easy insertion into the epidermis, allowing them to be used during exercise. Miyazaki et al. (2009) performed a double-blind, randomized, controlled trial to investigate the effect of PTNs on lower back pain. In this study, a double-blind, randomized, placebo-controlled trial was performed to clarify the synergistic effect of acupuncture using PTNs and resistance training programs in young adults. Methods Sham PTNs, which looked like PTNs but without a needle tip, were developed by an acupuncture needle manufacturer. Twenty-two healthy young men aged between 22 and 23 years ( $21.7 \pm 0.6$  years) were randomly and equally assigned to two groups, namely the resistance training plus "real" acupuncture

ture with PTN intervention group (AG;  $n = 11$ ), and the resistance training and "placebo" acupuncture intervention groups (PG;  $n = 11$ ). Both the real and sham needles were applied to two meridian points (ST32 and GB31) in the lower limb area. The AG participants underwent structured acupuncture using PTNs, and their exercise regimen consisted of home-based resistance training of the lower limbs (squat) using their own bodyweight. They measured exercise intensity with the OMNI Resistance Exercise Scale (OMNI-RES, on a 10-point scale) and performed repetitions until they reached a perceived exertion intensity of 8 of 10 for 4 weeks. The PG participants underwent structured placebo acupuncture and the same resistance training program. The outcome measures were body composition, isometric peak torque in knee extension, vastus lateralis muscle thickness, 30-s chair-stand test, vertical jump, and rebound jump index. The evaluation parameters such as subjective leg pain caused by delayed-onset muscle soreness were measured on the 100-mm horizontal visual analogue scale. A Kappa statistic value was used to evaluate the validity of the PG. Results The Kappa statistical value was  $-0.36$ . After intervention, we observed a statistically significant two-factor interaction between the AG and PG groups in the left ( $F = 18.3$ ,  $p < 0.001$ ) and right isometric peak torques ( $F = 18.3$ ,  $p < 0.001$ ) in knee extension and vertical jump ( $F = 5.9$ ,  $p < 0.05$ ). However, no statistically significant synergistic effect of "real" acupuncture using PTNs and resistance training was observed in the other measures. Conclusion This result suggests that the effect of exercise may be enhanced by intervention with concurrent acupuncture using PTNs. Acknowledgment This work was supported by JSPS KAKENHI Grant Number 15K01638. References Miyazaki S et al. (2009). Applicability of press needles to a double-blind trial: a randomized, double-blind, placebo-controlled trial. *Clin J Pain*, 25(5), 438-44. Streitberger K et al. (1998). Introducing a placebo needle into acupuncture research. *Lancet*, 352, 364-365. Contact terada@sta.tenri-u.ac.jp

## Training and Testing

### COMPLEX TRAINING: THE EFFECT OF EXERCISE SELECTION AND TRAINING STATUS ON POST-ACTIVATION POTENTIAL IN RUGBY LEAGUE PLAYERS.

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1. Department of Sport Health and Exercise Science, University of Hull, UK. 2. School of Public Health, Physiotherapy and Sports Science, University College Dublin, Ireland. Introduction Complex training is underpinned by post-activation potentiation (PAP) which theorises that the explosive capability of a muscle is enhanced following a near maximal voluntary contraction. An individual's response to complex training differs due to factors including the recovery interval, exercise selection and training status (Tillin and Bishop, 2009). The aim of this study was to compare the PAP response of the hexbar deadlift (HBD) and back squat exercises (BS) in professional and amateur rugby league players. Methods Ten professional and ten amateur rugby league players performed two experimental sessions. Participants performed a vertical countermovement jump before and, 2, 4, 6, 8, 10, 12, 14 and 16 minutes after a conditioning activity (CA). This comprised of 1 set of 3 repetitions at 93% 1RM of either HBD or BS. A force platform was used to determine peak power output (PPO), force at PPO, velocity at PPO and jump height of each countermovement jump. The surface EMG of the vastus lateralis, rectus femoris, tibialis anterior and gastrocnemius medialis of each participant's dominant leg was recorded during each countermovement jump. Ten participants performed a control trial without a CA. For all variables, the post-CA jumps were compared to baseline. Results PPO improved for the HBD at 2 ( $p < 0.001$ ), 4 ( $p = 0.01$ ) and 6 minutes ( $p = 0.002$ ), but was not improved for BS. PPO decreased for the control group at 16 minutes ( $p = 0.016$ ) but did not for HBD or BS. For both HBD and BS force at PPO improved at 4 minutes ( $p = 0.014$ ). For both HBD and BS velocity at PPO decreased at 16 minutes ( $p = 0.004$ ). Velocity at PPO decreased for the control group at 14 minutes ( $p = 0.05$ ) but did not for HBD or BS. There were no changes in jump height or EMG variables. There were no differences between professional and amateur players. Discussion Results of this study suggest that HBD elicits PAP earlier than the BS. HBD is an effective alternative to BS as it is a safer, less technically demanding exercise which enables greater loads to be lifted (Swinton et al., 2011). Complex training appears to be a suitable training modality for professional and amateur rugby league players. Methods of altering the force-velocity curve during the CA should be investigated to make the movement more specific to the plyometric activity (Crum et al., 2012). References Crum, A., Kawamori, N., Stone, M., Haff, G. (2012). *J Strength Con Res*. Swinton, A., Stewart, A., Agouris, I., Keogh, J., Lloyd, R. (2011). *J Strength Con Res*. Tillin, N., Bishop, D. (2009) *Sports Med*. Contact david.scott@hull.ac.uk

### THE DIAGNOSTICS OF ED ELEMENTS IN COMPETITIVE SPORT

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THE DIAGNOSTICS OF SELECTED ELEMENTS IN COMPETITIVE SPORT (ILLUSTRATED WITH AN EXAMPLE OF POLISH WOMAN BASKETBALL FIRST LEAGUE) Introduction The basic element of controlling training process is a verification of effectiveness and accuracy of used methods in purpose of supervising training and sport competition (Gabrys and Kosmol 2000, Neuman et al. 2005, Ozimek 2007, Zemkova 2008). The aim of this papers is to present the selected elements of diagnostics in competitive sport with special attention to the determination raining indicators in selected areas of motor preparation of team members of Polish basketball woman first league. Methods The research included 15 members of Polish woman basketball of first league. The program of the research was as follows: Warm-up. Psychomotorics on a large field (before and after effort) – a test evaluating reaction and orientation speed performed by legs on a field of 3 meters (a square; Fitro Agility Check). Evaluation of lower limbs (before and after effort) – tests: SQUAD JUMP, CMJ – Counter movement jump with and without backswing and DROP JUMP. Aerobic capacity – BIP TEST – every 3 min. increase in load and biochemical examination (K4b2 Cosmed; BIOSEN C-line). Results The results point to a direct aim of conducted research and determine the effect on the controlled indicators on the effectiveness of training, comparisons between participants, evaluation of oxygen consumption, determination of the kinetics of oxygen deficit and oxygen debt as well as determination of the level of lactate at different moments of effort. The results of this research provide direct information on the state of preparation and its possibilities related to the conducted control of training effects. Discussion The scope of training control and its effect should include a wide range of observations. Their most important elements include: biochemical supervision, physiological supervision of anaerobic and aerobic capacity in laboratory conditions as well as conditions specific to a particular sports discipline, physical fitness and specialist preparation regarding power, force, speed, speed and strength endurance as well as the analysis of a sports training conducted in a training series (Gabrys and Kosmol 2000, Zemkova 2008). Numerous questions related to success and failure of a sportsperson can be answered by a sports training diagnostician. What is more, comprehensive and systematic diagnostics supports both the work of a player and a trainer (Neuman et al. 2005, Ozimek, 2007). Acknowledgements The scientific work funded from the budget centers on the science in years 2015-2018 grant N N RSA3 01753, No Nr

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### EFFECTS OF HIGH INTENSITY INTERVAL TRAINING DURING THE TRANSITION PERIOD IN FOOTBALL PLAYERS SUB-19

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**Introduction** Currently exists a growing interest in the application of high-intensity interval training (HIIT) in football (Buchheit et al. 2013). HIIT has shown efficiency to improve performance variables in team sports (laia et al. 2009). However, little research has been reported regarding the effects of HIIT on performance after winter transition period in football. Therefore, the aim of this study is to compare the effects on performance versus traditional training HIIT during the winter transition period in football players U19. **Methods** A total of 40 players (20 players U19 of premier league and 20 players of second league) of 17.8±0.4 and 16.8±0.4 years respectively performed a program of 3 sessions during the week of winter transitional period (7 days). The HIIT group, performed a high-intensity interval training that consisted of 5 repetitions of 15 seconds at 140% of your Maximum Aerobic velocity (VAM) followed by a period of 45 seconds at 60% VAM, plus 5 core exercises (2x30"). NO-HIIT group, performed 30 minutes of continuous running at 60% of maximum heart rate. The training sessions were monitored with Runtastic mobile application and a training log. The performance were measured before and after the transition period: countermovement jump test (CMJ) using MyJump, squat power test by SmartCoach and body composition variables (body mass and fat percentage). Student's test was performed to analyze the differences for independent variables with software SPSS v.20 for Macintosh. **Results** The change percentage for the power in half squat ( $p=0.05$ ) and CMJ ( $p=0.03$ ) was significantly negative for NO-HIIT group. After the transitional period, both groups showed significant intra-group increases for fat percentage (HIIT group: 6.37±7.9; NO-HIIT group: 3.80±5.75;  $p=0.01$  and 0.02 respectively). **Discussion** The main finding of the study was that HIIT group obtained favorable results for power variables. A similar study showed that football players achieved to maintain the values of VO2max during the transitional period, with a lower density of HIIT sessions (Slettalokken et al. 2014). Other studies have shown the effectiveness of HIIT training versus continuous training for both VO2max and power variables in young players (Sperlich et al 2011; Piliandis 2013 et al.). These results could show that intermittent high intensity training can be a useful method and recommended to maintain or even improve variables such as average power in squat and CMJ during the transitional period. **Conclusion** The HIIT group showed significantly favorable results for the half squat and power CMJ compared with NO-HIIT group. The fat percentage was significantly increased in both groups.

### HEART RATE AND PERCEPTUAL ACUTE RESPONSES OF PRACTITIONERS DURING THE DIFFERENT MOMENTS OF CAPOEIRA CLASS

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**Introduction** Among the sports eliciting acute cardiovascular adaptations, we can highlight Capoeira as a Brazilian martial art/dance that has spread worldwide (Silva et al., 2012). **Objective** To analyze the heart rate (HR) and perceptual acute responses of practitioners during the different moments of Capoeira class. **Methods** Sixteen physically active adults (10 male: 26.4±5.2y; 06 female: 30.3±8.8y) performed a Capoeira class with continuous monitoring of HR (ZEPHYR®), rate perceived exertion - RPE (Borg Scale [6 to 20]), felling scale - FS (+5 to -5) and perceived activation - PA (+1 to +6). The Capoeira class composition, which lasted for 60', was from: a) 2' playing rhythm instruments; b) 2' singing songs; c) 8' to warm-up; d) 3 sets with 2' of ginga by 1' recovery each; e) 3 sets with 2' of technical movements by 1' recovery each; f) 12' with passive participation in Capoeira circle and; g) 1' of Capoeira game in the circle. The remaining time (23') was distributed in recovery between movements during the class. On different day a maximal incremental test in cyclergometer (CEFISE®) was performed starting at 25W (Fem) and 50W (Male) with increments of 25W every 1' until exhaustion (50 RPM's), to anaerobic threshold (AT) and maximal power (PMAX) determination. **Results** When compared to rest of total sample the HR (77±13 bpm) increased ( $P<0.01$ ) from warm-up (102±12 bpm) until Capoeira circle (135±25 bpm), as well as differed from the total class average (117±13 bpm). To verify the Capoeira class HR in relation to aerobic fitness, it was found that the total class average occurred at 80±10%AT and 65±7%PMAX. The RPE shows increase ( $P<0.01$ ) from rest (8±3 pts) to ginga (12±2 pts), technical movements (14±2 pts), Capoeira circle (14±2 pts) and total class average (11±2 pts). The other perceptual variables did not change ( $P>0.05$ ) from rest to different moments of the class, with FS keeping in the total class average at 3±2 pts and PA at 4±1 pts. **Discussion** The main finding of study was that a Capoeira class, characterized by its main movement (ginga), and by several others, as well as by moments for the musical rhythm with singing and playing characteristic instruments, acutely increase the HR and RPE in practitioners. These results suggest that Capoeira can be a physical activity strategy for cardiovascular adaptations. Besides, it is speculated from the modulation of the RPE and FS during the class, that Capoeira can be an important tool for adherence to an individual in the regular physical activity. **Conclusion** A single Capoeira class increase acute and significantly the HR and perceptual responses of practitioners. **Reference** Silva FF, Souza RA, Carvalho WRG, Costa RP, Jerônimo DP, Silveira Júnior L. Analysis of acute cardiovascular responses in experienced practitioners of Capoeira: A Brazilian art form. JEPonline 2012;15: 112-119. Contact serginhocapo@gmail.com

### THE RELATIONSHIP BETWEEN PHYSIQUES AND PHYSICAL STRENGTH IN JUNIOR HIGH SCHOOL STUDENTS

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1. **Introduction** Junior high school age is an acceleration period in physical growth and development. Especially, the cardiorespiratory function is significantly improved in this period. This study is to examine the relationship between the change of physiques and physical strength in junior high school students. We especially focused on endurance and instantaneous speed as physical functions. 2. **Methods** The data was collected from 110 junior high school students (60 males and 50 females). We measured their body height, body weight, and records of long-distance running (male:1500m and female:1000m) and short-distance sprint (50m) for three years. We collected the data every year in spring. We used ANOVA to find the mean difference among three different grades, and also used t-test for comparing two groups. The relationship between the change of physiques and two records of running was examined by correlation analysis with Spearman's coefficient. We adopted significance level of less than 5% for all the tests in this study. 3. **Results and Discus-**



sion According to Sakamoto(2004), the paces of development in physiques and physical skills vary considerably from person to person in the period, from 13 to 14 years old, in both male and female. We could see several differences regarding physiques and physical skills in this study. For example, as to short-distance sprint, the records have been improved with advancing age among male students, and there was a difference between first grade and second grade students among female students. We also could see strong correlation between body weight and long-distance running among all grades in male students, and among first grade and second grade in female students. In terms of the relationship between physiques and differences of physical strength among each grade, there was a significant relationship between the difference of body height and the difference of record of long-distance running among first grade and second grade students for female. 4. Discussion Physical growth has highly influenced on improving both endurance and instantaneous exercise performance in the junior high school period. Especially, we could see a remarkable tendency in the short-distance sprint. It can be very important for the junior high school students to consider the influences of the change of their body weight on exercise performance because they are still in the progress of physical development. Reference Sakamoto Y et al. (2004). A study on change of the physical fitness and motor ability from the view of exercise behavior in junior high school students. J.Fac.Edu.Saga Univ., 9(1), 259-265. Contact keishi@kokugakuin.ac.jp Do not insert authors here

## THE LONG-TERM EFFECTS OF SPRINT INTERVAL TRAINING ON PHYSIOLOGICAL RESPONSE TO REPEATED MAXIMAL SPRINT CYCLING

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THE LONG-TERM EFFECTS OF SPRINT INTERVAL TRAINING ON PHYSIOLOGICAL RESPONSE TO REPEATED MAXIMAL SPRINT CYCLING Introduction While interval training is considered an effective modality for improving performance, there is a lack of data on the physiological adaptation to repeated sprint exercise over several months of training. The aim of the study was to compare the effects of two training strategies on cardiorespiratory response and work output in a sprint interval training-test in well-trained cyclists. Methods Twenty cyclists were randomized into two groups for 16 weeks of exercise training. Group E completed a traditional endurance training whereas the training of group I was modified to include sprint interval training (SIT) twice per week. Performance and physiological variables were measured by the SIT test on a Cyclus2 cycle ergometer (RBM, Germany) at three time points: pre- (T1), peri- (T2; 8 weeks), and post-intervention (T3; 16 weeks). The test involved a 20-min warm-up followed by three sets (S1, S2, S3; each separated by 20–30 min of active recovery) of four 30-s maximal bouts interspersed with 90-s recovery periods. Oxygen uptake (VO<sub>2</sub>), carbon dioxide production (VCO<sub>2</sub>), and pulmonary ventilation (VE) were measured using a Quark gas analyzer (Cosmed, Italy) and work output was determined. Data were aggregated for each set. Results Relative VO<sub>2</sub> significantly increased in group I at T2 (39.3±7.1, 40.4±8.1, 40.7±7.4 l/l) in S1, S2, S3) and T3 (40.2±6.9, 41.2±6.7, 41.3±7 l/l) compared with T1 (35.4±6.7, 36.8±6.4, 37.6±6.3 l/l), respectively, whereas no significant differences were observed in group E across the time points. VE, VCO<sub>2</sub> and work output had the same direction of change as VO<sub>2</sub> for groups I and E. Discussion Many authors have suggested that interval and endurance training are two modalities that induce beneficial physiological adaptations as measured by incremental testing (Bouchard et al., 2011; Roxburgh et al., 2014). However, Sloth et al. (2013) indicate that endurance training alone is unable to further elicit improved performance in well-trained athletes. Our findings indicate that a combined endurance and interval training protocol is more effective in increasing cardiorespiratory response and work output to repeated sprint exercise than conventional endurance training alone in athletes with several years training experience. At the same time, extended interval training (above 8 weeks) shows a plateau effect although effective in maintaining previously induced training adaptations. References Bouchard C, Sarzynski M, Rice T, Kraus W, Church T, Sung Y, et al. (2011). J Appl Physiol, 110,1160-1170. Roxburgh B, Nolan P, Weatherwax R, Dalleck L. (2014) J Sport Sci Med, 13,702-707. Sloth M, Sloth D, Overgaard K, Dalgas U. (2013). Scand J Med Sci Spor, 23,341-352. Supported by MNISW, grant nr NRSA300253 Contact paulinahebisz@interia.pl

## THE SPECIAL JUDO FITNESS TEST IN COMPETITOR PREPARATION DIAGNOSTICS DURING AN ANNUAL TRAINING PERIOD.

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THE SPECIAL JUDO FITNESS TEST IN COMPETITOR PREPARATION DIAGNOSTICS DURING AN ANNUAL TRAINING PERIOD. Szmatlan-Gabrys U.1, Garnys M.2, Gabrys T.3, Ozimek M.1 1: AWF (Krakow, Poland), 2:4SportLab (Warszawa, Poland), 3:AJD (Czestochowa, Poland) Introduction: A correlation analysis carried out between the values of capacity indicators, and special fitness, is a tool allowing us to determine the relationship and interaction between competitor preparation periods, and the appropriateness of the choice of supervision methods. (Franchini et al 2009 ) The aim of the research was to either confirm, or refute the hypothesis concerning the universal character of the SJFT in the evaluation of the preparation of the judoist. Methods. During the annual training period capacity indicators of 23 international sport level judoists aged 19-26, in 66-81 kg weight categories were registered. The subjects carried out three tests four times: Wingate Test with Pmax registration (W/kg, b.w) WTOT(J/kg, b.w) and IF(%), SJFT, registering index; during the treadmill Incremental Exercise the VO<sub>2</sub>, VCO<sub>2</sub>, VE, and HR were registered. (K4B2, Cosmed) The character and strength of the relationship between test indicators during the general preparation period (GPP), the special preparatory periods (SPP), and the competition period, were determined by means of a statistical analysis. Results. The statistically relevant correlations between the aerobic, anaerobic, and special capacity indicators divided the indicators into two indicator groups assigned to training periods. In GPP- SJFT, and VO<sub>2</sub>max (r=.397, p.05), as well as IF (r=-.396, p.05), SPP- SJFT with WTOT (r=.411 p.05),and Pmax (r=.405 p.05), CP - SJFT with WTOT (r=.425 p.05), and IF (r=-.461 p.05) Discussion. The research did not confirm the universal evaluation of special preparation of the judoist by means of the SJFT (Franchini 2009) A lack of relationship was shown between aerobic capacity and SJFT in SPP, and CP, as well as with anaerobic capacity in GPP. The statistically relevant relationship between the SJFT index and aerobic metabolism which was indicated by the research by Franchini et. al. (2011) was not confirmed. In SPP, and CP, WTOT correlates with SJFT index. Periodically the IF value shows a relationship with SJFT index value. (GPP, and CP r= -.396, r=-.461, respectively). In GPP aerobic, and in SPP, and CP anaerobic training measures dominate. Then, there appears also relationship between IF, WTOT, Pmax, and SJFT index. It can be stated, that SJFT is a tool evaluating the special preparatory judoist during training periods characterized by a great deal of anaerobic training loads. In training periods in which judoist passes from metabolic, anaerobic training loads to metabolic aerobic ones, SJFT is not a good judoist evaluation tool. Grant RSA3 01753. References: Franchini et al 2009 Arch. Budo 5:127-129 Francini et al. 2011, Int.J.Sport Phys.Perf. 6:334-343 Contact: ulagabrys1957@tlen.pl

## COMPARATIVE ANALYSIS OF MEN'S AND WOMEN'S ATTACK IN ESTONIAN VOLLEYBALL CHAMPIONSHIP LEAGUE

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**Introduction** Do the attack tactics of men and women in the highest volleyball league of Estonia differ and how? Which is the tempo of attack and are more spikes or decoys used, and what is the efficiency of different types of attack in men's and women's games? **Methods** A total of 20 videos of men's and women's championship games of 2014/2015 were analysed, and the tempos and types of attacks were registered. The assessment of the tempo of attack was based on Selinger's classification which uses three categories: tempo 3 — a slow tempo when the attacker begins the steps of approach when the set ball has reached the highest point of its flight trajectory; tempo 2 — a medium tempo, the attacker begins the steps of approach when the ball has left the setter's hands, and tempo 1 — a quick tempo where the attacker performs the approaching steps before the setter touches the ball (Selinger, 1986). To determine the type of attack the distinction between vigorous attack and set attack or decoy was used. Data Volley and Volleysoft 6-3 statistics programs were used to estimate the efficiency of attack. Multinomial logistic regression was applied to analyse the attack actions that could differentiate male and female game profiles. **Results** The difference between men and women appears in tempo 3 and tempo 1, as men use tempo 3 or the slow attack least of all the tempos of attack (11.2%), which refers to the faster attack action in men's games and to the tendency to attack against one blocker or against a block with a hole in it. In women, however, tempo 3 attacks were more frequent than tempo 1 attacks. The results of regression analysis showed that in men's teams the opportunity to perform a tempo 1 attack compared to tempo 3 was 1.48 times greater than in the case of women. In the case of tempo 2 attack compared to tempo 3, in men the potential performance of tempo 2 is 1.8 times greater than in women ( $p < 0.05$ ). The analysis of attack types revealed that both men and women use vigorous attacks in games more often than decoys. The difference between men and women lies in the relation between using the decoy and the spike. Women use the decoy in games 8% more than men do. **Discussion** Women's attack activity had lower proficiency than men's. Men gained a point from 46.2% of attacks, women — from 36.2%. For comparison, men's mean result in World Championship games in 2011 was 50.2% and in Brazilian women's Super League in 2012 38.7% (Costa, 2014). In conclusion, it can be said that in Estonian men's championship games tempo 1 attacks are used statistically significantly more often than in women's games. Men are more proficient at attack and use vigorous spike more often than women do. **References** Selinger, A., Ackermann-Blount, J. (1986) Arie Selinger's power volleyball. New York: St. Martin Press. Costa, G., Afonso, J., Barbosa, R., Coutinho, P., Mesquita, I. (2014) Predictors of attack efficiency and attack type in high level Brazilian women's volleyball. *Kinesiology* 46, 2, 242-248.

## THE COMPARISON OF BONY STRUCTURES BETWEEN JAPANESE AND FRENCH POPULATION ACCORDING TO THE PHYSICAL ACTIVITY LEVEL.

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**Introduction** It has been widely noted that weight trainings such as bench press or squat are closely related to the bone density. However, it still remains unclear how weight training can effect bony structures other than bone density. Newly invented the LD-100 system (Oyo Electronics, Kyoto, Japan), which is a fast, non-invasive ultrasonic instrument, can measure the new indexes of bone other than bone density. Furthermore, to our knowledge, international comparison such as Japan vs. U.S. regarding bony structures has not been conducted. Thus our aim of this study is to compare the Japanese and French population in bony structures based on physical activities, especially focusing on the contact sports athletes who regularly perform weight training as to examine how weight training effects the bone formation. **Methods** As Japanese population data, we collected 2 types of the subjects: (1) the contact sports athletes who are collegiate American football players ( $n = 56$ , age= $20.5 \pm 1.2$  years), regularly performing weight training, (2) the non-contact sports athletes ( $n = 24$ , age= $20.1 \pm 0.5$  years), referring to the data collected by Fujisawa et al. (2009). As French population data, we referred to the data collected by Breban et al. (2010), there are 2 types of the subjects: (1) the athletes ( $n = 22$ , age= $24.2 \pm 4.3$  years), (2) the controls who are non-athletes ( $n = 19$ , age= $27.4 \pm 4.8$  years). The data regarding the indexes of bone for the attenuation of waves (dB), radius thickness (mm), cortical thickness (CoTh, mm), and elastic modulus of trabecular bone (EMTb, GPa) were collected by the LD-100 system. All statistical analyses were performed by one-sample t-test. We set the alpha level at .05. **Results** Significant differences ( $p < 0.01$ ) were found in 6 of the 12 comparisons. Of note, the Japanese contact athletes were significantly higher in dB, CoTh, and EMTb than Japanese non-contact sports athletes and French non-athletes. **Discussion** We found that the contact athletes who regularly perform weight training showed superior bony structures. Our results may imply that, besides bone density, weight-training activities can improve the other bony structures. **References** 1) Breban et al. Trabecular and cortical bone separately assessed at radius with a new ultrasound device, in a young adult population with various physical activities. *Bone*. 2010 Jun;46(6):1620-5 2) Fujisawa et al. Proposed application of a bone density measurement to the evaluation of athlete's talent (III). *Doshisha Journal of Health & Sports Science*. 2009 1: 19-26 Contact Junta Iguchi: iguchi@kyotogakuen.ac.jp

## ENERGY SYSTEM INTERACTION DURING BASKETBALL EXERCISE SIMULATION IN JUNIOR ELITE PLAYERS

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**Introduction** The Basketball Exercise Simulation Test (BEST) has been proposed as a novel match-simulating fitness test for elite basketball players showing both discriminative and longitudinal validity (Scanlan et al., 2012). However, the energetic profile of the BEST is not known. Therefore the aim of this study was to assess the energetic profile of the BEST in junior elite basketball players. **Methods** 10 male elite junior basketball players (age:  $15.5 \pm 0.6$  y, height:  $180 \pm 9$  cm, weight:  $66.1 \pm 11.2$  kg) performed a modified BEST (20 circuits on half-court ( $\approx 1348$  m) consisting of jumping, sprinting, jogging, shuffling action and short breaks; Scanlan et al., 2012) simulating a 10 min quarter of FIBA Europe basketball play. Besides circuit time (C in s), sprint time (S in s) and sprint decrement (SD in %),  $\text{VO}_2$  (in ml/kg/min), heart rate (HR in bpm) and blood lactate concentration (blc in mmol/l) were obtained. Metabolic energy and power above rest (Wtot in kJ, Ptot in Watt/kg) as well as energy share (in kJ, %) were calculated from oxygen uptake during exercise (W<sub>aer</sub>, aerobic component), net lactate production (W<sub>blc</sub>, lactic component) and the fast component of post-exercise oxygen uptake kinetics (W<sub>pcr</sub>, alactic component) (Beneke et al., 2004). Interrelations between metabolic energy estimates and performance measures were assessed by linear regression. **Results** BEST performances (C:  $21.29 \pm 1.17$  s, S:  $1.65 \pm 0.13$  s, SD:  $11.9 \pm 4.2$  %) elicited peak values of  $\text{VO}_2$ , HR, BLC of  $57.6 \pm 3.7$  ml/kg/min,  $202 \pm 9$  bpm,  $10.3 \pm 2.1$  mmol/l, respectively. Wtot of  $761.0 \pm 168.4$  kJ and Ptot of  $19.3 \pm 1.6$  Watt/kg were supplied by a W<sub>aer</sub> of  $673.3 \pm 144.1$  kJ ( $89 \pm 2$  %), a W<sub>blc</sub> of  $38.7 \pm 13.2$  kJ ( $5 \pm 1$  %) and a W<sub>pcr</sub> of  $49.0 \pm 16.5$  kJ ( $6 \pm 1$  %), respectively. Assuming an aerobic replenishment of pcr energy stores

during short breaks (8-10s) between circuits (Beneke et al., 2004), the adjusted energy share during BEST yielded Waer:  $66\pm4\%$ , Wblc:  $5\pm1\%$  and Wpcr:  $29\pm1\%$ . In a stepwise linear regression model Waer explained 54% of variance in S, while Wblc and Wpcr did not further enhance the model. Discussion Consistent with general findings on energy system interaction during maximal exercise (Gastin et al., 2001) our data shows that the intermittent profile of junior elite basketball simulated by BEST primarily relies on aerobic energy. Additionally, a substantial repetitive alactic energy contribution seems to be present. These findings should be considered when basketball specific training programs are designed. References Beneke R, Beyer T, Jachner C, Erasmus J, Huettler M. (2004). Eur J Appl Physiol, 92(4-5), 518-23. Gastin PB (2001). Sports Med. 31(10), 725-41 Scanlan AT, Dascombe BJ, Reaburn PR (2012). J Strength Cond Res, 26(2), 523-30.

## THE INFLUENCE OF BACK AND LEG EXTENSOR MUSCLE POWER ON THE SPECIFIC MOTOR SKILLS OF YOUNG WATER POLO PLAYERS

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The aim of this research was to determine the extent of the influence of the power of back and leg extensor muscles on the specific motor skills of young, school-aged water polo players. The sample of participants in this paper consisted of 20 water polo players ( $N=20$ ), chronological age 12-14, average body weight  $85,95\text{kg}$  ( $\pm 27,15\text{kg}$ ), average body height  $174,5\text{cm}$  ( $\pm 10,25\text{cm}$ ), seated height  $84,25\text{cm}$  ( $\pm 7,55\text{cm}$ ), arm range  $183,70\text{cm}$  ( $\pm 11,30\text{cm}$ ), average thorax volume  $103,15\text{cm}$  ( $\pm 15,65\text{cm}$ ), upper arm volume  $33,45\text{cm}$  ( $\pm 6,75\text{cm}$ ), upper leg volume  $62,10\text{cm}$  ( $\pm 10,60\text{cm}$ ) and body mass index  $26,02$  ( $\pm 7,05$ ). The anthropometric characteristics were measured using standard anthropometric instruments (GPM, Switzerland). In order to evaluate muscle power, the IMADA 32X-1100 Japanese digital instrument for measuring power, with the software program WinWedge 3.4, was used. In order to evaluate the specific motor abilities, we used a battery of 6 tests (4 tests for the evaluation of swimmer fitness in the horizontal position and 2 two tests for the evaluation of specific motor skills in the vertical position of water polo players). In order to determine the level of muscle power influence we used the canonical correlation analysis and the regression analysis. By using Bartlett's Lambda test we determined that the variables of power and specific motor tests are linked to a single pair of canonical factors at the  $p=0,05$  level. The canonical correlational analysis indicated that the greatest influence of muscle power was realized on the variable 30SCBJ ( $-0,76$ ). The regression analysis showed that there is a mid-intensity correlation between absolute and relative values of back extensor muscle power and the tests of specific motor skills. A partial analysis of the criterion variables indicated that the factors of muscle power realize the greatest statistically significant influence on the 10XCBJ test at the level of  $p=0,05$ . The results of this study have indicated that the program based on specific extensive high intensity exercise can achieve significantly better results in the development of certain anthropological dimensions, as well as that they are significantly correlated in the sample of young water polo players. The generalization of the results obtained in this study can primarily be applied to the population of young water polo players included in this study.

## IMPACT OF PHYSICAL TRAINING PROVIDED IN 12 DIFFERENT SWISS ARMY BASIC MILITARY TRAINING SCHOOLS ON FITNESS DEVELOPMENT OF TRAINEES

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Introduction It is essential to provide recruits with an appropriate physical fitness training (PT) during basic military training (BMT) to boost their fitness level for the successful completion of military tasks and for injury prevention (Wyss et al., 2014). The aim of this study was to investigate the impact of different physical training quantities provided on fitness development in 12 Swiss Army BMT Schools. Methods All recruits of 12 Swiss Army BMT schools were asked to volunteer in this study. Their physical fitness was tested at the beginning and after 10 weeks of BMT using a fitness test battery which consists of five disciplines described in Wyss et al. (2007) and results in a total fitness score (FS) ranging from 0 to 125 points. The PT-instructors registered the duration and content of each PT session in a questionnaire. A linear regression was conducted to quantify the influence of PT quantity, proportion of sports games within PT and initial fitness level on fitness development. Results 1329 recruits from 12 different BMT schools volunteered in this study. The subjects were  $20,69\pm 0,14$  years old, had a height of  $177,57\pm 0,87$  cm and a body mass of  $73,69\pm 1,48$  kg. At the beginning of BMT, an average FS of  $74,85\pm 4,68$  points was reached, whereas, after 10 weeks,  $80,98\pm 6,38$  points were achieved. The training schools provided mandatory PT for  $124,05\pm 40,26$  minutes per week, of which  $26,09\pm 12,49\%$  was spent on sports games. The linear regression model showed that a low initial FS ( $B=-1,033$ ,  $p=0,026$ ) and a high amount of time spent on PT ( $B=0,128$ ,  $p=0,021$ ) were significant predictors for an increase in FS. Together with the factor "low percentage of sports games" ( $B=-0,253$ ,  $p=0,078$ ) and the intercept of 76.41, these variables describe 68.1% of the variances of the change in FS between BMT schools ( $R^2=0,681$ ,  $p=0,022$ ). Discussion The results indicate that on average, 60 minutes of PT per week are needed to maintain the initial fitness level, whereas 140 minutes are needed for a fitness improvement of 10%. The higher the initial FS, the higher the amount of PT necessary to improve the fitness level. However, not only the quantity, but also the quality of provided PT is crucial. A high percentage of sports games seems to be detrimental to fitness development. Sport games might be more often provided when PT-instructors are lacking time to prepare the PT sessions. It can be concluded that a certain amount of time has to be invested in both the preparation and the execution of PT to ensure recruits are getting physically fitter during their military service. References Wyss et al. (2007). Schw Z Sportmed, 55 (4), 126-131. Wyss et al. (2014). Mil Med (179), 49-55. Contact nadja.beeler@baspo.admin.ch

## RELATIONSHIP BETWEEN SPECIAL FITNESS TEST SCORE AND ANAEROBIC LOWER LIMB POWER AMONG FEMALE JAPANESE JUDOKAS

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Introduction The judo is performed by the Olympic Games and the world championship. The purpose of this study was examined the relationship between Special Judo Fitness Test (SJFT) index and lower limb power in female Japanese judokas. Methods Seventeen female judokas (mean age  $20,9\pm 0,8$  yrs, mean height  $162,9\pm 5,6$  cm, and mean body mass  $70,3\pm 12,9$  kg) performed the SJFT, which comprised three periods (1st =15 seconds, 2nd and 3rd=30 seconds interspersed with 10 seconds rest intervals) test for judo players. During this test, one athlete threw two others positioned 6 m from each other using the ippon-seoi-nage (one arm back carry throw) technique, created and described by Sterkowicz (1995). The following variables were quantified: throws performed during series 1st, 2nd, and 3rd; total number of throws. Anaerobic lower limb power was measured using 30 seconds Wingate Anaerobic Test (WAnT) carried

out by ergometric cycle. Data was analyzed with Pearson's correlation test between the number of throw by SJFT and lower limb power, and used repeated measures ANOVA. Significance level was adopted as  $\alpha=0.05$  and  $\beta=0.30$  (effect size  $|r|$  is used as the evaluation by Cohen [1988]) were used in analyses [Small: .10, Medium: .30, and Large: .50]. Results & Discussion Mean values ( $\pm$ SD [lower 95%CI, upper 95%CI]) the number of SJFT throws were 1st:  $5.3\pm0.7$ , 2nd:  $9.8\pm0.9$ , 3rd:  $9.9\pm0.8$  ( $p<0.001$ , generalized eta squared=.885 [1.802, .934], generalized omega squared=.878 [1.791, .930], and probability of replication=1.00) [Olejnik and Algina [2003]], and total throws was  $24.9\pm2.2$ . The values of mean power and peak power were  $436.8\pm83.3$  watts and  $567.3\pm117.4$  watts. It was negative correlation between the number of total throw by SJFT and lower limb power (mean power:  $r=-.554$  [-.817, -.101],  $p=.021$ , and power=.67. And peak power:  $r=-.496$  [-.789, -.020],  $p=.043$ , and power=.55). Szmuchowski (2013) reported no significance correlation between the SJFT and WAnT results, which was supported in this study. On the other hand, Franchini et al (2009) who found a correlation between the SJFT and WAnT results. It is necessary to consider whether this SJFT is effective for female judo players. References Sterkowicz S. (1995). Antropomortoryka 12: 29-44. Cohen, J. (1988). Statistical Power Analysis for the Behavioral Sciences 2nd, Psychology Press, UK. Olejnik S, Algina J. (2003). Psychol Methods, 8 (4): 434-447. Szmuchowski LA, Rodrigues SA, Corgosinho RF, Pinheiro GS, Pedrosa GF, Motta Drummond MD, Gonçalves R, Rohlfes IM, Couto BP. (2013). ARCHIVES OF BUDO, 9 (3), 175-179. Franchini E, de Moraes Bertuzzi RC, Takito MY, Kiss MA. (2009). Eur J Appl Physiol. 107 (4): 377-83. Contact okawa@budo-u.ac.jp

## EFFECTS OF PLYOMETRIC TRAINING WITH BLOOD FLOW RESTRICTION ON MUSCULOSKELETAL PERFORMANCE AND MUSCLE DAMAGE IN YOUNG ADULTS

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Introduction Plyometric training (PT) is efficient to develop high levels of force, as well the use of high training loads. On the other hand, the development of strength through low intensity exercises with blood flow restriction (BFR) have been used in different populations with positive results. However, the BFR method was not investigated in association with PT. In this sense, the aim of this study was to investigate the effects of PT with BFR and without BFR on musculoskeletal performance, anthropometry and muscle damage. Methods 20 men (18-30 years) were divided in two groups; PT-BFR ( $n=12$ ) and TP ( $n=8$ ) and evaluated before and after a eight week PT protocol. They trained twice a week with BFR (PT-BFR) and without BFR (PT). Musculoskeletal performance was measured using 10m and 30m speed tests, T-40 agility test, horizontal jumps (HJ), vertical jumps (VJ) and the maximum voluntary contraction (1MVC) in the squat exercise. Percentage of fat, lean mass and lower limbs muscular volume were measured. Muscle damage was assayed by plasmatic activity of creatine kinase (CK) and lactate dehydrogenase (LDH). Results PT-BFR group revealed increases in 30m, T-40, HJ, VJ and 1-MVC tests. PT group improved the 10m, HJ and VJ tests. Despite both groups have shown improvements in the performance tests, the PT group demonstrated significant increases compared with the PT-BFR in the percentage of change of 10m and VJ. There was a correlation between the percentage change of 30m and VJ test in the PT group. It was observed a decrease of fat percentage in both groups. CK and LDH activity were not changed. Discussion Similar data regarding performance observed in this study were found by Cook, Kilduff and Beaven (2014). They found increases in 40m sprint test in the group without BFR and improvements in the CMJ in the BFR group. The increased capacity to produce force after the training, without gains of lean mass may be explained through enhanced activation and synchronization of motor units, firing frequency and co-contraction (CREER et al., 2004). The absence of differences in the CK and LDH activities are probably due to the 72h rest given after the last training bout before the collection. References COOK, C. J.; KILDUFF, L. P.; BEAVEN, C. M. Improving strength and power in trained athletes with 3 weeks of occlusion training. Int J Sports Physiol Perform, 9(1), 166-72, 2014. CREER, AR; RICARD, MD; CONLEE, RK; HOYT, GL; PARCELL, AC. Neural, metabolic, and performance adaptations to four weeks of high intensity sprint-interval training in trained cyclists. Int J Sports Med, 25(2), 92-8, 2004. Contact enrico@usp.br

## THE INFLUENCE OF KNEE JOINT ANGLE AND TIME OF FORCE APPLICATION ON VERTICAL JUMP HEIGHT DURING VOLLEYBALL COMMIT-BLOCK

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Introduction Blocking successfully is a crucial feature of winning in volleyball. Key points for the effectiveness of block are anticipation, decision-making, movement speed and jumping ability (Lobietti, 2009). It was found that jumping from a position with knees more flexed seems to be the best strategy to achieve the best performance (Gheller et al., 2015). However, during volleyball commit-block (VCB) the time spent during deeper squat could negatively affect the efficacy of the VCB (Ficklin et al., 2014). Thus, we aimed to investigate the influence of three different knee starting angles and the time of force application on jumping performance during VCB. Methods Fifteen volleyball players were recruited ( $20.27\pm3.08$  yrs,  $76.60\pm9.27$  kg,  $184.53\pm6.63$  cm). Players performed three maximal vertical jumps in commit position in front of the volleyball net. In the first one the players performed jumps using their optimal knee joint angle (OR) ( $105.91\pm14.80$  deg). The second one was performed over their optimal one (OOR) ( $71.13\pm18.13$  deg) and third one under the optimal one (UOR) ( $135.94\pm7.95$  deg). The vertical jump height (VJH) and the time of force application (TFA) were obtained by Optojump Next (Microgate, Italy). The knee joint angle (KJA) was assessed using Microsoft Kinect™. One-way MANOVA corrected by GreenHouse-Geisser adjustment was used to detect differences among jumps in VJH, TFA, and KJA. The magnitude of the difference was assessed by partial eta squared (part  $\eta^2$ ). LSD was performed in accordance to univariate ANOVA. Results The MANOVA showed statistical difference among the three jumps ( $F(6,9)=53.273$ ,  $p<0.001$ , part  $\eta^2=0.973$ ). The univariate test detected difference among the independent variable in each dependent variable (VJH:  $F(1.93,27)=30.601$ ,  $p<0.001$ , part  $\eta^2=0.686$ ; TFA:  $F(1.96,27.49)=112.196$ ,  $p<0.001$ , part  $\eta^2=0.889$ ; KJA:  $F(1.807,25.303)=114.864$ ,  $p<0.001$ , part  $\eta^2=0.891$ ). In VJH, difference between OR and UOR ( $p<0.001$ ) was detected by LSD but no statistical difference was found between OR and OOR ( $p=0.956$ ). In TFA and KJA, statistical differences were found by LSD in each pairwise comparisons ( $p<0.001$ ). Discussion In contrast to Gheller et al. (2015), no difference was found in VJH, even if both TFA and KJA were different between OR and OOR. Thus, jumping at the preferred range should be the best way to reach successful VCB because of higher vertical jump performance applying shorter TFA than OOR. References Ficklin T, Lund R, Schipper M. (2014). J Sports Sci Med, 13(1), 78. Gheller RG, Dal Pupo J, Ache-Dias J, Defanico D, Padulo J, Dos Santos SG. (2015). Hum Mov Sci, 42, 71-80. Lobietti R. (2009). J Hum Sport Exerc, 4(2), 93-99.



## AORTIC ROOT DIMENSION IN SOCCER PLAYERS

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**Introduction** Cardiac adaption to different sports has been extensively described. However the potential effect of top-level training on the aortic root dimension (AO) remains less investigated. At same time the frequency of cases of pathological dilatation of AO in top-athletes has been increasing. The aim of this study is to assess echocardiographic characteristics in order to elucidate aortic adaption in different age groups of soccer players. **Methods** The subjects were 247 soccer players of the best clubs of Estonia. In the first group (n=149) the average age was  $19.1 \pm 1.24$  and in the second group (n=98)  $25.3 \pm 3.12$  years. The test battery included anthropometrics, ECG, and treadmill test and BLA concentration, VO<sub>2</sub>max, anaerobic threshold were recorded. The echocardiography was performed using GE Vivid E/9. The t-test and Pearson product moment correlation coefficients were calculated. **Results** Means: Group 1 (n=149): Age (y)  $19.1 \pm 1.24$ ; BSA (m<sup>2</sup>)  $1.95 \pm 0.12$ ; AO (mm)  $29.2 \pm 2.30$ ; AO/BSA (mm/m<sup>2</sup>)  $15.0 \pm 1.34$ . Group 2 (n=98): Age (y)  $25.3 \pm 3.12$ ; BSA (m<sup>2</sup>)  $1.99 \pm 0.11$ ; AO (mm)  $31.0 \pm 2.18$ ; AO/BSA (mm/m<sup>2</sup>)  $15.6 \pm 1.13$ . **Discussion** Sport-specific adaptive cardiac structural changes are still under debate. D'Andrea et al. (2010) concluded that the AO diameter was significantly greater in strength-trained athletes (n=245) than in endurance athletes (n=370). At the same time Pelliccia et al. (2010) assessed athletes of 28 different sports disciplines (n=1300) and showed that the AO dimension was explained by weight, height, left ventricular mass (LVM) and age, with type of sports training having a significant but lower impact. The mean AO was greater ( $32.2 \pm 2.7$  mm) than in our soccer players and 1.3% of athletes had an enlarged AO (over 40 mm). In our investigation the greatest AO is 37 mm in both age groups. Correlation analysis shows that statistically significant correlations between AO and other indices are similar in both groups. AO has the strongest correlation with LVM, moderate relationship with left atrial dimension and significant but surprisingly low correlation with age. **Conclusion** We can conclude that in soccer players sports-specific influence on the aortic root dimension occurs early and progresses moderately, being part of the symmetric remodeling of heart. **References** D'Andrea A 1, Cocchia R, Riegler L, Scardafale R, Salerno G, Gravino R, Vriz O, Citro R, Limongelli G, Di Salvo G, Cuomo S, Caso P, Russo MG, Calabro R, Bossone E. (2010) *Am J Cardiol.* 105(11):1629-34 Pelliccia A1, Di Paolo FM, De Blasiis E, Quattrini FM, Pisicchio C, Guerra E, Culasso F, Maron BJ. (2010) *Circulation.* 17;122(7):698-706 Contact tiuu.olm@gmail.com

## RELATIONSHIP BETWEEN PHYSICAL CHARACTERISTICS AND PERFORMANCE LEVEL OF COLLEGE KENDO ATHLETES.

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**Introduction** Kendo is the Japanese martial arts originating from Samurai traditions. During the course of the game, Kendo athletes were required to response to various situations, to move quickly in various directions. Thus, high performance Kendo athletes had great physical fitness level. However, few previous studies report physical characteristics and performance level of Kendo athletes. The purpose of this study was to evaluate relationship between physical characteristics and performance level of college Kendo athletes. **Methods** Twenty-four male Kendo athletes were participated in the experiment. Eight subjects had expert group (EG); they were regular players on the same university Kendo club, what club has won the annual team competition for all Japanese universities many times. Eight subjects had intermediate group (IG); they were regular players on the other university Kendo club, they were no participation experienced of the annual team competition for all Japanese universities. Eight subjects had under-skilled group (UG); they were not regular players on the same team as IG. Experiment was conducted in accordance with the Declaration of Helsinki. 30-m sprints, vertical jump (VJ), frontward medicine ball throw (F-MBT), backward medicine ball throw (B-MBT), repetitive side step (SS), multistage 20-m shuttle run test (20mSR) were measured. For the statistical analysis, One-way ANOVA by means of comparison between groups. The statistical significance was set at  $p < 0.05$  for all analyses. **Results** All Results show that UG had poorest in all groups. Significant correlations were found between IG and UG during VJ and B-MBT ( $p < 0.05$ ). In the B-MBT, IG showed significant differences against EG ( $p < 0.05$ ;  $IG > EG$ ). Other physical characteristics measurements showed no significant differences. **Discussion** In this study, UG showed poorest physical fitness level. From the result, it is necessary to some extent physical fitness level that Kendo athletes make high performance. However, they were almost no significant differences almost measurements between EG and IG. Furthermore, In the B-MBT, IG showed excellent result against EG. Therefore, in the university Kendo athletes who are higher than a constant level, it is thought that it is important how you make use of each physical property in a competition than the improvement of the physical level. Contact: hirono@shinshu-u.ac.jp

## COMPARISON BETWEEN DIFFERENT MEASUREMENTS OF PROPRIOCEPTION FOLLOWING ECCENTRIC EXERCISE-INDUCED MUSCLE DAMAGE

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**Introduction** There has well-documented shows eccentric exercise of the agonist will occur obvious exercise-induced muscle damage (EIMD) and delayed onset muscle soreness (DOMS). There are several indicators to assess muscle damage including circumference (CIR), muscle soreness (SOR), range of motion (ROM), maximal isometric voluntary contraction strength (MVIC) and plasma creatine kinase activity (CK). The previous studies [1,2] reported EIMD will impact position sense (PS) and reaction angle (RA) of lower limb function. However, there did not have research about comparison between different measurements of proprioception in EIMD. This study investigated the effects of different measurements of PS and RA knee flexors after EIMD. **Methods** Eight untrained young men performed an eccentric exercise of the knee flexors by the non-dominant leg to induce muscle damage. To observe the changing of CIR, SOR, ROM, MVIC, PS and RA at measured before, immediately after, 1~5 days after exercise. The assessments of PS and RA included concentric contraction (CC) and eccentric contraction (EC). Data were compared by repeated-measures of two-way ANOVA and Pearson product-moment correlation coefficient. **Results** All variables changed significantly following eccentric exercise ( $p < 0.05$ ). After eccentric exercise, the variety of EC was greater than CC ( $p < 0.05$ ). **Discussion** These results showed that eccentric exercise not only occur muscle damage, but also affect the proprioceptive assessment methods measured [3]. There has high correlation between using EC means measurement after eccentric exercise and other muscle damage indicators. Therefore, the best way for testing proprioception might be EC measurement after eccentric exercise. **References** 1) Paschalis et al. (2008). *Eur J Appl Physiol*, 103, 9-18. 2) Paschalis et al. (2010). *J Sports Sci*, 28, 33-43. 3) Carolina et al. (2011). *J Electromyogr Kinesiol*, 21, 141-147. Contact mjlin@mail.ncyu.edu.tw

## THE ACUTE EFFECTS OF DYNAMIC WARMUP ON SINGLE LEG BALANCE TEST IN SCHOOL CHILDREN

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**Introduction** Balance is one of the components of physical literacy. The immediate effects of two different kinds of dynamic stretching on static balance in school children have not been investigated. Therefore, the aims of this study were to 1) determine if two different kinds of dynamic warmup were associated with performance of open eyes and closed eyes single leg balance tests in school children; 2) explore any response differences between boys and girls on balance performance after performing the two dynamic warmups. **Methods** This study employed a randomized, crossover with repeated measures design. After a static warmup protocol and familiarization session, 61 school children (age:  $10.5 \pm 0.8$  years; height:  $1.35 \pm 0.06$  m; weight:  $31.5 \pm 6.2$  kg; BMI:  $17.1 \pm 2.3$  kg/m<sup>2</sup>) performed two baseline measurements, namely single leg balance test with open eyes (T1) and with closed eyes (T2) in random order with their dominant leg on the floor. Warmup protocol: Warmup A (WA) - Four points formed a square with 30cm length. Children started at left bottom corner and hopped with their dominant leg with 1-sec pace between each point six cycles clockwise. Warmup B (WB) - Their dominant leg stepped on the floor, the other leg stretched out to 3 points located 30cm from the dominant leg at the sequence of anterior, posteromedial and posterolateral directions eight times with 1-sec pace between each point. **Procedure:** Each child performed one warmup (WA/WB) and two tests (T1 and T2). After 2 min rest, they performed the other warmup and the two tests. The warmups and tests order were randomly assigned. **Results** Results of Multivariate tests showed that there was no statistically significant differences in two main effects (WA & WB), gender and no interaction was observed  $F(4, 352) = 0.482$ ,  $p = 0.749$ ; Wilk's  $\Lambda = 0.989$ , partial  $\eta^2 = .005$ . Results of one-way ANOVA showed that there was no statistically significant differences among baseline, WA and WB in T1 ( $F(2,180) = 0.472$ ,  $p = .624$ ) and in T2 ( $F(2,180) = 0.160$ ,  $p = .852$ ). The girls obtained the mean values of T1 increased 1.7 sec or 0.04% after WA and increased 6.0 sec or 14.5% after WB, whereas the boys obtained the average values of T1 decreased 0.6 sec or 1.45% after WA and increased 0.9 sec or 3.2% after WB. No improvement in T2 was observed in girls after performing WA and WB, while the average values of T2 increased 2.3 sec or 17.8% after WA and increased 2.2 sec or 17.1% after WB. **Discussion** These findings suggested that the use of WB improved the performance of T1 in girls, while the employment of WA improved the performance of T2 in boys. Our findings were limited to school children of age group from 9 to 11 years old. The underneath mechanism is not clear. Some children reported tiredness of their dominant legs at the end of the tests. Contact sarobert1218@gmail.com or not insert authors here

## EARLY CARDIAC REHABILITATION EXERCISE TRAINING IN OLD PATIENTS AFTER HEART SURGERY - TRAINING OR ACTIVATING EFFECTS?

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**Introduction** Early recovery of functional capacity after heart surgery is important for a successful reintegration in daily living. Aim of the study was to prove the effects of a standard rehabilitation program on exercise performance after heart surgery in older patients (Eder et al. 2010). We hypothesized that these patients would rather show activating than true training effects after 4 weeks of early rehabilitation. **Methods** The study included 60 (32 male, 28 female) patients (mean age  $73.1 \pm 4.7$ )  $12.2 \pm 4.9$  days after heart surgery. Subjects were trained in a standard rehabilitation training program individually adjusted for exercise performance and disease severity. All subjects performed a symptom limited ergospirometry. The MacNew questionnaire was used to assess quality of life (QOL). All tests were performed before and after four weeks of cardiac rehabilitation. Patients underwent structured and regulated walking or cycle ergometer exercise training. LTP1 and LTP2 as well as VT1 and VT2 were determined from lactate and gas exchange data according to usual standards (Kroidl et al. 2015). **Results** Subjects increased their  $VO_{2peak}$  from PRE ( $0.93 \pm 0.21$  ml.kg<sup>-1</sup>.min<sup>-1</sup>) to POST ( $1.21 \pm 0.14$  ml.min<sup>-1</sup>.kg<sup>-1</sup>) by 30.1%, with an increase in HRmax from PRE ( $102 \pm 28$  min<sup>-1</sup>) to POST ( $117 \pm 26$  min<sup>-1</sup>). Also maximal power output (P) significantly increased from PRE ( $44 \pm 14$  W) to POST ( $69 \pm 16$  W) by 55.7%.  $VO_2$  as well as P at LTP1 and LTP2 significantly increased from PRE ( $VO_2$ :  $0.62 \pm 0.11$  /  $0.84 \pm 0.16$  ml.kg<sup>-1</sup>.min<sup>-1</sup>; P:  $14 \pm 7$  /  $36 \pm 10$  W) to POST ( $VO_2$ :  $0.74 \pm 0.18$  /  $1.01 \pm 0.21$  ml.kg<sup>-1</sup>.min<sup>-1</sup>; P:  $25 \pm 10$  /  $51 \pm 13$  W), however this increase of 24.9 / 33.9% (P) and 12.9 / 18.3% ( $VO_2$ ) was significantly smaller compared to maximal. QOL scores significantly improved by 17.5%. **Discussion** The cardiac rehabilitation program significantly improved both maximal and sub-maximal exercise performance and QOL in old patients after heart surgery although the effects of activation indicated by an increase in HRmax were substantially greater than thresholds increases. We conclude that improvements in maximal exercise performance in patients after a training program should be interpreted with care as these improvements may just show a re-activation, a higher motivation or less fear not accompanied by true sub-maximal training effects which are more relevant for daily activities of the patients. The determination of turn points is recommended. **References** Eder B, Hofmann P, von Duvillard SP, Brandt D, Schmid JP, Pokan R, Wonisch M.: J Cardiopulm Rehabil Prev. 2010 Mar-Apr;30(2):85-92. Kroidl, R., Schwarz, St., Lehnigk, B., Fritsch, J.: Kursbuch Spiroergometrie. Thieme Verlag Stuttgart 2015. Contact [barbara.eder@tele2.at; peter.hofmann@uni-graz.at]

## THE EFFECT OF DIFFERENT REST INTERVALS BETWEEN SETS ON THE REPETITION MAXIMUM, EXERCISE VOLUME, AND PHYSIOLOGICAL RESPONSES DURING 10 RM BARBELL CURLS

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**Introduction** Weight training for the Pectoralis consists of bench press and pectoral fly, shoulder exercises are barbell presses and dumbbell lateral, brachial triceps exercises are triceps press downs and dumbbell kickbacks. For the bottom, squatting is the best exercise, while for biceps; the barbell curl is the best exercise (Hass, et. al., 2001). In this study, a single joint exercise, the barbell bicep curl was performed while measuring the heart rate and blood pressure. Measurements were also taken with changes in the number of iterations between the total momentums of the set along with the resting period. Conditions measured were the systolic blood pressure, and heart burden, analyzed on the basis of (RPP, myocardial oxygen demand). The purpose of the study was to identify the influence to change of repetition maximum, total work, HR, SBP, and RPP by different rest interval with in sets during 10RM Barbell Curls. **Methods** Weight training career more than twelve months and not more than health medical test results to target 10 men resting 30 seconds between sets, 90 seconds 180 seconds, respectively, under the conditions 5 set 10 RM Barbell Curls exercises were performed for each set of repeated count, the total work, HR, SBP, RPP was measured. **Results** 10 RM Barbell Curls exercise sets 5 sets the number of repetitions and the total work progressed significantly decreased, in accordance with the rest interval time of 180 seconds, 90 seconds, 30 seconds rest in order. Heart rate in a 30-second condition was significantly decreased after 4 sets, 90 seconds and 180 seconds condi-

tions tended to be maintained. Conditions, the systolic blood pressure increased significantly and 90 seconds, 30 seconds conditions showed a decreasing pattern, 180 seconds did not show significant changes in conditions. Conditions, the RPP compared to 30 seconds 90 seconds 180 seconds and showed a tendency in conditions, or there was no significant difference. Discussion In this study in case of the 10RM barbell curl exercise, 180 seconds was the most idealistic resting rate dependant on the heart rate, repetition, and the total amount of exercise. 90 second resting time had an increase in blood pressure and a 30 second resting period was too short for maximum muscle use. If the repetition of 1 set is 100%, than when the set reaches 50%, heart rates increase and it is more difficult on the heart to maintain the exercise. The rest time between the sets is dependant on the heart rate, repetition, and the total amount of exercise (Fleck, 2003). For the increase in muscle development for 10RM barbell exercises, the ideal resting time is 90 seconds to 180 seconds. References Fleck, S. J. (2003). Cardiovascular responses to strength training. In: *Strength and Power in Sport*, 2nd Ed. P. V. Komi (Ed.). Malden, MA: Blackwell Science, pp. 387-406. Hass, C. J., Feigenbaum, M. S., & Franklin, M. (2001). Prescription of resistance training for healthy populations. *Sports Medicine*, 31: 953-964. Contact \* healthyang@hanseo.ac.kr

### EFFECTS OF FUNCTIONAL PANTS WEARING ON AEROBIC AND ANAEROBIC MOTOR ABILITY, LACTATE, AND MUSCLE PAIN IN COLLEGE STUDENTS

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**Introduction** The purpose of this study was to prove the effects of functional pants wearing on aerobic and anaerobic motor ability, fatigue, and muscle pain in college student's. **Methods** Eight healthy college men participated in this study and subjects had not been involved in a resistance-training program at least 6 months. All subjects (n=8) performed two bouts of maximum exercise load test and wingate test in wearing and non-wearing of functional pants separated by 2 and 3 weeks. Aerobic and anaerobic motor ability, lactate in the blood and muscle pain were taken before, immediately after, 3, and 10 minutes in each wearing and non-wearing of functional pants. **Results** Our study showed that exercise time, VO<sub>2</sub>max and reaching time to maximum power had positive effects following the wearing of functional pants compared to the non-wearing of functional pants. After aerobic exercise, muscle pain was significantly lower following the wearing of functional pants compared to the non-wearing of functional pants, and lactate recovery rate in the blood was significantly faster following the wearing of functional pants compared to the non-wearing of functional pants. Discussion These data indicated that the wearing of functional pant improve aerobic motor ability and muscle pain (Chng et al., 2010; Davis & Green, 2009; Inbar & Bar-Or, 1986; Tariq et al., 2005). References Cheung, SS.(2007). Neuropsychological determinants of exercise tolerance in the heat. *Pro Brain Res.*, 162, 45-60. Davis, JK., & Green, JM.(2009). Caffeine and anaerobic performance: ergogenic value and mechanisms of action. *Sports Med.*, 39, 813-832. Inbar, O., & Bar-Or, O.(1986). Anaerobic characteristics in male children and adolescents. *Med Sci Sports Exerc.*, 18, 264-269. Tariq, SH., Haren, MT., Kim MJ., & Morley, JE.(2005). Andropause: is the emperor wearing any clothes?. *Rev Endocr Metab Disord.*, 6, 77-84. Contact \*ssilverman@naver.com

### EFFECTS OF SPECIAL MUSCLE STRETCHING ON THE BALL-SPEED AT DRIVER SWING OF AMATEUR GOLF PLAYERS

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**[Purpose]** In the present study, therefore, stretching exercises were performed by the subjects in order to examine their effects on golf swing-related factors that can be easily influenced by continuous and long-term repetitive movements, unstable postures, and excessive force. The study goal was to examine the effectiveness of stretching exercises for improved swing. The study investigated stretching for a safer golf swing compared to present stretching methods for a proper swing in order to examine the effects of stretching exercises on golf swings. **[Subjects]** The subjects were 20 amateur golf club members who were divided into two groups: an experimental group which performed stretching, and a control group which did not. The subjects had no bone deformity, muscle weakness, muscle soreness, or neurological problems. **[Methods]** A swing analyzer were used as the measuring tools. The swing analyzer was a GS400-golf hit ball analyzer (Korea). **[Results]** Hit-ball speed at golf driver swings were measured and the results show there was an increase of approximately 5m/s from 67.30±5.40m/s before the intervention to 72.00±4.73m/s at 12 weeks in the experimental group, but there was little change from 66.30±4.78m/s before the intervention to 67.90±4.81m/s at 12 weeks (Table 3) in the control group. Two-way repeated ANOVA the results show there were no interaction effects but there were significant differences (p<0.05) between the groups (F=5.95, p<0.05). **[Conclusion]** To examine the effects of a special stretching program for golf on golf swing-related factors, 20 male amateur golf club members performed a 12-week stretching training program.

### EFFECTS OF PROPRIOCEPTIVE REHABILITATION TRAINING ON MUSCLE FUNCTION IN PATIENTS WITH KNEE OSTEOARTHRITIS

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**[Purpose]** This study applied proprioceptive circuit exercise to patients with degenerative knee osteoarthritis and examined its effects on knee joint muscle function and the level of pain. **[Subjects]** This study included 14 female patients, ≥60-years-old, who demonstrated both clinical and radiological evidence of knee osteoarthritis, as described by the American Rheumatism Association, a proprioceptive circuit exercise group (n = 7) and control group (n = 7), were examined. **[Methods]** The proprioceptive circuit exercise program (20min/session) lasted for eight weeks. The subjects participated in the exercise program three times a week. Three sets (10 times/set) per session of the proprioceptive circuit exercise was performed. The detailed exercise program was consisted of the repetition of walk-in-place and four different types of proprioceptive circuit exercise including half squat, straight lunge, side lunge, one-legged balance exercise on a Jumper (TOGU, Germany) and Aero step (TOGU, Germany). For those participants who were unable to perform exercise properly due to the loss of their balance from the equipment, an exercise instructor held participants' hands until the end of each exercise. ISOMED 2000 (Germany) was used to measure knee joint isokinetic strength. **[Results]** In the proprioceptive circuit exercise group, knee joint muscle function whereas in the control group, no significant improvement was observed. **[Conclusion]** A proprioceptive circuit exercise may be an effective way to strengthen knee joint muscle function in patients with knee osteoarthritis.

## EFFECT OF WATER TEMPERATURE AQUATIC EXERCISE ON CARDIOVASCULAR SYSTEM AND BLOOD LACTATE CONCENTRATION\*\*

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**Introduction** The purpose of this study was to investigate the effects of aqua exercise with different water temperatures on heart rate, body temperature, cardiovascular stress and blood lactate among male college students of physical education major. **Methods** For this study 8 subjects were recruited and experienced aqua exercise and rest period with 18°C and 38°C water temperature, and physiological variables were measured at rest and 5, 10, 15 and 20 minutes post exercise. **Results** 1) heart rate response at rest to 38°C condition was found to be greater than that of 18°C water temperature ( $p < .001$ ). heart rate response during exercise is higher at 38°C than that of 18°C ( $p < .001$ ). heart rate response to different measurement times were significant ( $p < .001$ ) 2) systolic blood pressure at rest was greater at 18°C than that of 38°C ( $p = .001$ ). systolic blood pressure during exercise was found to be greater at 18°C than that of 38°C ( $p = .001$ ). Systolic blood pressure at different measurement times was also significantly different ( $p < .001$ ). 3) resting cardiovascular stress was not significantly different between 18°C and 38°C temperature condition. cardiovascular response to exercise was not different between 18°C and 38°C condition. But, cardiovascular stress at different measurement times was statistically different ( $p < .001$ ). 4) changes in body temperature at resting condition was found to be higher at 38°C than that of 18°C ( $p = .001$ ). changes in body temperature during exercise was higher at 38°C condition than 18°C ( $p = .001$ ). and therefore this change in body temperature based on measurement times was statistically different ( $p < .001$ ). 5) blood lactate at rest showed greater response at 18°C condition than 38°C ( $p = .01$ ). blood lactate response during exercise was greater at 38°C than 18°C ( $p = .001$ ). Blood lactate response at different time ranges was also statistically different ( $p < .001$ ). **Discussion** Taken together, heart rate response at 38°C water temperature at rest and during exercise was found to be greater, systolic blood pressure at 18°C water temperature was shown to be greater at rest and during exercise. There was no difference at rest and during exercise in terms of cardiovascular stress. Changes in body temperature at rest and during exercise was greater on 38°C water temperature. Blood lactate response at 18°C water temperature was greater than the other water condition. Therefore, heart rate response at 38°C water temperature was found to be greater at rest and during exercise, and systolic blood pressure was found not to be different at any water temperature. Blood lactate response at resting 18°C water temperature was found to be greater and was found to be greater at 38°C water temperature during exercise. These results mean that recovery process is recommended on warm water. \* para@hanseo.ac.kr \*\*This study was conducted to establish the foundation of Wellness Spa Clinical Coordinating Center(N0001200), and supported by "Ministry of Trade, Industry and Energy" and "Korea Institute for Advancement of Technology"

## RESEARCH REGARDING PHYSICAL FITNESS CHARACTERISTICS VIEWED OVER A LONG PERIOD OF TIME TARGETING JUNIOR TENNIS PLAYERS

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**Introduction** It has been a long time since the physical fitness improvement plan intending to strengthen Japan's tennis players started. We have been implementing physical fitness measurement of junior players in the Japanese tennis player training project since 2001. The purpose of this research is to analyze the results of physical fitness measurements of junior tennis players which we implemented from 2001 to 2012, understand the characteristics thereof, and suggest a directionality for future physical training. **Methods** The junior tennis players who were the subjects of measurement were 139 players from age 12 to 16 who had achieved good results in domestic and overseas matches and been designated in each region as strengthened. The items measured were height, weight, grip strength, standing long jump, sit-ups, long sitting body anteflexion, round-trip running, 5-direction run, shuttle stamina, and medicine ball throwing. The method of analysis was aggregating the physical fitness measurement results by gender and comparing them by year (2001 group, 2005 group, and 2012 group). Furthermore, we converted the measurement data to a standard score (H score) and conducted a comparison on relative physical fitness points to consider the characteristics of each year. **Results and Discussion** The comprehensive physical fitness points were significantly lower in the 2012 group compared to the 2001 and 2005 groups in both boys and girls. Among these, the most remarkable differences were found in sit-ups, grip strength, and medicine ball throwing—items which require muscle strength. On the other hand, in the girls the tests of physique, endurance running (shuttle stamina), sprinting ability (running back and forth on the court) tended to be better in the 2012 group. No difference was observed in sprinting ability among the boys. These facts suggest the possibility that recent Japanese junior tennis players have adopted a playing style which focuses on sprinting ability and footwork and training focusing on these as well in comparison to past junior tennis players. The results suggest that in the future it will be necessary to maintain this play style as a foundation while making training plans which emphasize muscle strength and power-related physical fitness building.

## PEAK TORQUES AND HAMSTRING TO QUADRICEPS RATIO IN PROFESSIONAL SOCCER, FUTSAL AND BASKETBALL PLAYERS

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**Introduction** Quadriceps (Q) and hamstrings (H) muscle strength inadequacies and imbalances has been shown to be associated with increased risk of lower extremity injury in athletes. A reduced (0.75 or less) hamstring to quadriceps ratio (H/Q ratio) may put athletes at a higher risk for lower extremity injuries. The purpose of the present study was to examine the peak torques of the Q and H muscles and their torque-ratio (H/Q) in professional soccer, futsal and basketball players. In addition, differences between the limbs were examined. **Methods** Seventy six participants (football n: 44, futsal n: 16, basketball n: 16) were evaluated using an isokinetic dynamometer. Peak torque and H/Q ratios were evaluated at both 60 degrees/s and 300 degrees/s. **Results** It was found that basketball players produced significantly greater torques (at 300degree/s) in both the right and left Q compared with the football and futsal players ( $F = 7.37$ ,  $p < 0.05$  and  $F = 7.25$ ,  $p < 0.05$  for right and left Q respectively). In addition basketball players demonstrated significantly greater torques for hamstrings compared to the other 2 groups ( $F = 5.98$ ,  $p < 0.05$  and  $F = 5.55$ ,  $p < 0.05$  for right and left H respectively). No significant differences were observed in H or Q torques or H/Q ratio among the players of different sports. Finally, no significant differences were observed between the right and left limbs among the players with mean values being less than 10% in all groups. **Discussion** It is concluded that basketball players have stronger quadriceps and hamstring muscles only when tested at faster speeds. Also, based on the H/Q ratios



and the absence of asymmetries these professional players do not seem to be at an increased risk for injuries. Isokinetic evaluation of the lower extremities may provide the coaching team with valuable evidence regarding potential asymmetries between Q and H that may progressively contribute in performance deterioration and increase the risk of muscle injuries development. Possible asymmetries may be eliminated by incorporating the appropriate training into the habitual exercise routines of professional athletes.

### CONSCRIPTS PHYSICAL ABILITY LEVEL AND THEIR OUT DURING BASIC TRAINING COURSE IN 2011 -2014

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**Introduction** Several studies in the field of military confirmed that low physical capability of conscripts may affect their military training and obligations (Tomczak et al., 2012). More recent studies have confirmed that a low physical performance is one important reason for the dropout before the end of recruit basic training courses (BTC), due to health problems or injuries (Taanila et al., 2011). The purpose of this study was to analyze conscripts physical ability level and dropout during their Basic Training Course (BTC) in 2011 – 2014. **Methods** The sample of this study consists of conscripts who began service in 2011 (n=3352), in 2012 (n=3235), in 2013 (n=3255) and in 2014 (n=3264). To assess soldiers physical condition and their progress of training suitability we use in Estonian Defense Forces (EDF) the United States Army Physical Fitness Test (PFT) which is modified for the EDF demands. PFT is designed to test the muscular strength, endurance, and cardiovascular respiratory fitness of soldiers (Army Physical Readiness Training 2012). The test consists three different exercises: (1) push-ups in two minutes; (2) sit-ups in two minutes and (3) 3.2 kilometers run. Scoring of the PFT is based on gender, age category and number of repetitions performed, where each event ranges from 0 to 100 points. To pass the PFT is necessary to collect more than 190 points as the sum of three exercises. All soldiers in EDF must do the PFT; first test at the start of the BTC, second at the end of the BTC and third at the end of the service time. In this study we focus on first two tests. **Results** The PFT analysis revealed that the first test successfully passed 38,6 – 50,8% of conscripts and second test 87,4 – 95,2% of conscripts in different years. There were not statistically significant differences between passing the tests in different years. The dropout during the BTC was 3,7 – 5,5% of conscripts in different years. If we compared conscripts first test and their dropout during the BTC, we found that as higher was the first test passed recruits number that lower was the dropout conscripts number. **Discussion** In conclusion we can say that the physical preparation of the conscripts is very different before military service. It is important to raise the recruits physical ability before the military service to make their BTC more effective. **References** Army Physical Readiness Training. (2012) FM 7-22, HQ, Department of the Army, Washington, DC, USA. Taanila H., Hemminki A.J.M., Suni J.H., Pihlajamäki H., Parkkari J. (2011). Low physical fitness is a strong predictor of health problems among young men: a follow-up study of 1411 male conscripts. BMC Public Health, 2011 11: 590. Tomczak, A., Brandt, J., Kłos, A. (2012). Physical fitness and nutritional status of polish ground force unit recruits. Biology of Sport, 29(4), 277-280.

### TAI CHI CHUAN TRAINING MAY IMPROVE BALLET MOVEMENTS IN SENIOR HIGH SCHOOL STUDENTS

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**Introduction** Tai Chi Chuan (TCC) training is known to be able to improve core stability and balance while performing various movement tasks. Whether TCC training can contribute to the performance of jumps, spin, and balance required in ballet dancing is unclear. The purpose of this study was to investigate the effect of 8-week TCC training on the ballet movements (sauté jumps, pirouette en dehors spin, and passé posture balance) of senior high school dance class students. **Methods** A total of 16 senior high school dance class students participated in this study (8 in the training group and 8 in the control group). The two groups had similar age, body height, body mass, and around 10 years of dancing experience. The training group received Yang Style (24 form) TCC training for 8 weeks (2 times/week, 1.5 hours/time) in addition to their regular dance class. The control group had the same regular dance class as the training group without receiving additional training. An AMTI force platform (1,000Hz) was used to measure the sauté jump explosive force and air hang time and passé posture balance of the participants. A motion analysis system with 9 infrared high speed cameras (200Hz) was used to record their lower extremity movements when performing pirouette en dehors. Independent t tests were used to compare the differences in the percentage of changes of all variables after 8-week training period between the two groups. **Results** The results showed that the training group demonstrated greater improvement than did the control group in the following areas: the maximum lower extremity push-off force ( $4.63 \pm 2.86\%$  vs.  $-1.84 \pm 2.87\%$ ,  $p<0.001$ ) and air hang time ( $5.18 \pm 2.65\%$  vs.  $-7.03 \pm 4.76\%$ ,  $p<0.001$ ) during sauté jumps; the front-back ( $-11.70 \pm 10.18\%$  vs.  $-0.46 \pm 9.63\%$ ,  $p=0.04$ ) and right-left ( $-14.53 \pm 10.30\%$  vs.  $1.27 \pm 10.02\%$ ,  $p=0.008$ ) center of gravity (COG) shift distance during passé posture balance; and the working leg hip joint external rotation angle ( $6.38 \pm 4.79\%$  vs.  $-1.47 \pm 2.62\%$ ,  $p=0.001$ ), the supporting leg plantar flexion angle ( $2.76 \pm 1.14\%$  vs.  $-3.20 \pm 3.98\%$ ,  $p=0.001$ ), and the front-back ( $-24.39 \pm 14.54\%$  vs.  $17.03 \pm 44.07\%$ ,  $p=0.024$ ), right-left ( $-31.77 \pm 15.35\%$  vs.  $29.59 \pm 55.04\%$ ,  $p=0.009$ ) COG shift distance during pirouette en dehors spin. **Discussion** Young Tai Chi Chuan training seem to be able to improve some of the ballet movements that may contribute to the performance of young dancers. A plausible reason may be due to TCC training improved their trunk and lower extremity control ability that allowed them to perform ballet movements more proficiently. All participants in this study were in the same class. The limitation of the study is that the control group was not able to have the same amount of training time as the training group had due to various reasons. Contact yungshentsai@gmail.com

### EFFECTS OF MENTAL AND PHYSICAL FATIGUES ON FOOTBALL PLAYERS' IN-GAME BEHAVIOURS

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This study aimed to identify the effects of mental and peripheral physical induced fatigues on football players' in-game behaviours. Ten Under-15 players performed a Gk+5v5+Gk small-sided game (SSG) on a 30x20m pitch based 3 bouts of 6 minutes each, and performed under three different conditions: i) physical fatigue condition (PF), induced by performing a repeated change-of-direction; ii) control condition (CTR), in which players performed the SSG without any previous activity; c) mental fatigue condition (MF) using a 30 minutes computerized version of the Stroop task. Time-motion variables and players' positional data were gathered using global positioning systems (5 Hz). Positional data were used to compute tactical-related variables such as team's stretch index, distance between players' dyads and synchronization of longitudinal and lateral displacements of players' dyads. When compared with CTR condition, players under PF condition was likely to lower the number high-intensity accelerations by ~33% (Cohen's d:  $0.5 \pm 0.5$ ) and possibly lower the ratio of high distance covered by ~38% (Cohen's d:  $0.3 \pm 0.5$ ). From the tactical perspective, the distance between players' dyads in PF was very likely

lower compared to CTR. Also in PF, player's spent likely ~7% more time synchronized in longitudinal displacements than in CTR and most likely ~14% more than in MF (Cohen's  $d$ :  $0.7 \pm 0.3$ ). The teams' stretch index were very likely and most likely lower in MF than in PF and CTR, respectively. Although players spent less time synchronized in MF, the distance between players' dyads showed a very likely more predictable pattern (i.e., lower approximate entropy values) in MF than in PF (Cohen's  $d$ :  $-0.4 \pm 0.2$ ) and possible more than CTR. Applying a physical stimulus previously to tactical tasks may be used to promote an increase in players' longitudinal displacements synchronization and optimise the in-game physical performance, since dyads become more coupled. The induced mental fatigue decreased the team dispersion and the time that players' spent synchronized in longitudinal displacements. This self-organized behaviour may be linked with the increased perception of mental fatigue, that encouraged team contraction and as consequence of higher proximity between players might decreased the need to stay synchronized with the surrounding teammates. Therefore, induced mental fatigue seems to change the way of how players perceive the environmental information. Overall, coaches may use both situations to promote variability in players' tactical behaviours, and consequently, provide wide adaptive environments.

## PRE SEASON VO2MAX ESTIMATION OF YOUNG MALE ELITE BASKETBALL PLAYERS

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**Introduction** Aerobic capacity is an important determinant of team sport performance that can accurately be assessed with spirometry. Due to the complex set up and high costs, there is a need to establish quick and feasible alternatives. One popular field test is the shuttle run, which has repeatedly been shown to yield accurate and valid VO2max estimates (Mayorga-Vega et al., 2015). Additionally, modern heart rate monitors (HRM) have been equipped with complex algorithms that allow aerobic capacity to be measured at rest. However, the accuracy of HRM methods has not yet been investigated for young team sport athletes. Consequently, the purpose of this study was to compare two different field-test estimates of aerobic capacity in a group of young elite basketball players. **Methods** 10 male elite basketball players (height =  $188.3 \text{ cm} \pm 6.5$ ; weight =  $79.5 \text{ kg} \pm 9.4$ ; age =  $17.1 \pm 0.86$ ) were recruited for this study. Participants were equipped with a chest-strap and an associated HRM (Polar M400). The activity level was selected based on the current training status (5-8 hours/ week) and anthropometric data entered into the HRM. The participants laid down and rested for approximately 5 minutes. After this time, the HRM automatically provided an estimate of the aerobic capacity. Next, the participants performed an all-out shuttle run test to reassess aerobic capacity. **Results** The average VO2max value estimated by the HRM method was  $55.3 (+/- 3.9) \text{ ml/kg/min}$ , compared to  $53.4 (+/- 3.9) \text{ ml/kg/min}$  in the shuttle run. Paired-samples t-test did not reveal any significant differences between VO2max methods ( $p = 0.276$ ). **Discussion** The results indicate that the estimates of aerobic capacity provided by the HRM are similar to those established by the fatiguing shuttle-run test. Although, true VO2max was not assessed in this experiment, the HRM method was compared to a reliable and valid field test. Previous research has found different correlation coefficients between the HRM test and lab-based spirometry from moderate (Esco et al., 2011) to high (Vainämo et al., 1996; Peltola et al., 2000). In summary, the HRM method offers a simple, nonfatiguing way to assess aerobic capacity in young elite basketball players. However, since we did not compare these methods to a gold standard, the obtained values should be regarded with caution. **References** Esco MR, Mugu EM, Williford HN, McHugh AN, Bloomquist BE. (2011). J Exer Physiol online. 14(5):31-37. Mayorga-Vega, D; Aguilar-Soto, P; Viciano, J. (2015). Journal of sports science & medicine. 14 (3), S. 536-547. Peltola, Hannula, Held, Kinnunen, Nissilä, Laukkanen, Marti. (2000). ECSS Väinämö, Tulppo, Mäkelä, Rönkä. (1996). International Conference on Neural Networks. pp 1939-1949. Contact felix.sempf@sport.uni-goettingen.de

## INTENSITY STRUCTURE OF TECHNICAL AND TACTICAL TRAINING SESSIONS IN U-16 FEMALE POLISH NATIONAL VOLLEYBALL TEAM

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**Aim.** Major part of training volume in young volleyball players consists of technical-tactical aspects. Level of these skills is basic criteria for selection of players for national team. Purpose of this study is evaluation of training load applied during preparatory camp before national team selection. **Methods.** In this study 24 players were included, age 15 years old, VO2max  $50.8 \pm 6 \text{ ml/kg/min}$ , VT  $153 \pm 13.7 \text{ bp/min}$ , RCP  $174 \pm 10 \text{ bp/min}$ . Training intensity was monitored with Polar Team (Polar, Kempele, Finland). All players were tested with progressive running test at 40m distance, speed increasing from 8km/h every 2 minutes by 1.5 km/h until exhaustion. Exhaled air was continuously sampled by an K4b2 (Cosmed, Italy) and the rate of VO2, VCO2, VE were calculated on-line. Threshold values VT and RCP were calculated according to procedures described by [Chicharro 2000]. HR that corresponded to the exercise intensities: below VT1 were classified as low-intensity (LI); between VT1 and RCP as moderate-intensity (MI); above RCP as high-intensity (HI) [Lucia et al. 1999]. **Results.** Training load structure observed during training sessions is presented in percentage values in intensity zone LI, MI, HI respectively in training description: receiving and passing (upper), movement skills, a.m. (60.9, 26.7, 12.4); receiving and passing (lower), movement skills in defense, a.m. (48.7, 35.5, 15.8); various technical skills (passing, serving, digging, attacking), movement skills, s.m. (61.3, 32.1, 6.6); attacking (74.3, 21.4, 4.3); mastering of attacking skills (various court zones) (79.2, 18.3, 2.5); competition: small game 3v3 (44.1, 36.5, 19.4); Competition: small game 2v2 (75.2, 17.5, 7.3); integration of technical skills during game s.m. (69.9, 27.4, 2.7) **Conclusion.** Training load in volleyball during technical and tactical part mainly ranges between 50-70% of intensity load. Highest load was observed during receiving and passing combined with movement skills training on the court. Lowest training load was observed during integration of technical skills during game. Presented method of training load assessment allows quantifying cardio-vascular load of players during training. For complete assessment of training load aspects of anaerobic lactic load related to high intensity should be also monitored. This research is supported by the Ministry of Science and Higher Education within the project No. RSA2 04852 **References** Chicharro, JL et al. Br J Sports Med 34: 450-455, 2000. Lucia, A, et al. Intern J Sports Med 20: 167-172, 1999. Contact: tomaszek1960@tlen.pl

## SPRINT PARAMETERS AFFECTED BY EXERCISE INDUCED MUSCLE DAMAGE IN THIGH MUSCLES

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**Introduction** Maximal Voluntary isometric Contraction force (MVC) is considered as one of the best tools for quantifying muscle damage (Raastad et al. 2010). Other performance related to muscle function, such as jump performance, has been reported to be affected by Exercise Induced Muscle Damage (EIMD). The aim of this study was to assess which parameters of sprint running are more sensible to

EIMD. Methods 9 physically active women (age  $26.8 \pm 2.2$  years) performed 10 sets of Concentric-Eccentric (C-E) bilateral squats on a flywheel inertial device (Yoyo Squat; Yoyo-Technology; Stockholm). Each set consisted in 3 submaximal repetitions to accelerate the disk, immediately followed by 10 high-intensity voluntary C-E reps. 3 minutes of rest were given between sets. Indirect markers of EIMD as Delayed Onset Muscle Soreness (DOMS), MVC of knee extensors and Counter Movement Jump height (CMJh), were assessed before and immediately after exercise, and after 1, 24, 48 and 72 hours (h). Instantaneous speed throughout 40 meters of sprint running was measured by radar (Stalker ATSiI, Texas) following the same temporal points. Sprint data was analysed using the method proposed and validated by Samozino et al. (2015) to compute force, acceleration, power and force-speed profile. Results Flywheel exercise caused a significant decrease in MVC levels ( $-18.2 \pm 14.0\%$ ,  $p=.004$ ) after exercise, that continued for 24h and were re-established near basal levels 48h after. While CMJh showed no significant changes during all post exercise period, maximum speed and maximum power generated in the 40m sprint showed a similar pattern than MVC. Maximal power diminished ( $-14.4 \pm 9.6\%$ ,  $p=.006$ ) 24h after exercise and remained under basal levels 74h before ( $-15.4 \pm 11.8\%$ ). MVC and maximal power showed good correlation before ( $r=0.87$ ,  $p=.007$ ) and 24h after exercise ( $r=0.78$ ,  $p=.013$ ). Discussion The decrease in MVC and high levels of DOMS 24h after exercise suggest moderate EIMD. Maximal power during a 40m sprint running showed a similar pattern than MVC values during the follow up and was affected 72h after exercise. Maximal sprint power decreases as a consequence of muscle damage can be used as a sensible marker of EIMD. References Raastad T, Owe SG, Paulsen G, et al. (2010) Med Sci Sports Exerc, 42:86-95 Samozino P, Rabita G, Dorel S, et al. (2015) Scandinavian Journal of Medicine and Science in Sports. doi: 10.1111/sms.12490. Funded by Institut Nacional d'Educació Física de Catalunya (INEFC), Generalitat de Catalunya (2014SGR/1629), Spanish ministry of economy and competitiveness (MICINN; DEP2013-46574-P) & Spanish ministry of education, culture and sport (MECD; FPU14/03006) and by European Space Agency (ESA 12RL000214)

## EFFECT OF GRADED COLD EXPOSURE ON PERCEIVED EXERTION AND HEART RATE RESPONSE AT DIFFERENT INTENSITIES OF EXERCISE

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Introduction Cold weather exercise is considered "a challenging environmental condition" that poses health risks to individuals including cold weather athletes. Cold weather athlete's routinely train at a variety of exercise intensities in sub-zero temperatures however our understanding of how cold air exercise affects exertion and heart rate is unknown. Thus the aim of this study was to determine the perceived exertion and heart rate response to 5 different sub-zero ambient temperatures during Low (L), Moderate (M) and Heavy (H) intensity exercise. Methods Seventeen females (age:  $21.6 \pm 3.3$  yrs; ht:  $167.1 \pm 7.2$  cm; wt:  $60.5 \pm 8.1$  kg;  $VO_{2max}$ :  $49.6 \pm 6.6$ ) completed 5 blinded running trials (L: 5 min at 6 km/hr, 1% grade; M: 10 min running at 2 km/hr <  $VO_{2max}$  velocity, 1% grade; H: 8 min at  $VO_{2max}$  velocity, 5% grade) at 0, -5, -10, -15 and -20° Celsius (humidity 40%) on different days in randomized order. Trials were completed on a customized cold weather treadmill (h/p/cosmos, Germany) in a digitally controlled environmental chamber. Rating of Perceived Exertion (RPE) and heart rate (HR) were recorded at the end of every minute during each trial. Session based RPE and self-reported physical symptoms were asked post trial. Results There was a significant increase in HR at low intensity exercise ( $0^{\circ}C = 118.9$  bpm;  $-20^{\circ}C = 123.4$  bpm) but similar HR during moderate exercise across temperatures (range 0 to  $-20^{\circ}C = 157.5$  to  $156.2$  bpm;  $p=0.52$ ). HR during heavy at -15 and  $-20^{\circ}C$  was significantly lower compared to 0, -5 and  $-10^{\circ}C$  with greater decrease in the last 3 minutes compared to min 1 to 3. RPE was not significantly different across temperatures at L or M (L: 7.0 to 7.2; M: 11.4 to 12.1). During H at min 1, 2, 3, 4, 5 and 6 RPE was not different across temperatures. At min 7 and 8 RPE was greater at  $-20^{\circ}C$  (increase of 0.5 to 1;  $p<0.05$ ) compared to the other temperatures. Session based RPE was significantly greater at -15 and  $-20^{\circ}C$  compared to  $0^{\circ}C$  (7.6, 7.9, 6.6 respectively;  $p<0.05$ ) and frequency of physical symptoms was greater at -15 and  $-20^{\circ}C$  ( $p<0.5$ ). There was no difference in the distance run across temperatures. Discussion It was found that air colder than  $-15^{\circ}C$  does influence HR, RPE, session based RPE and physical symptoms, however the response is dependent on the intensity of exercise. This has implications for cold weather exercise prescription guidelines in healthy individuals as well as athletes completing maximal intensity workouts in the cold. Although further investigation is required this data would indicate that high intensity intervals no longer than 6 min in temperatures colder than  $-15^{\circ}C$  are well tolerated after which time both HR and RPE change significantly. Contact kennedy@ualberta.ca

## COMPARISON OF LOAD INTENSITY EXPERIENCED BY PLAYERS WHEN PLAYING THE TOP TWO WOMEN'S COMPETITIONS

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Introduction This study focuses on the analysis of the load intensity imposed on players in a championship match in the women's top league and the second highest league. This is the crucial point for defining the effective training program since the relationship between the match and intensity of training exercise is considered the key training problem of sport games (Kelly and Coutts, 2010). The aim of this case study is to compare the load intensity experienced during championship matches in the top two competitions. Methods The heart rate (HR) of players ( $n=10$ ; starting lineup of each team only) was monitored using the Polar TEAM 2 system. The average HR is calculated only from the parts of the match where the players were actively involved in the game and the game clock was running (the so-called "live time") according to Abdelkrim et al. (2007). Results In case of the starting lineup of players (the top league team), the average HR value was calculated as  $175.1 \pm 14.2$  heart beats per minute, which corresponded to  $91.9 \pm 6.2\%$  of  $HR_{max}$  and in case of the second highest league team, it was calculated as  $179.4 \pm 10.3$  heart beats per minute ( $91.2 \pm 4.1\%$  of  $HR_{max}$ ), both determined during the graded exercise test in laboratory conditions. There wasn't a significant difference in the exercise load between the two competitions (5% of significance level). Discussion In addition to the quality of a competition and playing positions, load intensity could be also affected by the actual outcome of the game, the number of foul plays (e.g. necessity to change players) and of course, by tactics selected by coaches. Monitoring load intensity in sport games characterised by interval loads is generally problematic. Unlike more specific indicators, such as oxygen consumption ( $VO_2$ ), heart rate monitoring, however, represents a practical, widely applicable but also reliable method to assess load intensity (Vala et al., 2014). References Abdelkrim NB, El Faza S, El Aii J. (2007). Time - motion analysis and physiological data of elite under-19-yearold basketball players during competition. British Journal of Sports Medicine, 41, 69-75. Kelly VG, Coutts AJ. (2010). Planning and Monitoring Training Loads During the Competition Phase in Team Sports. Strength & Conditioning Journal., 29(4), 32-37. Vala, R., Valová, M., Cipryan, L., Petr, J. (2014). Analysis of intensity of exercise load of junior ice hockey players during a championship match-case study. 19th annual Congress of the EUROPEAN COLLEGE OF SPORT SCIENCE Book of abstracts. Amsterdam: Digital Printing Partners, 712-712. Contact vata@email.cz

### EFFECTS OF PHOTOTHERAPY APPLIED IN ASSOCIATION OF STRENGTH TRAINING: PRELIMINARY RESULTS

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**INTRODUCTION:** Positive results were found with light application (laser and/or LED) to improve skeletal muscle performance and delay fatigue. However, there are few studies showing its effects on strength training. The aim of the study is to assess the effects of phototherapy applied at different moments in each session of strength training performed three times a week with controlled load. **METHODS:** Forty-eight volunteers, male, healthy and physically active, were recruited. Phototherapy (with combination laser and LEDs) with dose of 30 J and/or placebo was applied before and/or after each session of strength training on quadriceps (bilaterally) according randomization (A: phototherapy before and after; B: phototherapy before/placebo after; C: placebo before/phototherapy after; and D: placebo before and after). Volunteers performed leg press and leg extension exercises, three times a week for 8 weeks. Strength training was performed beginning with 60% of the maximal load, followed of 80% of the maximal load. The variables were assessed at baseline and repeated monthly. **RESULTS:** Volunteers from Group A obtained an increase in Peak Torque Concentric measured in isokinetic dynamometer of about 21% for right and left legs when compared to other groups and baseline. Group D (placebo) obtained an increase of about 6% for right and left legs. No increase in muscle mass was detected. **DISCUSSION:** Our study confirms the interference of phototherapy in strength training. Phototherapy has demonstrated positive effects in improvement of exercise performance and recovery (Leal-Junior et al, 2015). Baroni et al. (2015) associated the application of laser before each eccentric exercise training lasting eight weeks, with better outcomes ( $p < 0.05$ ) than observed in control group and with no irradiation. It is known that phototherapy irradiation in healthy muscles leads to increased cytochrome c-oxidase activity, and may explain the effects of this therapy in stimulating intact skeletal muscles (Hayworth et al., 2010). Through these results, we can infer that phototherapy applied before and after training sessions, with the parameters used for this study can improve muscle quality, since it could increase strength significantly without increase in muscle mass. Moreover, the optimal moment of application can change depending the periodisation of training. **REFERENCES:** Baroni BM, Rodrigues R, Freire BB, Franke Rde A, Geremia JM, Vaz MA (2015). *Eur J Appl Physiol*, 115, 639-647. Hayworth CR, Rojas JC, Padilla E, Holmes GM, Sheridan EC, Gonzalez-Lima F (2010). *Photochem Photobiol*, 86, 673-680. Leal-Junior EC, Vanin AA, Miranda EF, de Carvalho Pde T, Dal Corso S, Bjordal JM (2015). *Lasers Med Sci*, 30, 925-939. **CONTACT:** adrianevanin@yahoo.com.br

### USING EXTERNAL AND INTERNAL PARAMETERS OF EFFORT IN MONITORING THE TRAINING OF JUNIOR III FOOTBALL PLAYERS

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**Introduction** To achieve remarkable performances during a match, it is not enough to have the motivation and desire to succeed, but it is also necessary to understand the concept of total training, which claims that man is an indivisible whole and each exercise has a global impact on all components of performance (Brunet-Guedj E. et al., 2006). During a football game, metabolic systems are exerted as follows: 70% aerobic system, 15-20% anaerobic lactic acid system and 10-15% anaerobic alactic acid system (Cazorla G., 2002). It should be mentioned that, for reaching a steady state of maximal oxygen consumption ( $VO_{2max}$ ), this one goes through several intermediate stable states which are encompassed in the concept of  $VO_2$  DRIFT. Coaches should avoid the serious error of working in the slow component of  $VO_{2max}$  (Wilmore J.H. et al., 2008). **Methods** The research sample was made up of 18 athletes registered at School Sports Club 1 of Bucharest and born in 1998. Athletes were subjected to two tests (1st testing - 12.08.2014 and 2nd testing - 12.02.2015). The tests used were: 5-minute endurance test and 240-meter shuttle test. Data collection was achieved using GPSports equipment and SPI IQ software. **Results** The obtained reports provide data about the following items: covered distance, travel speed, acceleration speed, maximal aerobic velocity (MAV),  $VO_{2max}$ , heart rate etc. and their evolution. In the 5-minute endurance test, 1st testing, the arithmetic mean for relative  $VO_{2max}$  is 54.9%, while in the 2nd testing, the arithmetic mean has increased to 58.6%; the difference between the two tests is 3.7%, which shows a progress between tests as regards higher aerobic capacity. **Discussions** The use of 5-minute endurance test and calculation of maximal aerobic velocity (MAV) etc. provide information regarding the exercise capacity level of athletes and their limits. Scientific monitoring of training reveals important data about the body's response to specific stimuli and helps coaches to conduct preparation according to the structure and components of periodization. **References** Brunet-Guedj E.B., Brunet B., Girardier J. et al., 2006, *Médecine du sport*, 7e édition, Ed. Masson, Paris, pag. 5; Cazorla G., 2002, *Expertise des exigences physiques et physiologiques du football de haut niveau*, II-èmes Journées Internationales des Sciences du Sport, INSEP, Paris, p. 27; Wilmore J.H., Costill D.L., Kenney W.L., 2008, *Physiology of Sport and Exercise*, 4th edition, ed. Human Kinetics, SUA, pag. 106; [http://gpsports.com/gpsports\\_website/brochures/spi\\_iq\\_2013.pdf](http://gpsports.com/gpsports_website/brochures/spi_iq_2013.pdf)

### METHOD AND DEVICE FOR ANAEROBIC THRESHOLD DETERMINATION

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**Introduction** The optimal loads for aerobic training are chosen using individual anaerobic threshold (AT) values. The method for determination of AT of small and large muscle groups by the dynamics of the integrated electromyographic (EMG) activity and changes in the content of deoxygenated hemoglobin (HHb) in the muscle is proposed and the algorithm for its evaluation is elaborated. **Methods** 8 subjects performed two incremental exercise tests until exhaustion: the bicycle ergometer test and one leg knee extension test. The EMG activity of the middle part of m. vastus lateralis was continuously recorded during testing, changes in the concentration of deoxyhemoglobin (HHb) was recorded by NIR spectroscopy in the same area of m. vastus lateralis. During bicycle exercise the blood lactate concentration was also measured. **Results and Discussion** The dynamics of nonlinear areas on graphs reflecting the EMG activity and oxygen consumption by working muscle differ qualitatively at the end of the test: deoxyhemoglobin concentration reaches a plateau, whereas EMG intensity increases dramatically. The dependence describing the change in the HHb content in m. vastus lateralis and its EMG activity during the test has a characteristic maximum, therefore, the ratio of these indicators HHb/EMG is convenient to use for determining the AT. Significant correlation ( $r = 0.78$ ;  $p < 0.05$ ) between the power at AT determined by HHb/EMG ratio and the power at the anaerobic threshold determined by the lactate concentration in capillary blood was found. This method for determination of AT is also suitable for determining the AT during exercise of small muscle groups. The miniature wireless device fasten on the working muscle and including electromyograph and infrared spectrometer is elaborated for practical usage of this method. Information is transferred from



device to tablet computer and is processed by means of original software and is kept in database. Conclusions The proposed technique of accessing the moment of AT according to the data of EMG and NIRS of working muscles is quite simple and noninvasive, which opens prospects for its use in the medical and sports practice. The work is performed according to the Plan for Fundamental research of SRC RF Institute of Biomedical Problems RAS

## **GROWTH AND DEVELOPMENT OF THIGH MUSCLE THICKNESS AND ANAEROBIC POWER GENERATION CAPACITY IN SHORT-DISTANCE AND ALL-ROUND JUNIOR SPEED SKATERS**

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**Introduction** The force and power generation capacities of the lower limb muscles are improved by speed skating training in junior speed skaters (Nemoto et al. 1990, de Koning et al. 1991). However, there are differences in aerobic and anaerobic power output between short-distance and middle- to long-distance skating (de Koning et al. 2005). Therefore, the mass and anaerobic power generation capacity of the lower limb muscles are expected to show different developmental trends during puberty between short-distance and all-around skaters. This study investigated the effects of training on the growth and development of thigh muscle thickness and power generation capacity in male Japanese junior speed skaters. **Methods** Subjects were 425 male speed skaters aged 12-18 years old. They were divided into two groups according to type of skating: short-distance skaters (SS; competitive distance: 500-1000 m) and all-around skaters (AS; competitive distance: >1500 m). Thickness of the anterior thigh (MTTa), lateral thigh (MTTL), and posterior thigh (MTTp) was measured by B-mode ultrasound. Maximal anaerobic power (MANP) was measured using a bicycle ergometer. Mean skating velocity of 500 m (SV500), calculated from recently attained individual best times, was used as a measure of skating performance. Mean values of these parameters were calculated by age, and rates of growth were calculated by differentiating these values with respect to time. **Results** MTTa and MTTp were significantly larger in the SS skaters than in the AS skaters at 16 and 17 years old. MANP and MANP normalized by body mass were significantly higher in the SS skaters than in the AS skaters at 16-18 years old. Moreover, SV500 was higher in the SS skaters than in the AS skaters at 16-18 years old. The highest rate of growth in thigh muscle thickness was observed at 14.9-15.3 years old in the SS skaters and at 14.0-14.7 years old in the AS skaters. In the SS skaters, the highest rate of change in MANP and SV500 was observed at 14.9 years old and 14.6 years old, respectively, almost coinciding with the highest rate of growth in muscle thickness. In the AS skaters, however, the highest rate of change in MANP (13.0 years old) and SV500 (13.2 years old) occurred before the highest rate of growth in muscle thickness. **Discussion** These findings suggest that different modes of training for speed skating have different effects on muscle mass, anaerobic power generation capacity, and 500-m skating performance after puberty in male speed skaters. Developmental trends in these three parameters nearly coincided in the SS skaters, whereas rapid growth of power generation capacity and skating performance occurred before rapid growth of muscle mass in the AS skaters. **References** de Koning J J, Bakker F C, de Groot G, van Ingen Schenau G J, (1994), *J Appl Physiol*, 77, 2311-2317. Nemoto I, Kanehisa H, Miyashita M, (1990), *J Sports Med Phys Fitness*, 30, 83-88. de Koning, Jos. J., Carl Foster, Joanne Lampen, Floor Hettinga, and Maarten F. Bobbert, (2005), *J Appl Physiol*, 98, 227-233.

## **THE REALITY OF THE SELECTION OF TALENTED PLAYER (II): RELIABILITY OF PERFORMANCE INDICATORS. A DESCRIPTIVE EXAMPLE**

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**Introduction** Comparison between players have been one of the ways to identify the talented football player (Verburgh, Scherder, Van Lange & Oosterlaan, 2014). This comparative has been based on performance indicators (Carling, Reilly & Williams, 2009). This paper aims to determine the reliability of these indicators to identify a player with talent. **Methods** The research design is a descriptive study. It has been compared on the one hand, the performance between players nominated to the Golden Ball. And on the other hand, it has been compared the performance of a talented football players with his teammates. The data collection has been carried out from Champions League 2014/2015 for being the most internationally prestigious competition of clubs in Europe. Statistical analysis was realized using SPSS program v. 22.0. **Results** The comparison between players nominated for the Golden Ball showed those players nominated most times obtained the highest score in matches, minutes, influence on his team and goals/shots. On the other hand, the comparison between a talented player with his teammates showed that matches, minutes, goals/shots, dribbles and penalties were higher than their peers. **Discussion** The results indicated that the indicators used in the literature and specialized databases do not discriminate between the best players in the world and those who are not. In addition, it might be possible to question the conclusions of previous studies (Mackenzie & Cushion, 2013) who have not complemented this assessment with other tools to measure the tactical side (González-Villora, Serra-Olivares, Pastor-Vicedo & Teoldo da Costa, 2015) of the talented footballer. **References** Carling, C., Reilly, T., & Williams, A. (2009). *Performance Assessment for Field Sports*. Routledge: London and New York. González-Villora, S., Serra-Olivares, J., Pastor-Vicedo, J. C., & Teoldo da Costa, I. (2015). Review of the tactical evaluation tools for youth players, assessing the tactics in team sports: football. *SpringerPlus*, 4(1), 1-17. Mackenzie, R., & Cushion, C., (2013). Performance analysis in football: A critical review and implications for future research. *Journal of Sports Sciences*, 31(6), 639-676. Verburgh, L., Scherder, E. J., Van Lange, P. A., & Oosterlaan, J. (2014). Executive Functioning in Highly Talented Soccer Players. *Plos One*, 9(3).

## **THE EFFECTS OF PHV ON PHYSICAL PERFORMANCE ON YOUNG SOCCER PLAYERS**

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**Introduction.** In youth soccer academy categories are organized into annual age groups in order to provide similar competition level and age specific training program (Deprez et al, 2012). Several studies (Figueiredo et al, 2009) have shown better performance in strength, power, speed and endurance in relation to a faster biological maturity in the same age group. Talent identification is often based on physical capacities and so there is the risk that players who are physically less mature may be deselected but not on the basis of their adult potential. No studies evaluated a possible correlation between age of peak height velocity (APHV) and physical capacities. The aim of this study was to examine the relationship between APHV and physical capacities in young soccer players. **Methods.** 158 young soccer players (8-16 years old) were recruited in this study. Players had their APHV indirectly estimated by the leg length, height and weight using equation from Mirvald et al (2002): Maturity offset =  $-9.236 + 0.0002708 \times (\text{leg length} \times \text{sitting height}) - 0.001663 \times (\text{decimal age} \times \text{leg length}) + 0.007216 \times (\text{decimal age} \times \text{sitting height}) + 0.02292 \times (\text{weight/height ratio})$ . Counter movement jump (CMJ), agility (Illinois test

modified for young players), linear sprint performance (5, 10, 20 m), balance (Y balance test, YBT) and flexibility (Sit and reach test, S&R) were evaluated to determine the players' physical capacities. Relationships between APHV and physical variables were evaluated using Pearson's product-moment correlation. The magnitudes of the correlations were considered as trivial (<0.1), small (0.1-0.3), moderate (0.3-0.5), large (0.5-0.7), very large (0.7-0.9), nearly perfect (>0.9) and perfect (1.0) in accordance with Hopkins et al (2009). Statistical significance was set at  $P < 0.05$ . Results. All physical variables were significantly correlated with APHV. Very large magnitude correlations were observed between APHV and linear sprint performance on 5, 10 and 20 meters ( $P < 0.001$ ,  $r = -0.71$ ;  $P < 0.001$ ,  $r = -0.82$ ;  $P < 0.001$ ,  $r = -0.86$ , respectively), large magnitude correlations were observed between APHV and agility test ( $P < 0.001$ ,  $r = -0.56$ ), S&R ( $P < 0.001$ ,  $r = 0.55$ ) and CMJ ( $P < 0.001$ ,  $r = 0.52$ ), moderate magnitude correlation was found between APHV and YBT ( $P < 0.001$ ,  $r = 0.38$ ). Conclusions. Our results indicated correlations between APHV and physical performance in young soccer players and so the physical capacities should be evaluated in relation to individual biological maturation for talent identification and in order to program appropriate training in groups with a great variability of APHV. References. Deprez D, Vaeyens R, Coutris AJ, Lenoir M, Philippaerts R. *Int J Sports Med*, 2012;33(12):987-93. Figueiredo A J, Gonçalves C E, Coelho e Silva M J, Malina R M. *Ann Hum Biol*, 2009;36:60-73. Mirwald R L, Baxter-Jones AD G, Bailey D A, Beunen G P. *Med Sci Sport Exerc*, 2002;34:689-694 Hopkins WG, Marshall SW, Batterham AM, Hanin J. *Med Sci Sports Exerc*, 2009;41:3-13.

## THE EFFECT OF BODY POSITION DURING BREAKS ON PHYSIOLOGICAL RESPONSES TO SIMULATED BOXING: SITTING VERSUS STANDING

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**Introduction** The acute physiological responses to boxing have been well documented (Giovani and Nikolaidis, 2012; Tasiopoulos et al, 2015) however, less information has been available with regards to the impact of different recovery strategies during breaks on these responses. The aim of the present study was to examine the effect of two conditions (sitting versus standing) during breaks on heart rate (HR) responses, rate of perceived exertion (RPE) and neuromuscular fatigue in a simulated boxing match consisting by three 3-min rounds with 1-min breaks. **Methods** Male boxers ( $n=15$ , age  $21.4 \pm 6.3$  yrs, body mass  $67.7 \pm 10.0$  kg, body height  $172 \pm 6$  cm, body mass index  $22.9 \pm 4.2$  kg.m<sup>-2</sup>, training experience  $2.9 \pm 1.9$  yrs) participated in this study. Mean HR was calculated for each round and break. RPE (6-20 Borg scale) was recorded immediately after each round. Countermovement jump (CMJ) and handgrip muscle strength (HGS) were measured before and after match. Results A between-within analysis of variance showed no time  $\times$  body position interaction with regards to all variables ( $p > 0.05$ ). However, in the case of RPE the  $p$  value almost reached statistical significance ( $p = 0.062$ ,  $\eta^2 = 0.426$ ), where, compared to the sitting position, a trend of increased perception of effort for the standing position across time was highlighted. A main effect of time on CMJ, HR and RPE was observed ( $p < 0.05$ ), in which (a) CMJ after match was higher than before ( $34.1$  vs.  $32.1$  cm, respectively,  $p = 0.007$ ,  $\eta^2 = 0.443$ ), (b) HR was higher in the third round than the second and the first one ( $187$ ,  $184$  and  $177$  bpm, respectively,  $p < 0.001$ ,  $\eta^2 = 0.609$ ), and (c) RPE was higher in the third round than in the first one ( $14.7$  vs.  $12.6$ , respectively,  $p = 0.047$ ,  $\eta^2 = 0.457$ ). **Conclusions** Although the present study did not provide evidence for different physiological impact of body position during break in simulated boxing match, there were indications that manipulating the body position might result in different perception of effort. References Giovani, D., Nikolaidis, P.T. *International Journal of Exercise Science*, 2012;5(2):106-13 Tasiopoulos, I., Tripolitsioti, A., Skordis, D. Nikolaidis, P. *Biology of Exercise*, 2015;11(1):65-67. Contact giannhstasio@yahoo.gr

## DETERMINANTS OF MULTIPLE TURNS IN DANCERS

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**Introduction:** Successful performance of a turn requires that the dancer rotates his/her body about a vertical axis with a controlled body posture while maintaining balance on a single leg support. Technical aspects of dance performance improve with enhanced physical fitness (Angioi et al., 2009), however, there is a need to precisely define the fitness components that underlie technical skills execution. The aim of this study was to examine the association between selected physical fitness parameters and the execution of multiple turns on a single leg support in dancers. **Methods:** Thirteen female, professional ballet dance students (age:  $23.34 \pm 4.12$  years, dancing experience:  $16 \pm 5$  years, height:  $163 \pm 1$  cm, body mass:  $50.9 \pm 4.6$  kg) participated in this study. The number of completed 'en dehors' and 'en dedans' turns performed with dominant leg support and the technical execution of one turn were evaluated separately by two dance experts. The dancers underwent a series of physical fitness tests (balance, lower limb muscular power, muscular endurance, and active and passive flexibility). Pearson's correlation coefficient ( $r$ ) was used to detect linear associations among the number and the execution of turns and physical fitness parameters. Stepwise multiple regression analyses examined the strength of the association between physical fitness parameters, the number of turns and one turn technical execution score. **Results:** Balance on the ball of the foot was significantly correlated with the number of 'en dehors' and 'en dedans' turns ( $r = 0.751$  and  $r = 0.853$ , respectively,  $p < .01$ ), the one turn execution score ( $r = 0.610$ ,  $p < .05$ ), and balance on the ball of the foot on a balance platform ( $r = 0.751$ ,  $p < .05$ ). Multiple regression analysis indicated that balance on the ball of the foot accounted for 57.4% of the variance in multiple 'en dehors' turns (adjusted  $R^2 = 0.574$ ,  $F = 17.172$ ,  $p = .002$ ). In addition, balance on the ball of the foot and one-turn score accounted for 70.9% of the variance in multiple 'en dedans' turns (adjusted  $R^2 = 0.709$ ,  $F = 15.651$ ,  $p = .001$ ). Lower limb muscular power, muscular endurance and active and passive flexibility demonstrated no association with the number of turns executed and the one turn score. ICC of the total score for the two dance experts was  $r = 0.93$ ,  $p < .01$ . **Discussion:** It is concluded that balance on the ball of the foot accounts for a large part of the variance of multiple 'en dehors' and 'en dedans' turns execution in classical dancers thus being in line with previous research (Sugano and Laws, 2002). The results of this study provide information to dance teachers on the training focus for turning skills execution. References Angioi M, Metsios G, Twichett E, Koutedakis Y, Wyon M. (2009). *J Dance Med Sci*, 13: 115-123. Sugano A, Laws K. (2002). *Med Probl Perform Art*, 17: 29-32. Contact: odonti@phed.uoa.gr

## CYCLISTS BODY STABILITY DURING 30 SECONDS ISOKINETIC SPRINT CYCLING EXERCISE IS RELATED WITH FMS SCORE, PEDALLING POWER SYMMETRY AND SMOOTHNESS

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**Introduction** Notable bilateral pedalling kinetics asymmetry is measured during steady state cycling and it has tendency to decrease due to higher power output or accumulated fatigue (Carpes et al., 2010). Less examined is pedalling kinetics asymmetry during maximal cycling and how it affects the performance. It is found that knee extensors and upper-body movement asymmetry affects negatively 5 sec. sprint cycling performance (Rannama et al., 2015), but there is no evidence how the core stability is related with this. The aim of the present study was to investigate how the body movement efficiency during 30 sec maximal cycling is related with pedalling technique, pedalling symmetry and core stability. **Methods** The pedalling power (Pped) and smoothness (PS- mean and peak effective force ratio in %) of 37 competitive cyclists ( $18.8 \pm 2.8$  y,  $181.4 \pm 6.2$  cm,  $74.4 \pm 7.2$  kg) were measured bilaterally with Garmin Vector pedals during 30s isokinetic (cadence fixed to 100 rpm) seated sprint cycling test. Absolute bilateral symmetry index (ASI %) between DO and ND side in Pped and PS were computed. The Cyclus 2 ergometer was mounted on Kistler force plates and cyclists body Centre of Gravity movement power (PCoG) were measured. The effectual power ratio coefficient (Pcof in %) between PCoG and Pped were computed. The state of cyclists Core stability evaluated with Functional Movement Screening test (FMS). The correlation analyse and a forward stepwise regression analyse between Pcof and Pped (w/kg), PS, Pped ASI, PS ASI and FMS score were made. **Results** The average values of measured parameters: Pped  $822 \pm 106$  W and  $11.1 \pm 1.0$  W/kg, PS  $32.8 \pm 2.6\%$ , Pped ASI  $5.1 \pm 4.5\%$ , PS ASI  $7.4 \pm 4.1\%$ , PCoG  $24.3 \pm 6.9$  W, Pcof  $2.9 \pm 0.7\%$ , FMS  $14.6 \pm 2$ . There was no significant correlation between Pped and Pcof, PS, ASI and FMS, but higher Pped associated with higher PCoG ( $r=0.43$ ). Between Pcof and other independent variables was developed regression model:  $Pcof = 7.838 - 0.125 \times PS + 0.062 \times Pped \text{ ASI} - 0.076 \times FMS$  **Discussion** The results of present study indicate that sprint cycling performance is not linearly related with body movement efficiency, but the relative amount of power that are generated by extra movements are positively related with Ppow asymmetry and negatively with PS and Core stability (FMS). This supports partly our previous findings between 5 sec. sprint performance, knee extensors strength and upper body kinematics asymmetry (Rannama et al., 2015). **References** Carpes FP, Mota CB, Faria IE. (2010). *Phys Ther Sport*, 11(4): 136-142. Rannama I, Port K, Bazanov B, Pedak, K. (2015). *J Hum Sport Exerc*, 9(1): S247-S258 Contacts rannama@tlu.ee

## PHYSICAL AND PHYSIOLOGICAL PERFORMANCE OF YOUNG SWIMMERS DURING THE SWIMMING SEASON

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In Today's swimming sport, the follow up of the developments of physical and physiological performance is pretty much important in terms of the success during the competitions. The personal and the team data which can be followed during certain periods, gives the information about the seasonal and ongoing development of the team as well as the variations that are formed over the years. In addition to the technical follow-up, the swimmers that are followed both physically and physiologically are more motivated individually and more willing to increase the team success. This research is the first measurement out of four that are planned to follow the physical and physiological performances of the National Level Swimmers throughout the season. Totally 27 swimmers (age =  $14.6 \pm 0.4$  year) participated to the study. The average age of the male swimmers who participate in this research is  $14.7 \pm 0.5$  and the average age of the female swimmers is  $14.5 \pm 0.3$  years. Swimmer's age, age of sport, height, weight, body fat weight, fat free weight, total body water, body mass index, basal metabolic rate, arm span, vertical jump, long jump, push-ups and sit-ups measurements have been made. The data has been analyzed through SPSS 21.0 Statistics with the help of T- Test (a statistical examination to measure the significance of the difference of two sets of data). When it is  $p \leq 0.05$ , the difference between the averages has been found meaningful. The results are important for monitoring of young athletes in all sports in terms of public health.

## ANTHROPOMETRIC AND PHYSIOLOGICAL CORRELATES OF 20 M SPRINT IN ELITE YOUNG FEMALE HANDBALL PLAYERS: THE EFFECT OF CHANGE OF DIRECTION

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**Introduction** The role of anthropometric and physiological characteristics for sprint in handball has been well documented (1-3); however, less information is available about correlates of sprint with change of direction (COD). The aim of the present study was to examine anthropometric and physiological correlates of 20 m sprint in-line (IL) and with COD in elite young female handball players. **Methods** Twenty-two female handball players (experience  $3.8 (1.6)$  yrs, age  $16.5 (0.7)$  yrs, height  $166 (8)$  cm, weight  $64.1 (11.8)$  kg, body mass index, BMI,  $23.1 (3.3)$  kg.m<sup>-2</sup>) performed a series of anthropometric (height and weight) and physiological measures (sit-and-reach test, SAR, right and left handgrip muscle strength test, HGT, Abalakov jump test, AJ, standing broad jump, SBJ, 20 m sprint IL and 20 m sprint with COD). **Results** Sprint with COD ( $5.07 (0.41)$  s) correlated with weight ( $r=0.44$ ,  $p=0.042$ ) and BMI ( $r=0.50$ ,  $p=0.017$ ). Both sprint IL and COD correlated with HGT ( $r=-0.65$  and  $r=-0.70$ ,  $p<0.001$ , respectively), AJ ( $r=-0.81$ ,  $p<0.001$  for both) and SBJ ( $r=-0.74$  and  $r=-0.77$ ,  $p<0.001$ , respectively). A step-wise regression analysis revealed that (a) 20 m sprint IL could be predicted by the equation:  $20 \text{ m sprint IL} = 4.702 - 0.037 \times \text{AJ}$  ( $R^2=0.65$ ,  $SEE=0.15$ ); (b) 20 m sprint with COD could be predicted by the equation:  $20 \text{ m sprint with COD} = 6.820 - 0.061 \times \text{AJ}$  ( $R^2=0.65$ ,  $SEE=0.25$ ). **Conclusions** Based on these findings, it was concluded that an excess body weight might have larger impact on sprint with COD than IL. The observation that both sprint modes could be predicted by AJ highlighted the importance of lower limb muscle power for sprint ability either IL or with COD. **References** 1. Nikolaidis, P.T., Torres-Luque, G., Chtourou, H., Clemente-Suarez, V.J., Ramirez-Vélez, R., Heller, J. *Movement and Sport Sciences/Science et Motricité*, 2016 epub. 2. Nikolaidis, P.T., Ingebrigtsen, J., Povoas, S.C., Moss, S., Torres-Luque, G. *Journal of Sports Medicine and Physical Fitness*, 2015, 55(4):297-304. 3. Nikolaidis, P.T., Ingebrigtsen, J. *Journal of Human Kinetics*, 2013;38:115-124. Contact jkost@otenet.gr

## DETERMINATION OF THE ANAEROBIC THRESHOLD FROM STRIDE FLIGHT TIME IN RUNNING

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**Introduction** This study is based on the assumption that neuromuscular and metabolic changes, which determine the anaerobic threshold in running, are also reflected in changes of specific kinematic parameters. Therefore, the main objectives of this research were to

investigate: 1) the relationship between stride flight time and running speed during incremental running, and the possible presence of a threshold (nonlinear change in the trend) for flight time (FTh); 2) the relationship between the ventilatory anaerobic threshold (ATh, respiratory compensation point) and the FTh. Methods Twenty-three PE students were subjected to an all-out incremental treadmill test, with measurement of gas exchange (VO<sub>2</sub>, VCO<sub>2</sub>) and kinematic parameters. Independent evaluators defined the ATh (V-slope method) and FTh thresholds. The APAS system (Ariel Dynamics, USA) with surface markers was used to measure the stride flight time, and the Quark b2 (Cosmed, IT) system for spirometry data. Student's t-test, correlation coefficient (r), and limits of agreement (LoA) were used to compare the ATh and FTh thresholds obtained in the graded exercise test. Results In 19 subjects FTh was determined as the point of stagnation or decrease of stride flight time with increasing running speed. In the remaining 4 subjects, flight time increased at speeds above FTh. A strong relationship between ATh and FTh ( $r = 0.84$ ,  $p < 0.01$ ) was determined. The average values of ATh and FTh did not differ significantly, although a trend towards somewhat higher values for FTh was present ( $LoA = 0.2 \pm 2$  km/h). Conclusions We conclude that, during a graded treadmill test, there is close coupling between changes of stride flight time and gas exchange parameters that determine the threshold between two adjacent intensity domains. The results of this research open a possibility for the development of new methods of determining the anaerobic threshold by monitoring stride parameters during graded treadmill running.

## THE EFFECT OF MUSCULAR STRENGTH AND STRENGTH ASYMMETRY ON JUMPING HEIGHT AMONG SOCCER PLAYERS

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**Introduction** The game of soccer involves frequent one-sided activities, which may lead to muscle strength asymmetries between two legs (Kellis et al., 2001). Bilateral muscle asymmetries may reduce performance and increase injury risk (Fousekis et al., 2010). There are many studies that investigate relationship between muscle strength and jump height, but there is lack of studies that investigate relationship between muscle strength asymmetries and jump height. The purpose of this study is to investigate relationship between knee flexors/extensors strength, strength asymmetries and vertical jump height. **Methods** The 17 male soccer players of Estonian Premium League teams ( $22.6 \pm 3.9$  yrs,  $182.7 \pm 7.1$  cm,  $79.4 \pm 9.6$  kg, soccer experience  $15.9 \pm 4.0$  yrs) performed countermovement jump (CMJ) and counter-movement jump with arm swing (CMJA) in Kistler force plate. The jump height was calculated with impulse method. Knee extensors (EX) and flexors (FL) peak torque (PT) was measured with an isokinetic dynamometer Humac Norm (USA). Concentric actions were measured at angular velocity of 60, 180 and 300°/s, and eccentric (ECC) actions at angular velocity of 60°/s. The hamstring quadriceps (H/Q) ratio and absolute bilateral asymmetry index (ASI) between dominant (D) and non-dominant (ND) legs were computed ( $ASI = 100 * (D - ND) / 0.5 * (D + ND)$ ). The forward stepwise regression analyses were made between both jump height values and relative EX and FL PT (N/kg), H:Q ratio and ASI of EX and FL PT in different testing speeds. **Results** The regression model for CMJ height:  $CMJ = 10.49 + 22.82 * EX300 - 0.199 * FL300ASI$  ( $p < 0.01$ , adjusted R square = 0.74). The regression model for CMJA height:  $CMJA = 21.3 + 21.9 * EX300 - 0.393 * EX300ASI - 0.218 * FL300ASI$  ( $p < 0.01$ , adjusted R square = 0.76). **Discussion** Results on current study are in line with previous study by Lehance et al (2009) that knee EX strength is strongly correlated with CMJ height, but the current study found these strong correlations at lower angular velocity. The main finding of this study is negative relationship between CMJ height and knee EX and FL strength asymmetry measured in high testing speed, it supports modelling based findings of Yoshioka et al (2011). **References** Kellis, S., Gerodimos, V., Kellis, E., Manou, V. IES. 2001, 9, 31–39. Fousekis K., Tsepis E., Vagenas G. (2010). J Sports Sci Med. 2010, 9, 364–373. Lehance C., Binet J., Bury T., Croisier J.L. Scand J Med Sci Sports. 2009, 19, 243–251. Yoshioka, S., Nagano, A., Hay, D., Fukushima, S. J Sports Sci, 2011, 29(8), 867–177.

## ANTI-GRAVITY SYSTEMS FOR PATIENT TRAINING

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**Introduction** All of a person's weight is supported by his or her legs during dynamic motions such as walking, running, and jumping. Human ankles and knees are easily hurt. Specially, it is very bad for knee-patients. Therefore, the proposed systems allows patients to experience reduced gravity environments from microgravity to full gravity (e.g., earth surface, lunar surface and Martian surface). **Methods** The anti-gravity systems consists of 4 wire ropes, 4 road cells, 4 drum-winch, a harness, and, a treadmill. It tracks the person's motion to move with a constant velocity in the horizontal direction as well as to maintain a constant vertical force directly above the person by measuring the deflections and tensions of the 4 wire ropes and adjusting accordingly. The feasibility of the proposed controller has been examined with walking and running experiments on treadmill assuming that patients experience 3 reduced gravity environments, that is, earth gravity, lunar gravity and Martian gravity. **Results** Reactive forces under earth gravity, lunar gravity and Martian gravity are approximately captured as 1, 1/6 and 1/3 of total weight of a patient, respectively. The application of this system would greatly improve medical rehabilitation for conditions including lower extremity rehabilitation, neuromuscular and proprioceptive retraining. **References** <http://www.spaceref.com/news/viewsr.html?pid=45163>. P. Lutz, J. von Zitzewitz, G. Rauterk, M. Fritsch, C. Everarts, R. Ronsse, A. Curtk and M. Bolliger, (2013), IEEE International Conference on Rehabilitation Robotics, Multidirectional Transparent Support for Over-ground Gait Training, 24–26. Contact [ohung@kitech.re.kr](mailto:ohung@kitech.re.kr)

## MUSCLE ACTIVITY OF LOWER EXTREMITIES AND THE TRUNK WHILE DOING SQUATS WITH VIPR

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**Introduction** ViPR is often used in loaded movement training (Dalcourt, 2014). The purpose of this study was to evaluate muscle activities of the lower extremities and the trunk while performing squats using ViPR. **Methods** Seventeen collegiate students (men=8, women=9, age=20.7±0.7 y) participated in this study. All subjects underwent bilateral squats using ViPR. ViPR is a 4-kg pipe-shaped weight (diameter, 14 cm; length, 107 cm). Muscle activities were measured during normal squats (1. Normal) and four types of squats using ViPR (2. holding ViPR on the head: Head, 3. holding ViPR in front of the thigh: Front, 4. Holding ViPR at the right side of the body: Right, 5. Holding ViPR at the left side of the body: Left). Surface electromyography (SX230, Biometrics Co.) was used to assess muscle activity. The electrode was attached to the rectus abdominis, external oblique, internal oblique, multifidus, gluteus maximus, gluteus medius, rectus femoris, and biceps femoris. All the electrodes were attached on the right side. The section targeted for analysis was 0.4 s when the subject flexed



his/her knee, and the thigh was parallel to the ground. The root-mean-square was calculated and normalized to the % maximal voluntary isometric contractions (MVC) from each squat. Subjects attempted to elicit MVC for each muscle. One-way ANOVA and multiple comparisons with Bonferroni method were used for statistical analysis. Results The external oblique muscle had the most intense activity (30.5%) on the Left, and significant differences in muscle activity were noted between Left and Normal (13.1%,  $p < .05$ ). The internal oblique muscle had the most intense activity (45.8%) on the Right and was significantly different when compared with all other muscles ( $p < .0001$ ). The multifidus muscle had the most intense activity (50.5%) on the Left, and was significantly different from that in Normal (31.4%), Front (37.3%) and Right (36.8%,  $p < .001$ ). Discussion Significant differences were not noted for trunk muscles and muscle activities of the lower extremities when squats using ViPR of 4 kg were compared with normal squats. On the other hand, activities of the external oblique muscle, the internal oblique and the multifidus improved by holding ViPR on either side of the body and when squatting. References 1. Mumford P. ViPR. Ultra-Fit Magazine 2013 06;23(5):24-26. 2. DALCOURT M. Loaded Movement Training. IDEA Fitness Journal 2014 05;11(5):30-37. 3. Bryant CX. Embracing the Self-Care Model. IDEA Fitness Journal 2014 05;11(5):80-81. Contact: s-izumi@hosei.ac.jp

## BACKSTROKE SWIMMING: THE EFFECT OF USING HAND PADDLES ON SWIMMING PERFORMANCE.

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Introduction It is recognised that the use of swimming aids such as hand paddles during training creates substantial improvement in swimming efficiency and performance (Abdelhameed and Hassaneen, 1997). This is a consequence of the improvement occurred to a specific power of the swimmers and the overall technique (Abu-Elella, 1994). Freestyle swimming has been extensively investigated with regard to the energy expenditure and biomechanical characteristics with hand paddles (Ogita et al., 1999; Elsokary et al., 2001). However, there is lack of information in the literature regarding the physiological demands and performance characteristics in backstroke swimming with hand paddles. Therefore, this study was undertaken to investigate the effect of using hand paddles on backstroke swimming's technical characteristics and performance of Egyptian elite swimmers. Methods Twelve Egyptian elite swimmers competing at the national and level on backstroke swimming style were included in this study. Data collection and measurements were performed in four different sessions with 3-days time interval. In each session, swimmers were requested to swim individually a 100-m backstroke with or without paddles at the same speed and level of intensity (100% of maximum speed). Results Performance and stroke technical characteristics demonstrated lower stroke length, higher stroke number and gliding length without the use of hand paddles. The rating of perceived exertion ( $16.42 \pm 2.8$  vs  $11 \pm 2.84$ ) was higher without the use of hand paddles. Discussion This study investigated the effect of using hand paddles on the physiological and certain biomechanical characteristics of backstroke swimming on Egyptian elite swimmers. The finding indicated that backstroke swimming with hand paddles demonstrated significantly higher efficiency than without on Egyptian elite swimmers, which is consistent with the findings of Ogita and colleagues (1999). References Abdelhameed K, Hassaneen M. (1997) The Principles of athletic training, Dar Elfeker Elarby, Egypt. Abu-Elella A. (1994) Teaching Swimming, Dar Elfeker Elarby, Egypt. Elsokary K, Brekaa M, Elashmawy E. (2001) Sports Biomechanics, Monshat Elmaarf, Alexandria, Egypt. Ogita F, Onodera T, Tabata I, (1999) Effect of hand paddles on anaerobic energy release during supramaximal swimming, Medicine & Science in Sports & Exercise, 31(5) 729-735.

## PROGRAMMED AND SYSTEMISED PHYSICAL ACTIVITY OR FREESTYLE SWIMMING FOR THE PHYSICAL FITNESS OF EGYPTIAN ADOLESCENTS

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Introduction A plethora of physical and psychological changes during adolescence associated with various components of physical fitness (WHO, 2010). Evidence from high quality literature and guidelines suggested that physical activity of high and moderate intensity (e.g. 9 min race, 1 min abdominal test, etc.) should be performed by adolescents for at least three times a week for 10 - 20 minutes (ACSM, 2004). Furthermore, adolescents should participate in moderate or high intensity sports activity such as swimming for 60 or more minutes a day for at least 3 days a week (Shams, 2007). However, to-date, there is no publication or assessment to investigate the influence of programmed and systemised physical activity and/or sports activity such as swimming on the physical fitness of Egyptian active adolescents. Consequently, this study was conducted to examine the effectiveness of Programmed Physical Fitness Training (PPFT) and sports activity "Freestyle Swimming" (FS) on the physical fitness of Egyptian active adolescents. Methods The total population in this study was all adolescents who are members at Tanta sports club (Egypt). 100 participants (aged 12 to 17) 50 male and 50 females were included in the study. Programmed Physical Fitness Training group (PPFT) comprised 50 participants (aged  $15 \pm 0.6$  years) 25 males and 25 females. Freestyle Swimming group (FS) comprised 50 participants (aged  $14 \pm 0.8$  years) 25 males and 25 females. Results The PPFT group demonstrated significant improvement in cardiovascular fitness and strength of the upper and lower limbs. The FS group demonstrated significant improvement on agility and strength of the upper limb. Discussion The findings of this study demonstrated that the effectiveness of the PPFT and FS on Egyptian active adolescents' physical fitness were not significantly different. Although the PPFT creates more positive changes in the physical fitness, majority of Egyptian active adolescents frequently prefer the FS. References ACSM. (2004) Physical Activity and Bone Health, Med Sci Sports Exerc, 11: 1985-96. Shams A. (2007) Swimming, Mansoura University, Mansoura, Egypt. World Health Organization (2010) Global Recommendations on Physical Activity for Health. Geneva, World Health Organisation.

## ASSESSMENT OF MATCH INTENSITY IN ICE HOCKEY PLAYERS

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Introduction Ice hockey is a team sport where the players demonstrate comprehensive physical fitness. The extremely varied nature, intensity, and duration of activity encountered in ice hockey makes it difficult to precisely determine the metabolic demands of this sport. The purpose of this study is to determine the intensity of ice hockey youth elite players' effort during the game on the basis of their heart rates and the results of graded maximal test values. Methods Twenty youth ice hockey players, members of the Poland men's national under-18 ice hockey team (mean  $\pm$  SD;  $16.7 \pm 0.75$ y;  $182 \pm 5.5$ cm;  $79 \pm 7.2$ kg) participated in this study. Players performed an incremental exercise test on a cycle ergometer platform Cyclus 2 (RBM elektronik-automation GmbH, Leipzig, Germany) used to assess maximal oxygen uptake (exhaled air was continuously sampled by an gas analyzer K4 b2 (Cosmed, Italy)) in a period directly preceding their participation in the International Ice Hockey Federation World Junior Championships. The results of the test allowed us to indicate two physiological markers (ventilatory thresholds (VT1) and respiratory compensation point (RCP)) (Chicharro et al., 2000) and heart rates (HR)

necessary to determine 3 intensity zones. By juxtaposing each player's HR recorded during games played at the Championships with intensity zones obtained from the incremental exercise test, the length of time that individual players worked in each zone was calculated (Stanula, Rocznik, 2014). Results In each period, the defensemen spent around 22% of their playing time in the high intensity zone (HR exceeding 94.5% of HRmax) and approximately 22% in the moderate-intensity zone (HR between 82.6 and 94.0% of HRmax). In total, they spent more time in these two zones than the forwards for whom the respective values were around 19% (HR higher than 96.1% of HRmax) and 26% (HR from 85.4 to 95.6% of HRmax). The difference between the time the forwards and the defensemen spent in the high intensity zone during the entire match was statistically significant ( $p=0.043$ ). Discussion The main finding of this study is that ice hockey players' HRs recorded during a game and those obtained from an incremental test can be applied to estimate exercise intensity. A method that uses the aerobic and anaerobic metabolism variables to determine exercise intensity zones can significantly improve the reliability of assessment of the physiological demands of the game, which makes it a very useful tool for sports scientists and other sport-related professionals in managing the training process (Stanula et al., 2016). References Chicharro JL, Hoyos J, Lucia A. Br J Sports Med, 2000;34:450-455 Stanula A, et al. J Strength Cond Res, 2016;30(1):176-183. Stanula A, Rocznik R. J Hum Kinet, 2014;44(1):211-221. Contact a.stanula@awf.katowice.pl

## CHANGES IN RATE OF FORCE DEVELOPMENT AFTER ANGLE SPECIFIC LEG EXTENSION ISOMETRIC TRAINING

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**Introduction** Recent studies have shown that isometric training of the knee extensors at long muscle length (i.e. knee angle at 90°) shifts the force-length relationship towards smaller knee joint angles and increases squat jump performance (Ullrich et al., 2010). However, most power sports require the development of explosive muscle force with much larger knee angles and there is limited evidence regarding the effects of isometric training at different knee joint angles on explosive force generation. Thus, the purpose of the present study was to compare two isometric training programs performed at different knee angles on rate of force development (RFD) of the leg extensors. **Methods** The sample included fifteen male physical education who were divided into two groups and trained three times per week for 6 weeks. One group ( $n=8$ ) performed the isometric leg press exercise with knee angle set at 85°, while the other group ( $n=7$ ) performed the isometric leg press with knee angle set at 145°. Training involved 5-7 sets of maximal isometric leg press exercise with a 4 min of recovery between sets, during which 3 countermovement jumps were preformed. Before and after training, isometric strength during leg press at 6 different knee angles (60-160°) were assessed using a force platform. RFD during the first 100 ms of contraction was calculated from the filtered force data obtained at 1000 Hz. Data were analyzed using 2-way ANOVA with repeated measures and Tukey post-hoc test ( $p<0.05$ ). **Results** After training at a knee angle of 85°, maximal isometric force was increased similarly by 12.5% at all knee angles (main effect pre vs. post training,  $p=0.028$ ), but RFD did not change significantly ( $p=0.37$ ). In contrast, following training at a knee angle of 145°, maximal isometric force increased only at the knee angles of 140° (by 15.9%,  $p=0.04$ ) and 160° (by 48%,  $p=0.01$ ), while RFD increased only at the angle of 160° (by 55%,  $p=0.15$ ). **Discussion** Training at a knee angle of 145°, resulted in an angle-specific increase in peak isometric force and RFD, while training at a smaller knee angle resulted in an improvement of maximal isometric force only, with no effect on RFD. This data show that angle specificity of isometric training occurs only when training at a large knee angle. **References** Kubo K, Ohgo K, Takeishi R, Yoshinaga K, Tsunoda N, Kanehisa H, Fukunaga T. (2006) Scand J Med Sci Sports, 16:159-67. Ullrich, B, Heinrich, K, Goldmann, JP, Brüggemann, GP (2010) Int J Sports Med, 31, 243-250. Contact gbogdanis@phed.uoa.gr

## PRE-FRONTAL CORTEX OXYGENATION AND PERIPHERAL FATIGUE DURING WINGATE EXERCISE

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**Introduction** It is well accepted that biological fatigue ensues when maximal exercise is performed. Research supports that both central and peripheral fatigue is implicated, but it has been debated what is the contribution of each component to this fatigue (Noakes et al, 2005; Amann et al, 2013). However, it appears that the type, intensity and duration of exercise influences this response to exhausting exercise (Hargreaves, 2008). This study examined the effects of a single Wingate 30-sec anaerobic test on tissue oxygenation changes and its relationship to central nervous system vs. peripheral neuromuscular activation. We hypothesized that short-term high intensity exercise would elicit a peripheral fatigue but not a central limitation because of the brief nature of exercise. **Methods** Ten ( $n=3$  female) university athletes performed the Wingate anaerobic test (7.5% body mass resistance) on the Veletron cycle ergometer. Near infrared spectroscopy was used to assess pre-frontal cortex (PFC) and quadriceps muscle oxygenation changes throughout testing. Central activation (CA) was recorded using the interpolated twitch technique during a maximal voluntary isometric contraction (MVC, N) of the right quadriceps muscle in a knee extension chair (knee at 90 degrees flexion), performed pre- and post-Wingate. Electrical stimulation was provided by a constant current stimulator triggered by a Powerlab 16/30 stimulator panel. In addition to MVC, subjects were tested for peak twitch force (PT, N), time to peak twitch (TPT, msec), half relaxation time ( $1/2$  RT, msec), and relaxation time (RT, msec). Paired t-tests compared differences pre- to post-Wingate with statistical significance set at  $p<0.05$ . **Results** Pre- vs. post-Wingate results showed that CA was not changed ( $88\pm 8$  to  $92\pm 6\%$ ), but MVC was significantly reduced ( $815.4\pm 120.3$  to  $668.2\pm 56.8$  N), respectively. PT force was significantly reduced post-Wingate ( $506.6\pm 83.2$  to  $427.5\pm 84.5$  N, respectively). There was a greater absolute % reduction in muscle (15%) vs. PFC (3%) tissue saturation index (TSI%), and this was also reflected in a greater deoxygenation (HHb) change in the muscle ( $8.3\pm 10.5\mu M$ ) vs. the PFC ( $2.6\pm 3.5\mu M$ ), despite both tissues been well perfused with oxygen (PFC  $HbO_2=16.5\pm 9.2\mu M$ ; MHbO<sub>2</sub>= $6.4\pm 5.1\mu M$ ). **Discussion** This study supports the contention that the central and peripheral contribution to fatiguing exercise is related to the type of exercise, as it has been documented that either, or both, a central and peripheral fatigue occurs during maximal exercise (Noakes et al., 2005; Amann et al. 2013; Hargreaves, 2008). Collectively our results showed that there is greater peripheral fatigue (significant reduction in MVC and PT with no significant change in CA) after a single 30-sec Wingate test despite both the brain and muscle being well perfused with oxygen. **References** Amann M, et al (2013). J Appl Physiol, 115: 355-364. Hargreaves, M. (2008). J Appl Physiol, 104: 1541-1542. Noakes TD, (2005). Br J Sports Med, 39: 120-124. Contact patrick.neary@uregina.ca Funding NSERC Canada

## VISUAL PACESETTERS DURING SUBMAXIMAL EXERCISE: COULD IMPROVE PERFORMANCE?

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**Introduction:** Recent research evidence indicates that synchronizing movement patterns to an external rhythmic auditory stimulus such as music could possibly lead to reduced metabolic cost via enhanced neuromuscular or metabolic efficiency (1-2). Besides acoustic, also the visual stimuli can be capable to induce mood changes, consequently it could be used to improve work load during physical activity (3), but no studies have evaluated the effects of visual stimuli on the efficiency and metabolic work. The main aim of this study was to assess the effectiveness of exercise routines which make use of different types of pacesetters, as well as to compare energy expenditure during training with acoustic or visual cues. **Methods:** Twelve healthy male subjects (age: 29.3 ( $\pm$ 5.9) yrs; height: 178.2 ( $\pm$ 8.1) cm; weight: 81.4 ( $\pm$ 9.1) kg) were enrolled and underwent to a 30 min long exercise on a cycloergometer at a constant speed (about 60 rpm) and workload intensity corresponding to 70% of ventilatory threshold. Three randomized experimental sessions were performed by each subject: Control Test (CT) without stimuli, Mirror Test (MT) video representing an exercise performed by subject with no audio, Visual Test (VT) video including a series of rhythmic images with no audio. In all trials, VO<sub>2</sub> was measured breath by breath by means a metabolimeter (K4b2, Cosmed, Rome, Italy). The corresponding energy was estimated by multiplying the VO<sub>2</sub> (ml\*kg<sup>-1</sup>) by 21 (equivalent energy in Joule). These values were taken in account in the result section for each subject and test. ANOVA for repeated measures was applied to evaluated differences ( $p < 0.05$ ) in relation to experimental session. **Results:** The metabolic work (MW) expressed in kJ, resulted: 940( $\pm$ 139.1), 882( $\pm$ 130.6), 874( $\pm$ 96.1) in CT, MT, VT respectively. The efficiency resulting lower of 6% and 7% in MT and VT respectively than CT. In particular, it is significantly different in MT and VT compared to CT. **Discussion:** Results from this investigation could be used for the development of new training strategies, in which images projected at various frequencies can be showed to the athletes to indicate the correct rhythm of the technical movement. This study would seem to highlight how the ergogenic effect could be attributed to synchronicity between stimulus and motor tasks, without necessarily being related to psychological factors as referred in past studies (4). The positive benefits could be ascribed to a more efficient agonist and antagonist co-contraction. **Reference:** Karageorghis CI et. al. (2009) J Sport Exerc Psychol.31:18–36 Terry PC et. al. (2012) J Med Sci Sport.15:52–7 Barwood MJ et al. (2009) J Sports Sci Med.8:435-442 Karageorghis CI et. al. (2010) Psychol Sport Exerc.11:551–9 Contact: lecce.daniela@libero.it

## ANTHROPOMETRY AND EXERCISE TESTING IN PROFESSIONAL CYCLO-CROSS ATHLETES

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**Introduction:** Cyclo-cross athletes can choose to cycle or carry their bike and run. Training, therefore, can be focused on biking and/or running. The aim was to determine anthropometric and physiological characteristics in professional cyclo-cross athletes and to investigate differences between the results of an exercise test on a cycle and a treadmill ergometer. **Methods:** Anthropometric parameters were analyzed in six elite (age 25 $\pm$ 3 y) and five U23 (age 19 $\pm$ 1 y) professional cyclo-cross athletes following the ISAK guidelines. They performed maximal exercise tests on a cycle ergometer and a treadmill with ergospirometric and blood lactate assessments, in the beginning and at the end of the season. **Results:** The mean somatotype was mesomorph-ectomorph. The somatotype components were 3.40 $\pm$ 0.56 (mesomorphy), 3.50 $\pm$ 0.76 (ectomorphy) and 1.50 $\pm$ 0.35 (endomorphy). Relative body fatness was similar between elite and U23 riders (4.19  $\pm$ 0.66 vs 6.02  $\pm$ 1.60 %BF ( $p=0.082$ ) resp.). Maximal ventilation, VO<sub>2peak</sub> and maximal lactate during cycle ergometry were higher compared to the treadmill tests (128.80 $\pm$ 19.81 vs 119.53 $\pm$ 14.70 l/min ( $p=0.05$ ), 70.06 $\pm$ 8.15 vs 64.92 $\pm$ 8.89 ml/min/kg ( $p=0.041$ ) and 7.92 $\pm$ 2.28 vs 5.72 $\pm$ 1.23 mmol/l ( $p=0.001$ ) resp.). A significant increase in load and VO<sub>2</sub> at the 2 mmol lactate threshold towards the end of the season was observed. Although absolute maximal load remained unchanged (376 Watt), maximal load per kilogram body-weight was significantly increased towards the end of the season (5.66 $\pm$ 0.53 W/kg vs 5.70 $\pm$ 0.53 W/kg;  $p=0.017$ ). **Discussion:** Professional cyclo-cross athletes have a mesomorphic – ectomorph somatotype profile and a low fat mass. Results of a maximal exercise test on a treadmill are significantly lower compared to the results on a cycle ergometer in cyclo-cross athletes.

## MAXIMUM OXYGEN UPTAKE DETERMINATION BASED IN DECREMENTAL TESTS

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**Introduction:** The validity of maximum oxygen uptake (VO<sub>2max</sub>) values may be questioned, because it depends on various factors, such as the incremental exercise protocols (INC) used. Beltrami et al (2012), published in their work a new approach about determination of VO<sub>2max</sub>; they used a the decremental (DEC) protocol, in which speed started high but was reduced progressively, achieving higher VO<sub>2max</sub>. However, the hypothesis that DEC can achieve higher values than INC was not retested. Thus, the aim of this study was to evaluate if DEC can reach higher VO<sub>2max</sub> values when compared with traditional INC. **Methods:** Thirteen healthy, well trained male athletic runners of national level (age: 18  $\pm$  1 years; height: 174  $\pm$  5 cm; total body mass 67  $\pm$  3 kg; fat body: 8.0  $\pm$  1.4%), performed 5 tests. The first four, were separated by 48 – 72 hours, the last one was performed 7 – 10 days ahead: (1) a traditional INC plus verification test (VER) at a constant workload 1 km/h higher than the last completed stage in INC; (2) DEC familiarization; (3) DEC in which speed started as same as the VER but was reduced progressively; (4) DEC until speed of VO<sub>2max</sub> (vVO<sub>2max</sub>) and immediately followed by 10 seconds stages of INC (DEC/INC); (5) INC final (INCf) to compare with the first INC. All tests were performed in a treadmill (Super ATL, Inbrasport, Porto Alegre, RS, Brazil) with 5% grade and using the gas analyzer Metalyzer II (Cortex, Leipzig, Germany). VO<sub>2max</sub> and vVO<sub>2max</sub> achieved in DEC, DEC/INC and INCf were compared with INC (student t-test). **Results:** No statistically differences ( $p > 0.05$ ) were observed between VO<sub>2max</sub> of INC (59.0  $\pm$  4.2 ml.(kg.min)<sup>-1</sup>) and DEC (60.1  $\pm$  5.3 ml.(kg.min)<sup>-1</sup>), DEC/INC (60.3  $\pm$  5.9 ml.(kg.min)<sup>-1</sup>) and INCf (59.6  $\pm$  4.5 ml.(kg.min)<sup>-1</sup>). No statistically differences ( $p > 0.05$ ) were also observed between vVO<sub>2max</sub> of INC (15.6  $\pm$  1.3 km/h) and DEC (15.2  $\pm$  1.5 km/h), DEC/INC (15.8  $\pm$  1.5 km/h) and INCf (16.0  $\pm$  1.3 km/h). **Discussion:** Beltrami et. al (2012) compared INC vs DEC and they found VO<sub>2max</sub> in DEC 4.4% higher than INC. Authors attributed this result to anticipatory mechanisms (sympathetic/parasympathetic drives) that can change the effort sensation. The findings of Beltrami et al (2012) are in contradiction of the classical model of exercise regulation. However, the hypothesis that DEC can achieve higher values of VO<sub>2max</sub> than INC was not confirmed in our study. Smirmaul et al (2013), in their opinion report, explain that different protocol can attain different values of VO<sub>2max</sub>. However, it is necessary more studies of the model proposed by Beltrami et al (2012). Some of our participants showed a large VO<sub>2max</sub> difference between INC and DEC tests. So, more studies are required to elucidated these questions. **References:** Smirmaul, BPC et.al. (2013). Front Physiol, 4, 203. Beltrami, FG et al. (2012). Br J Sports Med, 46(1), 23-299.

## USE MORPHOLOGICAL AND FUNCTIONAL CHANGES IN THE CONTROL OF TRAINING EFFECTS

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Ad hoc training effects are additive and, consequently, lead to more systemic changes that outwardly manifested by morphological changes. Immediately you can evaluate them based on registration of changes of somatic: body composition, thickness of skinfolds and body circuits. Yet taken control methods of training effects are mainly based on the study of fixed states (physical fitness level determined by the biochemical and physiological indicators, the result in sport). While the effects of current control is carried out only partially, in order to qualify for the effort made to set the intensity or type of zones of such measures. Therefore, studies were undertaken, aimed at developing methods of control of late (prolonged) and fixed effects of training on the basis of anthropological measurements and physiological indicators during the course of sports training, in particular periods and consequently, a more optimal use of different methods and training loads. Material and methods: The study involved 20 MTB cycling. Research cyclists included annual training cycle, and individual training units were divided into training: phosphate, glycolytic and oxidative. Subjects were taken anthropological body measurements of: height, weight, three components of body composition: lean body mass, fat and water, circuits of the body: chest, waist, hips, right and left forearm and upper arm and right and left lower leg and thigh and skin folds. By registering late changes of body circuit training was measured before, immediately after training and the next morning. However, in order to document the fixed effects were measured: body composition and thickness of skin folds and the level of physical fitness. Taking into account the type of energy conversion characteristics for metabolism of effort in cyclists, physical efficiency levels were measured Wingate test, to evaluate the anaerobic capacity. Results: The prolonged effects After training specific to cyclists sports, but mostly taking place on the basis of sources phosphate in the riders have a statistically significant increase in circuit libs – thighs (right and left) After glycolytic training in cyclists statistically significant increase in waist circumference After aerobic training, riders waist circumference changes were the opposite direction, and further increased circuitry of the thighs. The fixed effects: The training used influenced by modifying the construction and composition of the body of tested competitors Reduction of fat tissue was in favor of lean body mass. Thanks to increased hydration. Also increased the level of physical efficiency, which directly translates into improved athletic performance and training effectiveness. References: Ashe M, Scroop G, Frisken P, Amery C, Wilkins M, Khan K. (2003) Body position affects performance in untrained cyclists. *Br J Sports Med*. 37, (5), 441–444.

## EFFECTS OF INDOOR CYCLING TRAINING ON ROLLERS UNDER CONDITIONS OF VASCULAR OCCLUSION IN AMATEUR TRIATHLETES

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Introduction Occlusion training was originally developed in Japan where it is known as KAATSU training (Sato, 2005). The effects of occlusion training have been studied in different types of populations (Takarada et al., 2000). Most investigations are associated with strength training (Manini & Clark, 2009) but there is little research about the effects of occlusion training in endurance training. The main objective of this research was to test the effects of an indoor cycling training protocol under conditions of vascular occlusion in the maximum aerobic power and anaerobic threshold of amateur triathletes. Methods 20 amateur male triathletes (Age  $25.0 \pm 5.7$ ; Stature  $176.5 \pm 6.8$  cm; Weight  $72.8 \pm 7.3$  kg) were divided into two homogeneous groups after the first test (maximum aerobic power cycling test): control group (CG n=10) without occlusion training or experimental group (EG n=10) with occlusion training. Triathletes conducted specific cycling training on rollers 3 days per week for 3 weeks. The rest of the time both groups completed the same training plan. The specific training for CG consisted of 5 minutes in zone 1 (below VT1) followed by 45 minutes in zone 2 (between VT1 and VT2) and ending with 2 minutes of recovery. The EG started with 5 minutes in zone 1 (below VT1) without occlusion followed by 22.5 minutes in zone 2 (between VT1 and VT2) with a 50% occlusion in the most proximal part of the lower limb, ending with 2 minutes of recovery without occlusion. All triathletes repeated the test after 3 weeks of training. Results The results showed very significant increases in the maximum aerobic power both in the control group (Pre:  $292 \pm 35.214$  w vs. Post:  $316.50 \pm 39.019$  w;  $P < 0.01$ ) and in the experimental group (Pre:  $292 \pm 42.895$  w vs. Post:  $317 \pm 36.530$ ;  $P < 0.01$ ), as well as significant improvements in the anaerobic threshold in the experimental group (Pre:  $229 \pm 35.730$  w vs. Post:  $239 \pm 32.128$  w;  $P < 0.05$ ) and control group (Pre:  $216 \pm 23.97$  w vs. Post:  $241.11 \pm 27.58$  w;  $P < 0.01$ ). Discussion The experimental group obtained very similar improvements in both the maximum aerobic power and the anaerobic threshold compared to the control group, but expending a considerable lower training time. Thus, occlusion training seems to be a valid methodology to improve maximum aerobic power and the anaerobic threshold of amateur triathletes in the cycling segment. However, more research is needed in order to find the best occlusion training protocol for endurance training. References Manini, T. M., & Clark, B. C. (2009). Blood flow restricted exercise and skeletal muscle health. *Exercise and Sport Sciences Reviews*, 37(2), 78–85. Sato, Y. (2005). The history and future of KAATSU Training. *International Journal of KAATSU Training Research*, 1(1), 1–5. Takarada, Y., Takazawa, H., Sato, Y., Takebayashi, S., Tanaka, Y., & Ishii, N. (2000). Effects of resistance exercise combined with moderate vascular occlusion on muscular function in humans. *Journal of Applied Physiology* (Bethesda, Md. : 1985), 88(6), 2097–106. Retrieved from Contact: sergio.selles@ua.es

## DOES A MENTALLY FATIGUING TASK INFLUENCE PHYSICAL AND COGNITIVE PERFORMANCE DURING A TOPTEST?

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Introduction The recent joint consensus statement on 'overtraining syndrome' (OTS) of ACSM & ECSS identifies several markers for non-functional overreaching (NFO) and OTS. Meeusen et al. (2004; 2010) developed a 'Training Optimisation' test (TOPTest) for diagnosing NFO & OTS. This double maximal cycling test (separated by a resting period) showed that reaction times and hormonal response to exercise are possible tools that can be used in the diagnostic procedure for training distress. However, it is not yet clear if the addition of a mentally fatiguing task could change performance. Therefore, the purpose of this study is to examine the possible influence of mental fatigue during the TOPTest. Methods A single blind, randomized, placebo controlled cross-over design was used. After a maximal cycle ergometer test (MAXtest), nine healthy male participants (age 18–35) performed two TOPTests in 18°C, separated by 1 week. The two maximal exercise bouts were separated by either a 1.5h rest period (control- C) or a 1.5h mentally fatiguing task, the Stroop (MF). The parameters measured throughout the study (baseline, post-MAXtest 1, pre/post-MAXtest 2) included cortisol, heart rate, M-VAS, the Profile Of Mood States (POMS), and a Flanker task measuring reaction time (RT) and accuracy. During the MAXtest blood lactate and Rating of Perceived Exertion were determined every 3 minutes. Data were not normally distributed, therefore a Wilcoxon test was used.



Results The MF condition resulted in higher M-VAS scores before the 2nd MAXtest compared with C. Significantly ( $p < .05$ ) higher values were observed for the fatigue, tension and anger scores of the POMS in the MF condition. No significant differences in accuracy and RT were detected when looking at the Flanker task post MF and C. Physical performance was not affected when looking at the maximal Watt before and after the MF and C task ( $p = .317$  and  $p = .157$ , respectively). Discussion A mentally fatiguing task during the rest period of a TOPTest influenced the subjective ratings of the POMS. Mental fatigue did not impact cognitive and physical performance, which is in contrast to the results observed by Marcora et al. (2009) who found physical performance to be negatively affected. Since subjective ratings are important for diagnosing NFO & OTS, mental fatigue is an important factor to take into account when testing for NFO & OTS. References Marcora SM, Staiano W, Manning V (2009). J Appl Physiol, 106(3), 857-864. Meeusen R, Nederhof E, Buyse L, et al. (2010). Br J Sports Med, 44(9), 642-648. Meeusen R, Piacentini MF, Busschaert B, et al. (2004). Eur J Appl Physiol, 91(2-3), 140-146. Contact rmeeu-sen@vub.ac.be

## TIME-MOTION ANALYSIS IN FENCING COMPETITION

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Introduction Fencing is a situation sport where two athletes fight in a continuous strategy game, masking their true intentions to surprise and hit the opponent. Fencing is generally classified as open-skill sport (Dal Monte et al 1980), characterized by a very high energy demand (Caldarone et al 1983; Nystrom et al 1990), closely linked to the athletes' coordinative and psychological characteristics (Sapega et al 1984). Within each competition there is a wide variability of actions duration, represented by numerous stopping and starting phases. Since the understanding of the complex multi-dimensional model of fencing requires a careful analysis of the various aspects of performance. The aim of this study was to analyze the time-motion structure of fencing competitions. Methods Eighteen male ( $n=9$ ) and female ( $n=9$ ) of 36 male ( $n=18$ ) and female ( $n=18$ ) Italian epee fencers were recorded during the 2013 National University (age:20-28) Championship. Duration (s) of fighting and nonfighting phases were recorded in all matches (5 touches for a maximum of 3 min), using Dartfish TeamPro Software. Differences ( $p < 0.05$ ) were analyzed in relation to gender (male vs female) and type of action (fighting vs nonfighting) through Analysis of Variance. Results Regardless of gender, higher ( $p < 0.05$ ) duration were found during fighting (male:  $15.2 \pm 13.6$ s; female:  $14.1 \pm 9.8$ s) phases with respect to nonfighting (male:  $7.3 \pm 4.1$ s; female:  $5.9 \pm 4.4$ s) ones. Discussion Findings indicate a longer duration of athlete fighting actions with respect nonfighting ones, independently from gender. This would probably depend to a strategic choice dictated by the preliminary stage of the competition, where the short duration of the match allows athletes to spend more time in fighting phase, in order to be able to get 5 touches before their opponent. References DAL MONTE A, et al (1980), Scuola dello Sport, CONI Roma. CALDARONE G, et al (1983), Pisa, Giardini: 15-27. NYSTROM J, et al (1990), International Journal of Sport Medicine, 11: 136-39. SAPEGA A, et al (1984), Clinic in Sport Medicine, 1: 500-03. Contact s.sanhueza@unicas.it

## THE EFFECT OF A PERIODIZED CONTRAST WATER THERAPY PROTOCOL ON MUSCLE RECOVERY FOLLOWING A BOUT OF HIGH VOLUME RESISTANCE TRAINING: A PILOT STUDY

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Contrast water therapy (CWT) has become a common post exercise recovery strategy among athletes to alleviate the delayed onset of muscle soreness and promote recovery. During CWT athletes alternate between cold and hot water immersion after a strenuous exercise bout. CWT can induce rapid changes intra-muscular hydrostatic pressure, which may alter blood flow in immersed musculature and improve the removal of metabolic waste products. However, a number of authors have concluded that further investigation of CWT is required to discover the optimal cold:hot ratio, temperature, duration and frequency practice. The aim of the present study was to investigate the effect of a periodized CWT approach, whereby the ratio of cold:hot water exposure was modified between sessions by systematically increasing hot and decreasing cold exposure durations. Twenty healthy male subjects (aged 18-30 years) were alternately allocated to the control or CWT group. Following a resistance training protocol of 10x10 repetitions of calf raises, with a load equating to 10% of the subjects body mass, the participants underwent their recovery protocol immediately, 24 and 48 post exercise. Creatine kinase (CK), muscle soreness (visual analogue scale) and swelling (calf circumference) was measured before each recovery protocol. Both protocols involved the complete immersion of the gastrocnemius within water tanks. The total immersion time for each session was 19 minutes in both groups. The CWT protocol alternated between cold (10-15°C) and hot (30-38°C) water. The cold:hot ratio was decreased between sessions. The control group remained within the thermo-neutral (20-25°C) water during all sessions. CK and perceived soreness values were significantly reduced ( $p < 0.05$ ) in the CWT group at 24, 48 and 72 hours in comparison to the control group. However, there was no significant difference in calf circumference between conditions. A periodized CWT protocol promotes a greater localized muscle recovery response compared to a thermo-neutral water immersion protocol following a high volume resistance training protocol.

## ANALYSIS OF THE TECHNIQUES PERFORMED IN A TAEKWONDO UNIVERSITY CHAMPIONSHIP

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Introduction The aim of this study was to analyze the performance of taekwondo athletes according to the medal obtained (golden, silver, bronze and non-medalists) in a Spanish University Championship (2011), with emphasis on the kicking zone, the trajectory and the kicking leg. Methods 356 performs of 178 bouts were analyzed: golden ( $n = 54$ ), silver ( $n = 49$ ), bronze ( $n = 71$ ) and non-medalists ( $n = 182$ ). The variables analyzed were: i) kicking zone (trunk or head), ii) trajectory (linear, circular or with previous spin), and iii) kicking leg (right or left). Only one observer was involved in the study. Intraobserver measures were reliable with an ICC = 0.85 ( $p < 0.01$ ). According to the Belmont Report, because the analyzed video tapes are in the public domain, no participant's informed consent was required. A previous K-S test was carried out to determine non-parametrical tests (Kruskall Wallis test followed by Mann Whitney U test for pair comparisons were conducted) ( $p < 0.05$ ). Results There were differences in linear techniques ( $\chi^2[3] = 58.762$ ,  $p = 0.01$ ), and right leg ( $\chi^2[3] = 9.041$ ,  $p = 0.03$ ). That is, medalists (golden [G], silver [S] and bronze [B]) performed more linear actions ( $G = 5.93 \pm 6.96$ ,  $S = 6.43 \pm 4.52$ ,  $B = 5.37 \pm 3.75$ ) than non-medalists ( $[U = 3524.00]$ ,  $[U = 1965.50]$ , and  $[U = 3235.00]$ ;  $p = 0.01$ , respectively) who performed  $2.70 \pm 3.38$  actions. With regard to the kicking leg, non-medalists performed more actions with right leg ( $17.51 \pm 10.00$ ) than golden medalists ( $14.20 \pm 8.62$ ) ( $U = 3909.000$ ;  $p = 0.02$ ). No differences were found in variables related to the kicking zone ( $p > 0.05$ ). Discussion Results of the current study showed that medalists performed more linear actions and fewer actions with right leg (golden medalists) than non-medalists. Medalists could use

linear techniques due to the major speed of these techniques than other ones (e.g., circular) (Leel et al., 2005) which could lead the victory. These results pointed out also the major ability of golden medalists to perform fewer techniques with right leg assuming the capability to perform techniques using both legs. These results could lead to a reorientation of technical-tactical training of taekwondo athletes to deal with actions linked to medalists. References Leel, C, Lee, Y, Cheong, C. (2005). Proceedings of the XXIII International Symposium on Biomechanics in Sports, 595-597. Beijing, China. Contact ca.menescardi@ucv.es

### **A TARGETED STRENGTH TRAINING PROGRAMME AND ITS EFFECT ON PERFORMANCE AND INJURY RISK: A CASE STUDY IN SPRINTING**

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**INTRODUCTION** Athletic performance and injury risk are key components within sports science; and while they may appear unlike, they are in fact inherently coupled. A maximal sprint effort on a non-motorised treadmill (NMT) for example, can provide both performance (i.e. power) and injury risk (i.e. asymmetry) variables within the same trial (Brown et al., 2015). However this link is seen less often in practice due to the overwhelming demands of performance. Recent observations show that hip extension strength is related to sprint horizontal force (FH) and thus performance (Morin et al., 2015), and that targeted strength training can decrease lower-extremity asymmetry (Brown and Brughelli, 2014). We therefore assessed an athlete on a NMT to illuminate any sprint asymmetry and then prescribed a targeted strength training programme aimed at altering the deficiencies. **METHODS** One male athlete performed four 6-s sprints on a NMT once per week for two 6-week blocks. The sprint testing consisted of an initial "unloaded" sprint to profile symmetry and three subsequent sprints with randomised electronic-brake loads to profile performance. A general training regime with no additional sprint training was programmed during weeks 1-6, and then targeted hip extension exercises based on the asymmetries found were added for weeks 7-12. **RESULTS** Pre to post training, the athlete maintained maximal velocity (8.4 to 8.3 m·s<sup>-1</sup>; -0.26%) and improved relative maximal FH (8.3 to 10 N·kg<sup>-1</sup>; 15%) and power (18 to 20 W·kg<sup>-1</sup>; 13%). The athlete also increased FH in his "weak" leg (2.7 to 3.1 N·kg<sup>-1</sup>; 15%) thereby decreasing his original FH asymmetry (52 to 45%; 13%). Greater outcomes were found in weeks 10-12 compared to weeks 7-9. **DISCUSSION** We examined both global force production and individual contribution from each leg during a maximal sprint and found encouraging alterations in performance and injury risk variables as a result of targeted hip extension exercises. These changes are very likely the result of the exercise prescription to increase FH (via hip extension) in the "weak" leg, thus elevating global FH and subsequently performance while simultaneously reducing the FH asymmetry between the legs (Morin et al., 2015). These pilot findings may have strong implications for individualised programming to both increase sprint performance and decrease injury risk. **REFERENCES** Brown SR, Cross MR. (2015). *Eur Coll Sport Sci*, Malmö, SE. Morin JB, Gimenez P, Edouard P, Arnal P, Jiménez-Reyes P, Samozino P, Brughelli M, Mendiguchia J. (2015). *Front Physiol*, 6(404). Brown SR, Brughelli M. (2014). *Phys Ther Sport*, 15(3), 211-215.

### **COMPARISON OF MUSCLE ACTIVITY DURING STUMP STRAPS BENCH PRESS AND CONVENTIONAL BENCH PRESS ON SELECTED UPPER BODY MUSCLES.**

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**Background:** The "stump straps bench press" (STBP) is a variation of the conventional bench press (CBP) where some or the total amount of weight is attached to a barbell with flexible straps, so the weight hangs freely in the air. This study investigated the influence of STBP on muscle activity of chosen upper body muscles. **Objective:** The aim of this study was to compare muscle activity of the triceps, pectoralis major and deltoideus anterior during STBP and CBP on a flat bench. **Hypothesis:** Performing STBP requires greater muscle activity than CBP due to the free- hanging weights, which need to be stabilized throughout the entire range of motion. **Methods:** All of the participants (12 male resistance trained sport students) completed a 1 RM test prior to the study. With at least 3 day between the pretest and the intervention all subjects performed the bench press exercise with 4 sets of 10 repetitions (60% 1 RM) in a predefined cadence (2 s eccentric, 1 s isometric hold on the chest and a 1 s concentric). Two sets of STBP and two sets of CBP in randomized order with double acromial grip width. Group A (n=6) started with two sets of CBP followed by two sets of STBP with 3 minutes rest between sets. Group B (n=6) performed the same schedule but in reverse order. Repetitions of the first set were compared with repetitions of the third as well as the second set with the fourth. **Results:** There were no significant differences in none of the evaluated muscles between STB and CBP in EMG muscle activity. **Discussion:** One reason for these non-significant results could be the chosen percentage of the 1 RM, which might be too low to elicit alterations in muscle activity. Furthermore there might be a differences in stabilizing muscles of the shoulder (e.g. rotatorcuff) which were not examined in this study. Additional research with higher subject populations are recommended.

### **POSTACTIVATION POTENTIATION: EFFECTS OF VARIOUS CONDITIONING CONTRACTIONS ON BENCH PRESS POWER PERFORMANCE**

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**University of Heidelberg, Institute of Sport and Sport Science** **Introduction** Intense muscular contractions can enhance subsequent force generation thus leading to an enhanced muscular power performance. This phenomenon is called Postactivation Potentiation (PAP; Tillin & Bishop, 2009). The purpose of this study was to evaluate PAP-effects produced by three different conditioning contraction (CC) stimuli on upper body power performance. **Methods** Sixteen healthy resistance-trained male sport students (age, 23.1±3.2y; height, 183±9cm; body mass, 83±11kg; strength training/week, 3.8±1.8h; bench press one-repetition maximum [1RM], 97.6±16.6kg) volunteered to participate in the study. The 3 experimental trials composed either a concentric-eccentric (CON-ECC: 1 set of 3 repetitions at 87% of 1RM on a bench press), an eccentric only (ECC: 1 set of 3 repetitions at 120% of 1RM on a bench press) or a plyometric (PLY: 1 set of 10 plyometric push-ups) CC stimulus. The experimental sessions were performed on different days separated by a minimum of 48h, and determined randomly. Maximal muscular performance, as determined by a ballistic bench press throw at 30% 1RM, was measured before (baseline) as well as 1, 4, 8, 12 and 16 minutes after each CC stimulus via Myotest (Myotest SA Switzerland). **Results** Compared with baseline (CON-ECC, 914.5±138.0W; ECC, 925.8±144.3W; PLY, 920.1±145.1W), bench press power performance was significantly enhanced in CON-ECC (943.1±139.7W; P<0.05) after 8 minutes of recovery. However, no significant changes were obtained in ECC (912.0±155.2W) and PLY (947.6±149.2W). The results obtained from the comparisons between baseline power performance and the individual best power performance for each subject after each CC stimulus showed significant increases in CON-ECC (P<0.017; +5.7%) and PLY (P<0.017; +4.9%) CC

stimuli. There was no significant difference in ECC ( $P>0.017$ ; +1.8%). Discussion Our results indicate that after 8 minutes of recovery, CON-ECC CCs generated increases in bench press power performance. However, considering an individual recovery period, PLY CCs lead to an enhanced power performance in the bench press exercise as well. Due to the practical application prior to a competition, PLY CCs could be an interesting part of warm-up strategies aiming to improve upper-body power performance. References Tillin N, Bishop D (2009). Factors modulating post-activation potentiation and its effect on performance of subsequent explosive activities. *Sports Med*, 39(2), 147-166. Contact Mario.parstorfer@googlegmail.com

### EFFECT OF A CORE TRAINING PROGRAM ON MALE HANDBALL PLAYERS' THROWING VELOCITY

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In handball, throwing velocity is considered to be one of the essential factors in achieving the ultimate aim of scoring a goal. The objective of the present study was to analyze the effect of a core training program on throwing velocity in 30 handball players (age  $18.7\pm3.4$  years, height  $179.3\pm7.0$  cm, body mass  $78.9\pm7.7$  kg), 16 of whom were in the junior category and 14 of whom were in the senior category. The 30 players were randomly divided into two groups, the control group ( $n=15$ ) and the experimental group ( $n=15$ ). For a period of ten weeks, both groups attended their regular handball training sessions (four per week), but in addition, the experimental group participated in a program specifically aimed at progressively strengthening the lumbo-pelvic region and consisting of seven exercises performed after the general warm-up in each regular session. Pre- and post-tests were carried out to analyze each player's throwing velocity from different throwing positions and thus assess the effects of this specific training program. Statistically significant differences ( $p \leq 0.05$ ) in throwing velocity were observed between the experimental group and the control group. The results seem to indicate that an increase in the strength and stability of the lumbo-pelvic region can contribute to an improvement in the kinetic chain of the specific movement of throwing in handball, increasing throwing velocity

### INFLUENCE OF NON-WEIGHT-BEARING HIP POSITION ON KNEE VALGUS IN DYNAMIC TRENDLENBURG TEST

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Introduction To identify athletes at a higher risk of non-contact anterior cruciate ligament (ACL) injury, we developed a two-dimensional (2D) screening test focused on hip abductor and rearfoot function (Kagaya et al., 2015). However, influence of non-weight-bearing hip position on knee valgus in dynamic trendelenburg test (DTT) evaluating hip abductor function remains ambiguous. The purpose of this study was to determine the useful instruction for the subjects when DTT was evaluated. Methods Sixty-nine female basketball players (137 limbs) agreed to participate in this study. Their age was  $15.8\pm1.6$  years, height and weight were  $157.8\pm5.5$ cm and  $48.7\pm6.1$  kg, respectively. Subjects performed two kinds of single-legged squatting at different non-weight-bearing hip position. The first position was decided as the contralateral hip straight, and the second position was decided as the contralateral hip bent to about  $60^\circ$ . This procedure was recorded simultaneously using a 2D video camera in the front and the back on the subjects. Knee-in distance (KID) and Hip-out distance (HOD) were measured using 2-dimensional video images filmed at 30 Hz. KID was measured as distance from hallux to the point where the line connecting the center of the patella and the anterior superior iliac spine (ASIS) intersects the floor. HOD measured as the distance from hallux to the projection of ASIS on the floor. Hip abductor function and rearfoot dynamic alignment were evaluated by a dynamic Trendelenburg test (DTT) and a dynamic heel-floor test (HFT), respectively. Results The prevalence of DTT-positive demonstrated 33.6% (46 limbs) in non-weight-bearing hip straight, and 0% in non-weight-bearing hip bent. With regards to DTT-positive subjects (46 limbs) in non-weight-bearing hip straight, the hip straight task demonstrated greater KID ( $12.8\pm3.1$  cm,  $9.2\pm3.9$  cm) and HOD ( $14.1\pm1.7$  cm,  $13.0\pm2.0$  cm) than the hip bent position ( $p<0.001$ ). Additionally, the hip straight task demonstrated higher prevalence of HFT-positive (54.4%, 30.4%) than the hip bent position ( $p<0.01$ ). Discussion For the single-legged squatting, we instruct for the subjects to clasp their hands behind their backs and balanced on one leg without the contralateral hip bent. As the results of this study, the difference of non-weight-bearing hip position during single-legged squatting affected the prevalence of DTT-positive. Hodges et al. (1997) reported that the abdominal muscles, particularly transversus abdominis muscle, recorded the electromyographic activity prior to the onset of rectus femoris muscle in rapid flexion of the hip. Thus, it is thought that activities of abdominal muscles are facilitated in non-weight-bearing hip bent position, compared to in non-weight-bearing hip straight position, and which influences contractions of hip abductor muscles in weight-bearing hip. As a result of this experiment, an importance of integrating the conditions was recognized, and henceforth it is needed to establish an evaluation involving core muscle function.





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ISBN 978-3-00-053383-9

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