



O CORAÇÃO DE ATLETA

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Atleta

Aquele que participa numa equipa desportiva organizada ou de forma individual, e que requer treino sistemático e competição regular com outros indivíduos, procurando a excelência atlética.

Representam os membros mais dinâmicos e saudáveis de uma sociedade.

Performance

Realização eficaz, e perfeita, de uma atividade desportiva;

Obtenção de máximos e ótimos rendimentos;

Fenómeno complexo e multidimensional:

fatores orgânicos

motores

culturais

psicológicos



Atleta

- Idade
- Sexo
- Altura/Peso/SC
- Raça/Etnia

- Frio/Calor
- Altitude



"Coração de Atleta"

1899

Prof. Salomon Eberhard Henschen,
Director of the Medical University Hospital in Uppsala
Karolinska Institute in Stockholm

Através de percussão torácica avaliou as dimensões cardíacas de vários esquiadores

Conclusão: as cavidades cardíacas destes atletas encontravam-se dilatadas e esta dilatação permitia melhorar o rendimento dos atletas durante a prática desportiva.

"Coração de Atleta"

1940

Aumento da prevalência de bradicardia sinusal nos corredores da maratona de Boston

1975

Desenvolvimento do M-mode - ecocardiografia Morganroth descreveu um *remodeling* do VE dependendo do tipo de exercício.



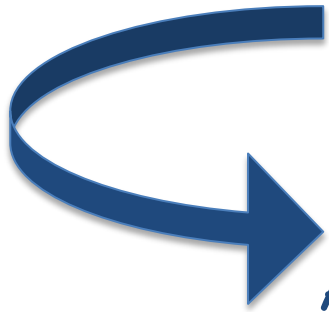
Coração de Atleta

- Resposta a um treino intenso e prolongado
- *Remodeling* estrutural, funcional e elétrico
- Adaptações cardiovasculares fisiológicas

Coração de Atleta



Adaptações cardiovasculares fisiológicas



Aumento da Performance

- Obtenção de máximos e ótimos rendimentos



Increasing Static Component
 ↑
 III. High (>50% MVC)
 II. Moderate (20-50% MVC)
 I. Low (<20% MVC)

Bobsledding/Luge*†, Field events (throwing), Gymnastics*†, Martial arts*, Sailing, Sport climbing, Water skiing*†, Weight lifting*†, Windsurfing*†	Body building*†, Downhill skiing*†, Skateboarding*†, Snowboarding*†, Wrestling*	Boxing*, Canoeing/Kayaking, Cycling*†, Decathlon, Rowing, Speed-skating*†, Triathlon*†
Archery, Auto racing*†, Diving*†, Equestrian*†, Motorcycling*†	American football*, Field events (jumping), Figure skating*, Rodeoing*†, Rugby*, Running (sprint), Surfing*†, Synchronized swimming†	Basketball*, Ice hockey*, Cross-country skiing (skating technique), Lacrosse*, Running (middle distance), Swimming, Team handball
Billiards, Bowling, Cricket, Curling, Golf, Riflery	Baseball/Softball*, Fencing, Table tennis, Volleyball	Badminton, Cross-country skiing (classic technique), Field hockey*, Orienteering, Race walking, Racquetball/Squash, Running (long distance), Soccer*, Tennis

A. Low
 (<40% Max O₂)

B. Moderate
 (40-70% Max O₂)

C. High
 (>70% Max O₂)

Increasing Dynamic Component →



Adaptações Cardiovasculares

Exercício Isotônico - Dinâmico

Predomínio - sobrecarga de volume:

- ↑ Débito cardíaco
- ↑ Volume sistólico
- ↑ Frequência cardíaca
- ↑ Moderado da Pressão Arterial
- ↓ Resistências vasculares periféricas



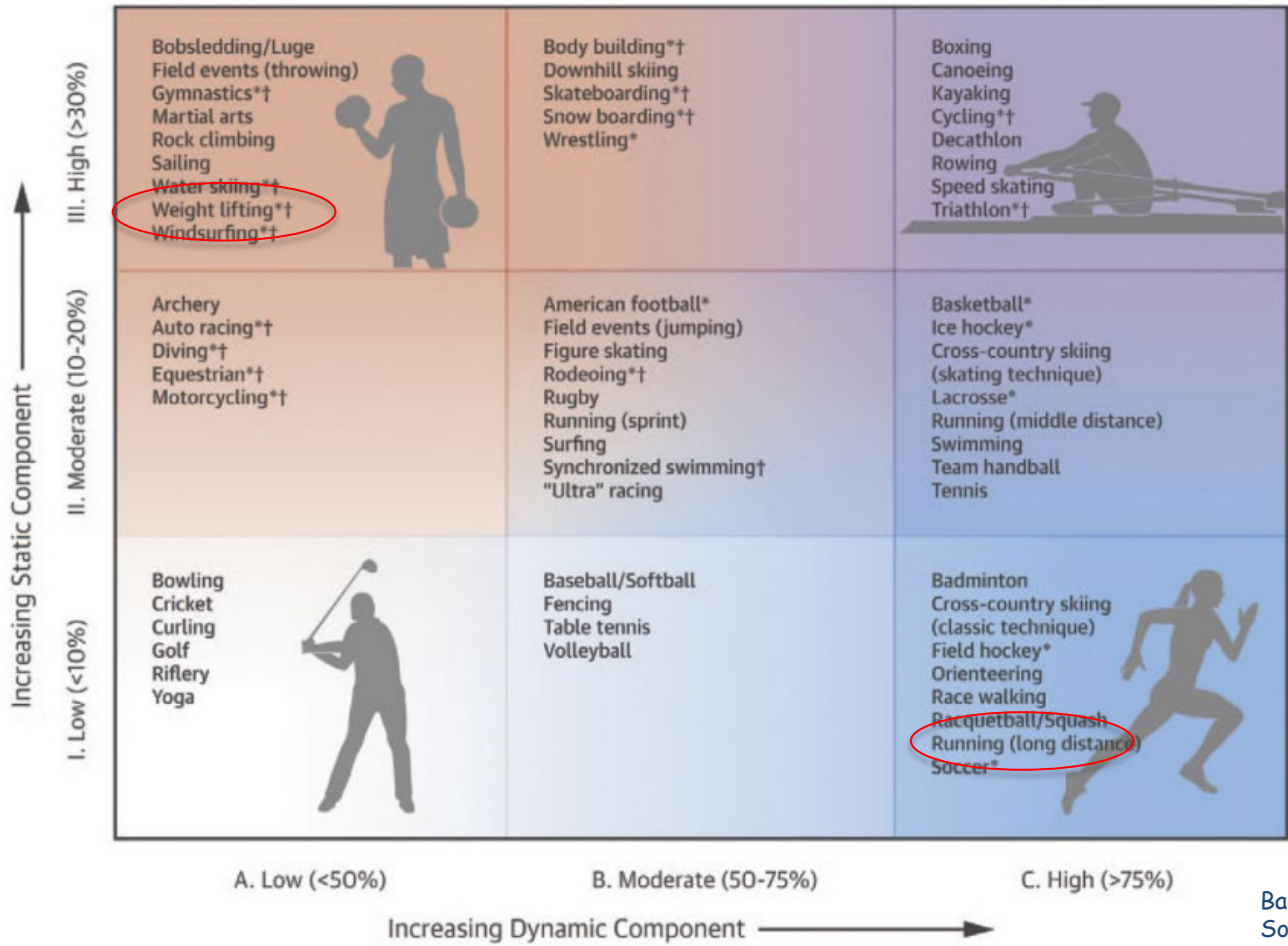
Adaptações Cardiovasculares

Exercício Isométrico - Estático

Predomínio - Sobrecarga de pressão:

- ↑ Acentuado da Pressão Arterial sistólica e diastólica
- ↑ Ligeiro do Débito cardíaco
- ↑ Ligeiro do Volume sistólico
- ↑ Ligeiro da Frequência cardíaca

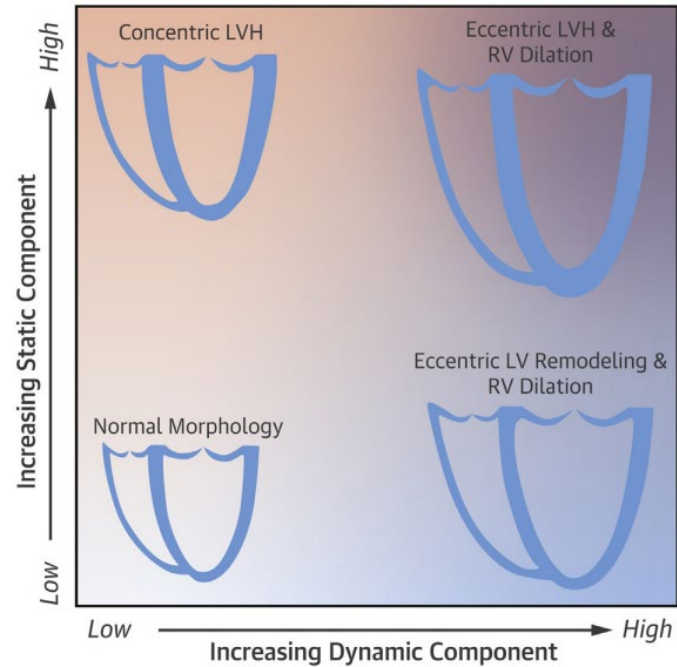
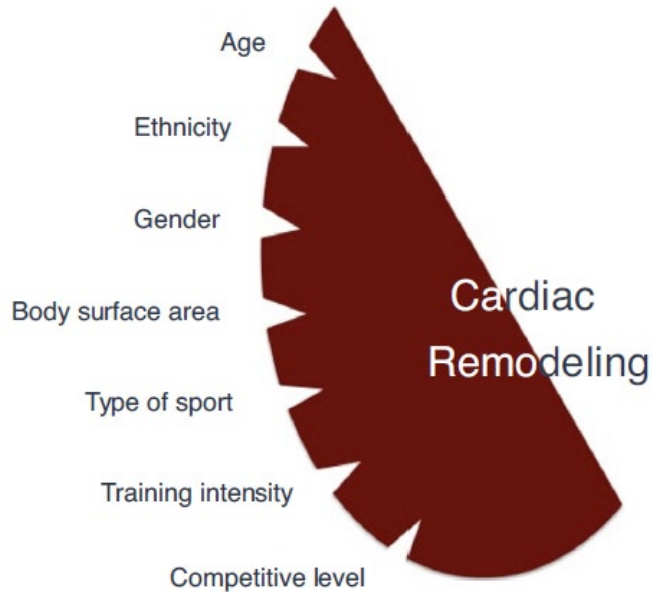




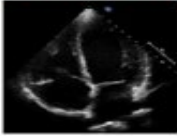
Adaptações Cardiovasculares

Isotónico VS Isométrico ... não são dicotómicos!

Adaptações Cardiovasculares

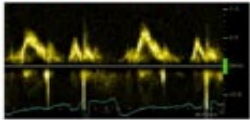


Structural changes



- ↑ LVWT 10-25%
- ↑ LV and RV cavity 15%
- Bi-atrial dilatation

Functional changes



- Functional changes
- ↑ diastolic filling
 - $E' > 9$ cm/s
 - $E/E' < 6$
 - $S' > 9$
 - ↑ Stroke volume

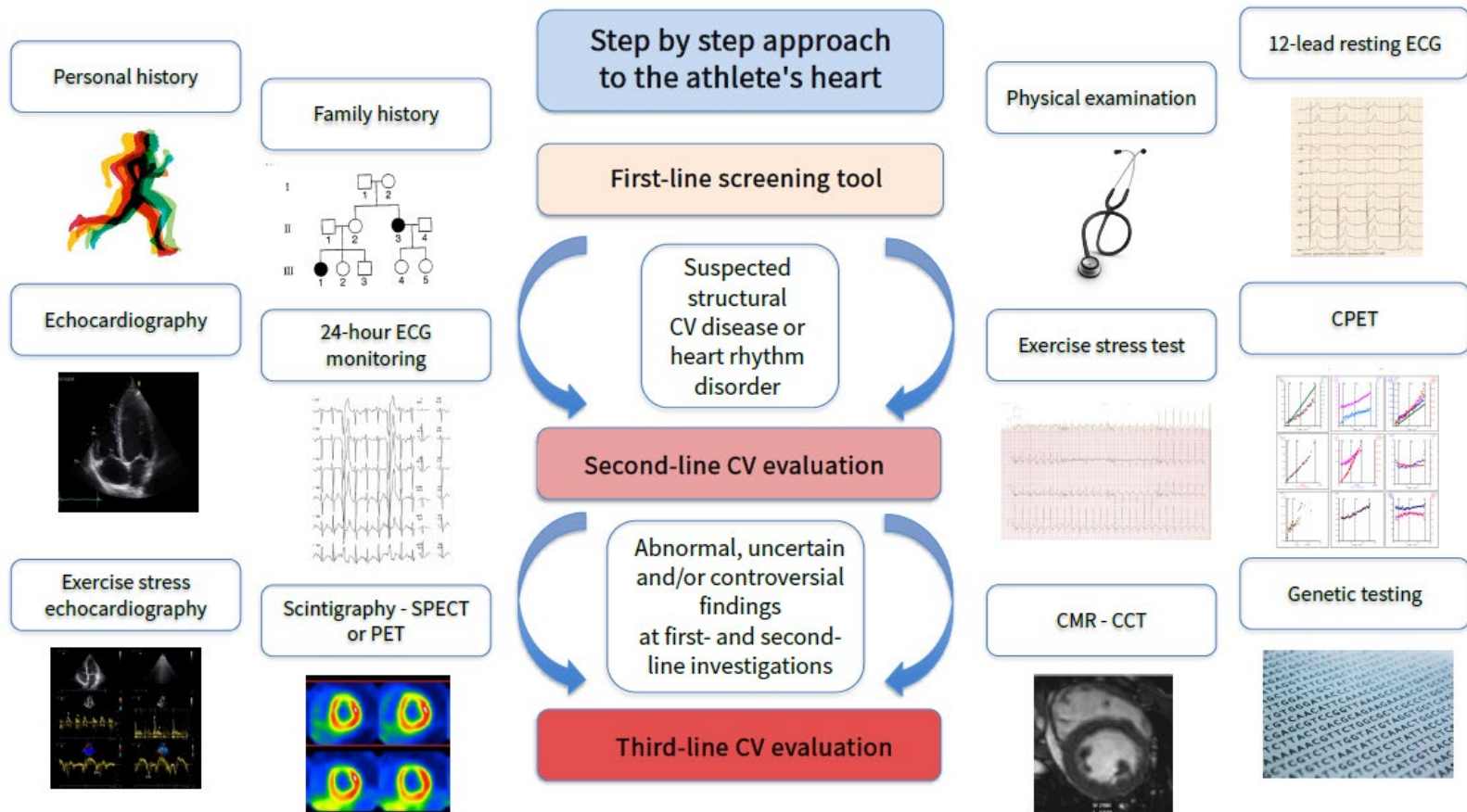


Electrical changes



- Sinus bradycardia
- Sinus arrhythmia
- First degree AV block
- Voltage LVH, and RVH
- Incomplete RBBB
- TWI in V1-V4 in black athletes

Adaptações Cardiovasculares



EXAME MÉDICO DESPORTIVO

DATA

NOME

C.C.

D. NASCIMENTO NACIONALIDADE

MORADA

C. POSTAL LOCALIDADE TEL

CLUBE MODALIDADE ESCALÃO

NOME/MÉDICO

COLAR VINHETA DO MÉDICO
OU
CARIMBO DA INSTITUIÇÃO PÚBLICA DE
MEDICINA DESPORTIVA

DECISÃO MÉDICA

APRESENTA CONTRAINDICAÇÕES PARA A PRÁTICA
DA MODALIDADE

NÃO APRESENTA CONTRAINDICAÇÕES PARA A
PRÁTICA DA MODALIDADE COM / SEM RESTRIÇÕES

QUAIS

ASSINATURA DO MÉDICO

CÉDULA PROFISSIONAL Nº

PARA A FEDERAÇÃO OU ASSOCIAÇÃO

1. DECLARAÇÕES PESSOAIS (A preencher exclusivamente pelo Atleta ou Encarregado de Educação)

	SIM	NÃO	ANO
1.Esteve internado no Hospital ou Clínica?	<input type="checkbox"/>	<input type="checkbox"/>	
2.Foi operado?	<input type="checkbox"/>	<input type="checkbox"/>	
3.Perdas de consciencia? Epilepsia?	<input type="checkbox"/>	<input type="checkbox"/>	
4.Teve alguma lesão no desporto?	<input type="checkbox"/>	<input type="checkbox"/>	
5.Hábitos alcoólicos / tabágicos?	<input type="checkbox"/>	<input type="checkbox"/>	
6.Consome narcóticos, estimulantes?(ou outras substancias)	<input type="checkbox"/>	<input type="checkbox"/>	
7.Toma regularmente algum medicamento?	<input type="checkbox"/>	<input type="checkbox"/>	
8.Doenças alérgicas?	<input type="checkbox"/>	<input type="checkbox"/>	
9.Asma, pneumotorax, tuberculose?(outras doenças pulmonares)	<input type="checkbox"/>	<input type="checkbox"/>	
10.Doenças do aparelho digestivo?	<input type="checkbox"/>	<input type="checkbox"/>	
11.Doenças do coração?	<input type="checkbox"/>	<input type="checkbox"/>	
12.Doenças renais?	<input type="checkbox"/>	<input type="checkbox"/>	
13.Doenças ósseas (coluna ou articulações)?	<input type="checkbox"/>	<input type="checkbox"/>	
14.Diabetes	<input type="checkbox"/>	<input type="checkbox"/>	
15.Doenças do sangue?	<input type="checkbox"/>	<input type="checkbox"/>	
16.Doenças mentais?	<input type="checkbox"/>	<input type="checkbox"/>	
17.Doenças da pele?	<input type="checkbox"/>	<input type="checkbox"/>	
18.Teve alguma doença aqui não mencionada?	<input type="checkbox"/>	<input type="checkbox"/>	
19.Já fez um exame médico desportivo?	<input type="checkbox"/>	<input type="checkbox"/>	
20.Resultado do exame anterior:			

Confirmo as declarações por mim efetuadas.

2. ANTECEDENTES FAMILIARES

	SIM	NÃO	*
1.D. Cardiovasculares (miocardiopatias, D. coronária, etc.)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2.Hipertensão arterial	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3.Morte súbita	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4.Asma	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5.Diabetes	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6.Epilepsia	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7.Tumores	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
8.Doenças hematológicas	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
9.Outros	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

*Preencha nº de código se a resposta for SIM; Pais 1 / Avós 2 / Irmãos 3

3. ANTECEDENTES PESSOAIS

	SIM	NÃO
1.Cirurgias	<input type="checkbox"/>	<input type="checkbox"/>
2.Perdas de consciência	<input type="checkbox"/>	<input type="checkbox"/>
3.Traumatismos cranianos ou fraturas ósseas	<input type="checkbox"/>	<input type="checkbox"/>
4.Palpitações, dispneia, dor torácica, lipotimia	<input type="checkbox"/>	<input type="checkbox"/>
5.Cardiopatias	<input type="checkbox"/>	<input type="checkbox"/>
6.Hipertensão arterial	<input type="checkbox"/>	<input type="checkbox"/>
7.Doenças do aparelho digestivo	<input type="checkbox"/>	<input type="checkbox"/>
8.Asma brônquica, alergias, rinite	<input type="checkbox"/>	<input type="checkbox"/>
9.Hepatites	<input type="checkbox"/>	<input type="checkbox"/>
10.Diabetes	<input type="checkbox"/>	<input type="checkbox"/>
11.Epilepsia	<input type="checkbox"/>	<input type="checkbox"/>
12.Hábitos alcoólicos/tabágicos	<input type="checkbox"/>	<input type="checkbox"/>
13.Vacinas atualizadas (Tétano, Hepatite B)	<input type="checkbox"/>	<input type="checkbox"/>
14.Outros	<input type="checkbox"/>	<input type="checkbox"/>

4. ANTECEDENTES DESPORTIVOS

	SIM	NÃO
1.Já fez desporto federado?	<input type="checkbox"/>	<input type="checkbox"/>
2.Vai retomar a atividade física?	<input type="checkbox"/>	<input type="checkbox"/>
3.Faz desporto regularmente?	<input type="checkbox"/>	<input type="checkbox"/>
4.Quantos treinos semanais?	<input type="text"/>	<input type="text"/>

5. EXAME BIOMÉTRICO

1.Peso	<input type="text"/>	kg
2.Estatura	<input type="text"/>	cm

12. EXAME CÁRDIO-CIRCULATÓRIO E RESPIRATÓRIO

	SIM	NÃO
1.Pulso radial (Simétricos, palpáveis e sincronos)	<input type="checkbox"/>	<input type="checkbox"/>
Pulso femoral (Simétricos, palpáveis e sincronos)	<input type="checkbox"/>	<input type="checkbox"/>
2.Auscultação cardíaca normal	<input type="checkbox"/>	<input type="checkbox"/>
3.Auscultação pulmonar normal	<input type="checkbox"/>	<input type="checkbox"/>
4.Frequência cardíaca		min
5.Pressão arterial		mmHg

13. EXAMES COMPLEMENTARES DE DIAGNÓSTICO

	SIM	NÃO
1.E.C.G. normal	<input type="checkbox"/>	<input type="checkbox"/>
2.Radiografia do tórax normal (Data)	<input type="checkbox"/>	<input type="checkbox"/>
3.Outros		

Normal ECG Findings

- Increased QRS voltage for LVH or RVH
- Incomplete RBBB
- Early repolarization/ST segment elevation
- ST elevation followed by T wave inversion V1-V4 in black athletes
- T wave inversion V1-V3 \leq age 16 years old
- Sinus bradycardia or arrhythmia
- Ectopic atrial or junctional rhythm
- 1° AV block
- Mobitz Type I 2° AV block

Borderline ECG Findings

- Left axis deviation
- Left atrial enlargement
- Right axis deviation
- Right atrial enlargement
- Complete RBBB

Abnormal ECG Findings

- T wave inversion
- ST segment depression
- Pathologic Q waves
- Complete LBBB
- QRS \geq 140 ms duration
- Epsilon wave
- Ventricular pre-excitation
- Prolonged QT interval
- Brugada Type 1 pattern
- Profound sinus bradycardia $<$ 30 bpm
- PR interval \geq 400 ms
- Mobitz Type II 2° AV block
- 3° AV block
- \geq 2 PVCs
- Atrial tachyarrhythmias
- Ventricular arrhythmias

No further evaluation required
in asymptomatic athletes with no family history of inherited cardiac disease or SCD

In isolation

2 or more

Further evaluation required
to investigate for pathologic cardiovascular disorders associated with SCD in athletes

Box 1 Normal ECG findings in athletes

1. Sinus bradycardia (≥ 30 bpm)
2. Sinus arrhythmia
3. Ectopic atrial rhythm
4. Junctional escape rhythm
5. First-degree AV block (PR interval > 200 ms)
6. Mobitz type I (Wenckebach) second-degree AV block
7. Incomplete RBBB
8. Isolated QRS voltage criteria for LVH
 - ▶ Except: QRS voltage criteria for LVH occurring with any non-voltage criteria for LVH such as left atrial enlargement, left axis deviation, ST segment depression, T wave inversion or pathological Q waves
9. Early repolarisation (ST elevation, J-point elevation, J waves, or terminal QRS slurring)
10. Convex ('domed') ST segment elevation combined with T wave inversion in leads V1–V4 in black/African athletes.

These common training-related ECG alterations are physiological adaptations to regular exercise, considered normal variants in athletes, and do not require further evaluation in asymptomatic athletes.

AV, atrioventricular; bpm, beats per minute; LVH, left ventricular hypertrophy; RBBB, right bundle branch block.

Bradycardia sinusal em atletas

- Surge em 80% dos atletas (<60bpm)
 - 20% - <50bpm
 - <41bpm severa; 41 a 50bpm moderada; 51 a 60bpm ligeira
- Sistema Nervoso Autónomo
 - ↑ Atividade Parassimpática
 - ↓ Atividade Simpática
- Adaptações na regulação intrínseca da FC (↓ da automaticidade)
- + acentuada em atletas com treino predominantemente isotónico

Coração de atleta...processo gradual

- Use of **≥ 3 hours/week practicing** sports as a minimum value for the (electrocardiographic) development of an athlete's heart.
- A minimum of **>3000 hours of lifetime exposure** is needed to lead to the electrocardiographic changes fitting athlete's heart.
- **Sinus bradycardia** appears to be an early sign of the development of athlete's heart.
- **First-degree AV-block** appears to occur as a late sign of the development of athlete's heart.

Coração de atleta...processo gradual

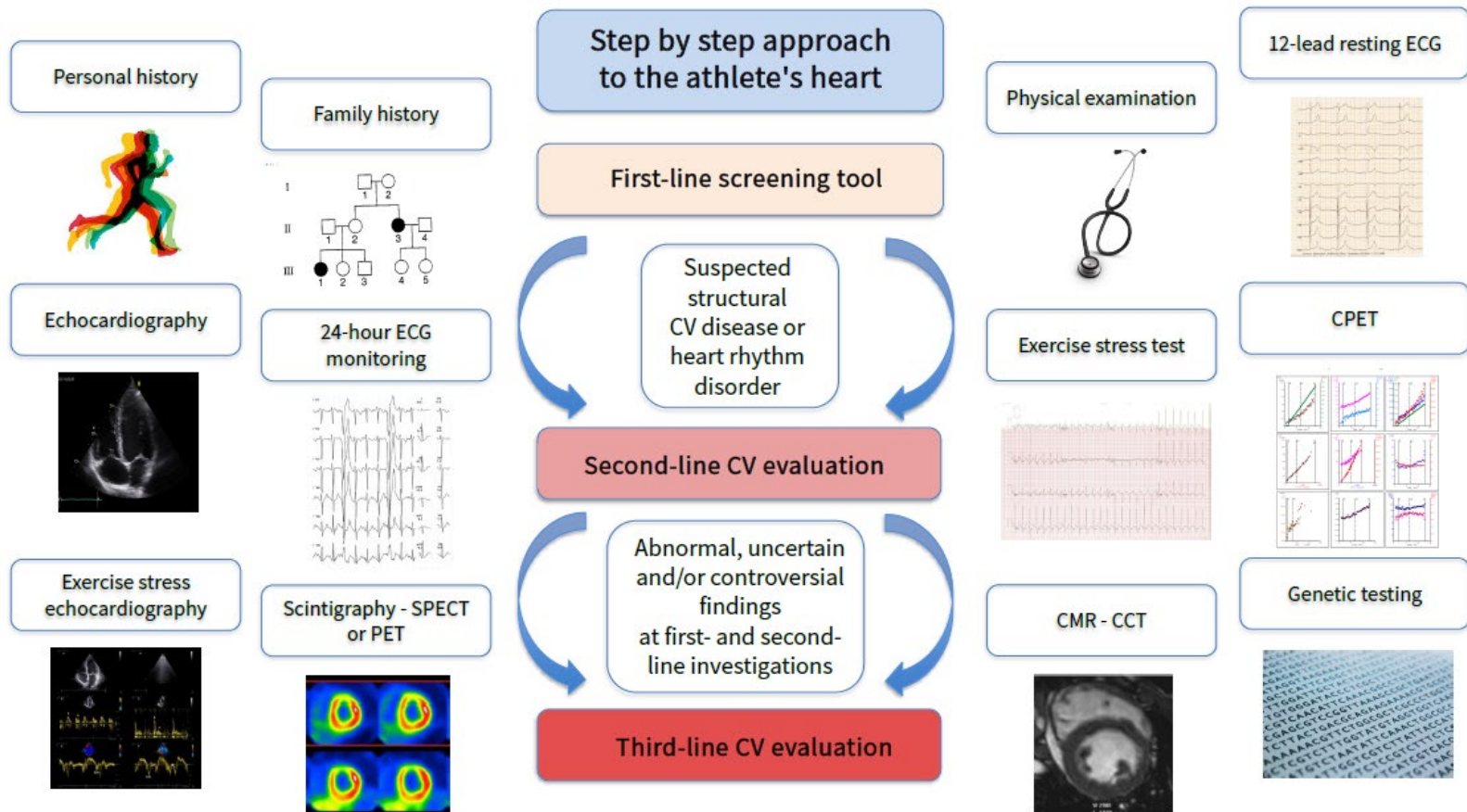
Table III. Current sport exposure vs. training-related ECG changes.

	<3 hours/week	3–6 hours/week	6–10 hours/week	> 10 hours/week	Total	Pearson Chi-square
Sinus bradycardia <60/min	15.9% _a	35.1% _b	38.6% _b	32.9% _b	34.4%	.000
Sinus arrhythmia	31.9% _a	26.1% _a	31.5% _a	27.9% _a	28.9%	.249
Rhythm						
Atrial	1.8% _a	1.8% _a	1.7% _a	–	1.5%	.690
Junctional	–	0.2% _a	0.4% _a	0.7% _a	0.3%	.690
AV-block						
1st degree	0.9% _{a,b}	1.0% _b	1.3% _{a,b}	4.3% _a	0.9%	.030
Incomplete RBBB	8.8% _a	14.3% _a	14.8% _a	11.4% _a	13.7%	.319
QRS voltage criteria for LVH						
Sokolow index ≥ 35mm	9.7% _a	20.6% _b	22.3% _b	20.0% _{a,b}	20.2%	.029
Early repolarisation	1.8% _a	2.9% _a	4.3% _a	2.9% _a	3.3%	.471
Total training-related ECG changes						
≥1 change	51.3% _a	67.6% _b	73.0% _b	67.1% _b	68.1%	.000
≥2 change	16.8% _a	28.6% _{a,b}	32.2% _b	25.7% _{a,b}	28.6%	.011

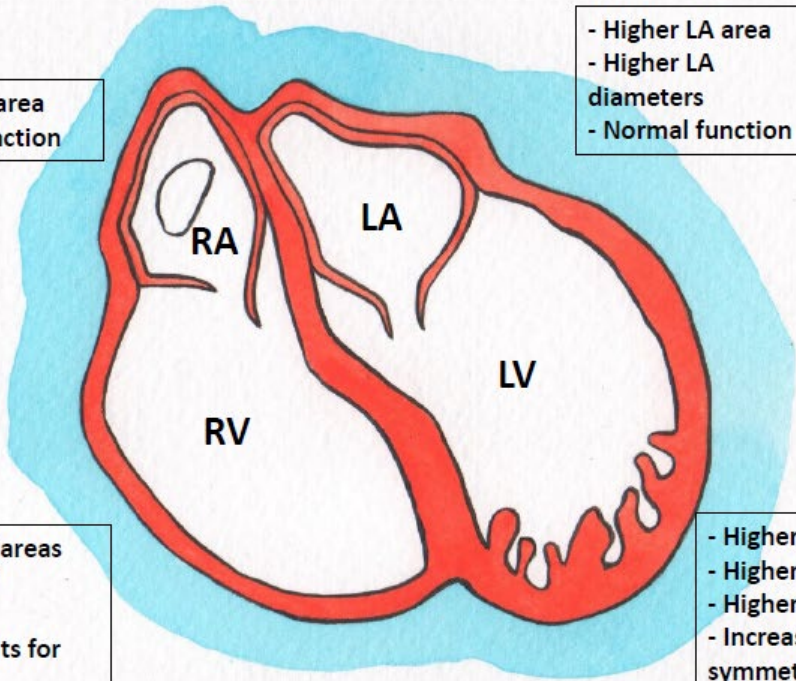
Coração de atleta...processo gradual

Table IV. Lifetime sport exposure vs. training-related ECG changes.

	0–1000 hours	1001–2000 hours	2001–3000 hours	3001–4000 hours	>4000 hours	Total	Pearson Chi-square
Sinus bradycardia <60/min	25.1% _a	33.5% _{a,b}	40.7% _b	42.7% _b	40.4% _b	36.1%	.000
Sinus arrhythmia Rhythm	33.5% _a	23.9% _a	25.8% _a	28.9% _a	30.6% _a	28.6%	.172
Atrial	1.2% _a	3.3% _a	2.5% _a	–	1.1% _a	1.6%	.221
Junctional	–	0.5% _a	0.4% _a	0.4% _a	0.5% _a	0.4%	.221
AV-block							
1st degree	0.8% _a	1.4% _a	0.8% _a	1.8% _a	3.8% _a	1.6%	.109
Incomplete RBBB	11.6% _a	12.0% _a	13.6% _a	15.1% _a	15.8% _a	13.5%	.626
QRS voltage criteria for LVH							
Sokolow index ≥ 35 mm	13.5% _a	16.3% _{a,b}	20.3% _{a,b}	27.1% _b	26.2% _b	20.4%	.001
Early repolarisation	3.6% _a	4.3% _a	2.5% _a	4.4% _a	3.3% _a	3.6%	.815
Total training-related ECG changes							
≥ 1 change	62.9% _a	65.1% _a	68.6% _{a,b}	76.4% _b	74.3% _b	69.2%	.007
≥ 2 change	21.9% _a	25.4% _{a,b}	29.2% _{a,b}	35.1% _b	36.1% _b	29.2%	.003



- Higher RA area
- Normal function



- Higher LA area
- Higher LA diameters
- Normal function

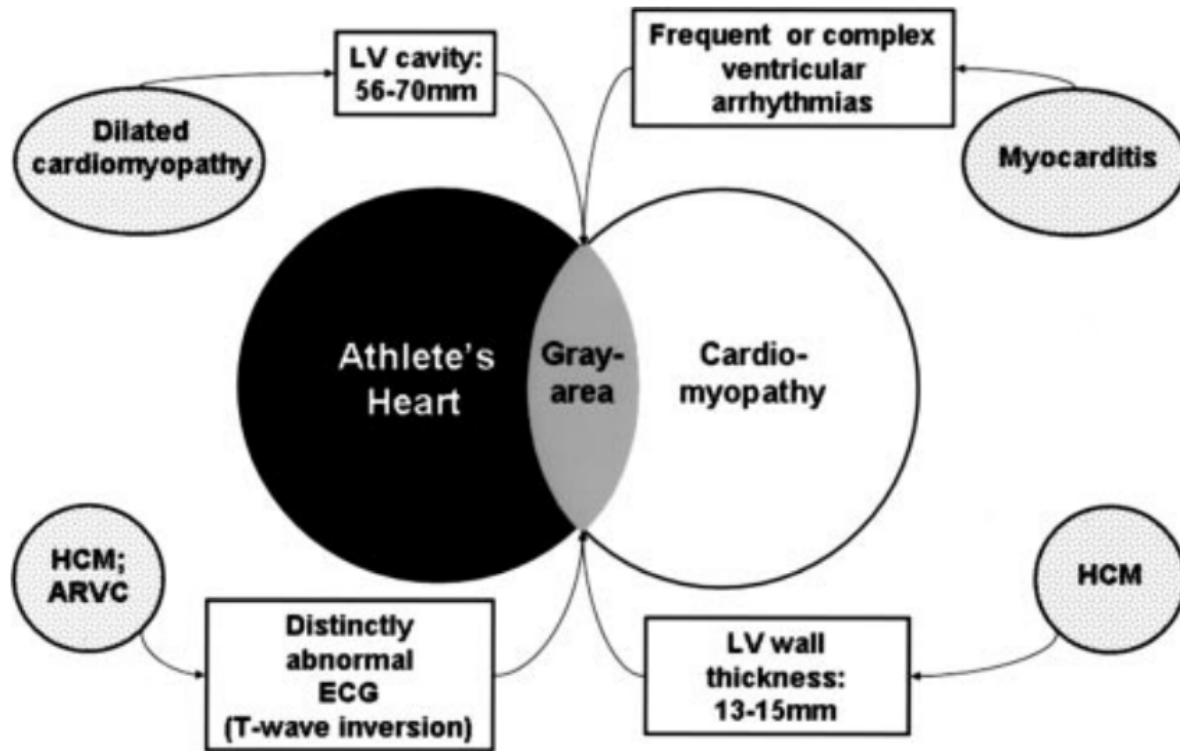
- Higher RV areas
- Higher RV diameters
- Upper limits for RVOT
- Normal FAC
- Normal GLS
- Normal TAPSE
- Normal PASP

- Higher LVEDD
- Higher LVM
- Higher SV
- Increased WT (mild and symmetric)
- Apical hypertrabeculation
- Preserved/mildly low systolic function
- Normal GLS
- Normal/accentuated diastolic function



Table 9. Differential diagnosis between athlete's heart and SCD-related cardiomyopathies in diagnostic grey zones.

	LV wall thickening	LV dilatation	RV dilatation	LV hypertrabeculation
Athlete's heart findings	<ul style="list-style-type: none"> • Strength and mixed disciplines (more common) • Afro-Caribbean ethnicity (more common) • Male gender (more common) • Normal SBP • Asymptomatic • Unremarkable family history • Normal ECG 	<ul style="list-style-type: none"> • Endurance athletes (typically) • Asymptomatic • Unremarkable family history • Normal ECG • Sometimes association with mild reduction in LVEF with normal function during the exercise 	<ul style="list-style-type: none"> • Endurance and mixed disciplines (more common) • Asymptomatic • Unremarkable family history • Normal ECG 	<ul style="list-style-type: none"> • Afro-Caribbean ethnicity • Asymptomatic • Unremarkable family history • Normal ECG
	<ul style="list-style-type: none"> • Mild symmetric and balanced LVH (often reversible after detraining) • Concomitant absence of a small LV cavity size • Normal/supranormal LV diastolic function • Preserved LV systolic function • Normal LV GLS 	<ul style="list-style-type: none"> • Concomitant RV dilatation and/or mild LVH • Preserved/mildly reduced LVEF with normal function during the exercise • Normal LV GLS • Normal/supranormal LV diastolic function • Normal/mildly enlarged LA and RA • Normal aortic and mitral valves 	<ul style="list-style-type: none"> • RV dilatation often reversible after detraining • Absence of wall motion abnormalities • Concomitant LV dilatation • Normal RV morphology • Preserved or mildly reduced LVEF with normal function during the exercise • Normal LV GLS • Normal/supranormal LV diastolic function • Normal/mildly enlarged LA and RA • Normal RV systolic function • Normal RV GLS • Normal sPAP or eventually upper limits • Normal tricuspid and pulmonary valve 	<ul style="list-style-type: none"> • Normal LV systolic function • Normal LV GLS • Normal/supranormal LV diastolic function • Normal or increased compacted LV wall thickness





Thick LV Walls



Clinical Factors c/w EICR
 Sport with Isometric Physiology
 Black Ethnicity
 Male Gender
 Normal Systemic Blood Pressure
 No subjective symptoms
 Unremarkable Family History
 Normal 12-lead ECG

Differential Diagnosis
 Hypertrophic CMP
 Hypertensive heart disease
 Illicit Anabolic Steroid Use
 Infiltrative heart disease
 Valvular heart disease

Imaging Data c/w EICR
 Mild symmetric LVH (walls <16 mm)
 Normal / mildly enlarged LA
 Normal RV dimensions
 Normal aortic & mitral valves

Dilated LV Chamber



Clinical Factors c/w EICR
 Sport with Isotonic Physiology
 No subjective symptoms
 Unremarkable Family History
 Normal 12-lead ECG

Differential Diagnosis
 Idiopathic / Familial Dilated CMP
 Toxic (ETOH, drugs) CMP
 Acute/Chronic myocarditis
 Nutritional deficiency
 Tachyarrhythmia-Mediated CMP
 Valvular heart disease

Imaging Findings c/w EICR
 Concomitant RV dilation
 +/- Mild LV wall thickening
 Normal / low normal LV ejection fraction
 Supra-normal LV diastolic indices
 Normal longitudinal strain values
 Normal / mildly enlarged LA & RA
 Normal aortic & mitral valves

Dilated RV Chamber



Clinical Factors c/w EICR
 Sport with Isotonic Physiology
 No subjective symptoms
 Unremarkable Family History
 Normal 12-lead ECG

Differential Diagnosis
 Arrhythmogenic CMP
 Toxic (ETOH, drugs) CMP
 1° or 2° pulmonary HTN
 Congenital heart disease
 Valvular heart disease

Imaging Findings c/w EICR
 Concomitant LV dilation
 Normal RV morphology
 Normal / low normal systolic function
 Supra-normal LV diastolic indices
 Normal / mildly enlarged LA & RA
 Normal RV systolic pressure
 Normal tricuspid and pulmonic valves

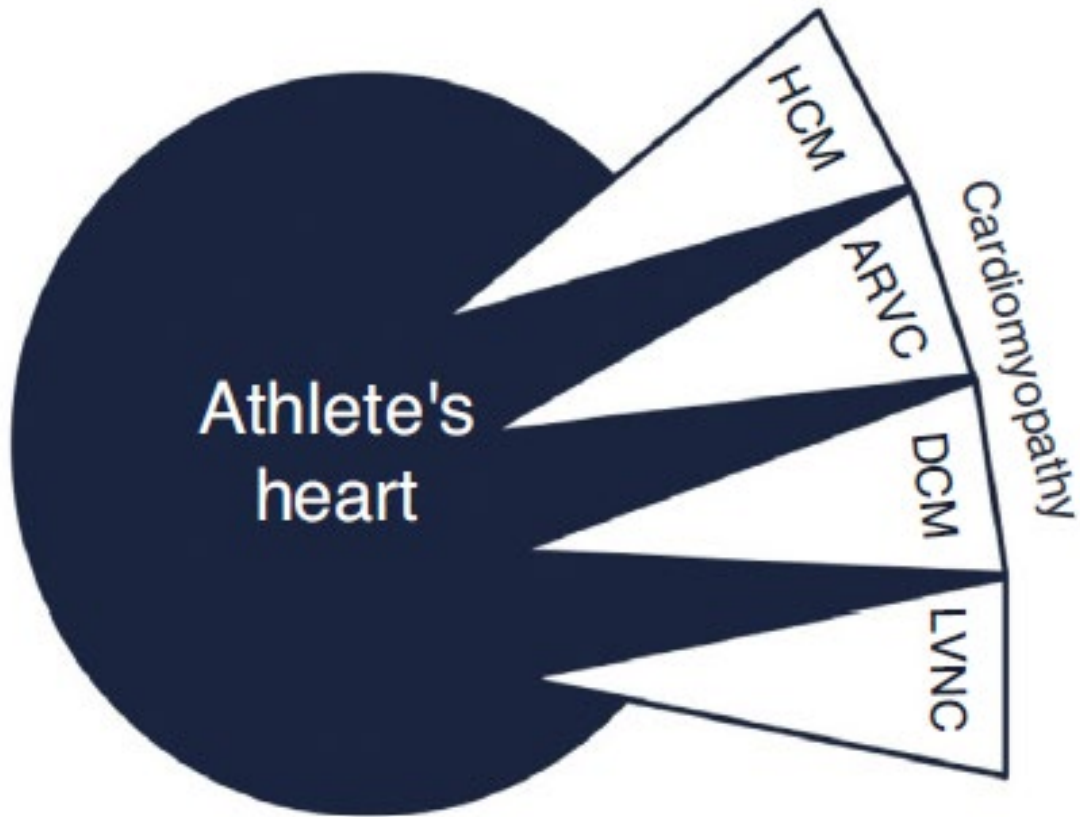
Hypertrabeculation



Clinical Factors c/w EICR
 Sport with Isotonic Physiology
 Black Ethnicity
 No subjective symptoms
 Unremarkable Family History
 Normal 12-lead ECG

Differential Diagnosis
 Non-compaction CMP
 Recent Pregnancy
 Sickle Cell Disease
 Aortic / Mitral Regurgitation

Imaging Data c/w EICR
 Normal LV ejection fraction
 Normal longitudinal strain values
 Normal compacted LV wall thickness
 Normal LV diastolic indices



Conclusão

- O coração de atleta apresenta alterações elétricas, estruturais e funcionais consequentes do exercício físico de longa duração e alta intensidade
- Compreender as adaptações cardiovasculares é fundamental na avaliação de atletas
- Modalidade desportiva, número de anos de prática desportiva, idade, sexo, raça/etnia e fatores ambientais
- O subdiagnóstico pode aumentar o risco de eventos potencialmente fatais e o sobrediagnóstico pode resultar em desqualificação indevida da competição



Referências Bibliográficas

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Muito obrigada!





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