



**CPC 2018**

A bradicardia como sinal de elevada performance do atleta

Virginia Fonseca  
Escola Superior de Tecnologia da Saúde de Lisboa

# 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 <sup>1,2</sup>.

Representam os membros mais **dinâmicos e saudáveis** de uma sociedade<sup>3</sup>.

1 - Maron *et al.* *Circulation* 1996;94:850-867.  
2 - Maron *et al.* *JACC*. 2005;45:1318-1375.  
3 - D'Souza *et al.* *Nature Communications* 2014



# Atleta

- Idade
- Sexo
- Altura/Peso/SC
- Raça
- Modalidade
  - Tipo de exercício
    - Dinâmico / Isotônico
    - Estático / Isométrico
  - Carga treino semanal

# Performance<sup>4</sup>

Realização eficaz, e perfeita, de uma atividade desportiva;

Obtenção de máximos e ótimos rendimentos;

Fenómeno complexo e multidimensional:

fatores orgânicos  
motores  
culturais  
psicológicos

4 - Gould, D. The development of Psychological Talent in U.S. Olympic Champions, 2001, Michigan Sate University

# Coração do atleta

- Resposta a um treino intenso e prolongado<sup>5,6</sup>
- *Remodeling* estrutural, funcional e elétrico<sup>7</sup>
- Adaptações cardiovasculares fisiológicas<sup>5,6</sup>

5 - Maron B, Pelliccia A., Circulation. 2006  
6 - Pluim B, *et al.*, Circulation. 2000  
7 - Prior, D. La Gerche, A. Heart 2012

## Adaptações Cardiovasculares ao Exercício Exercício Isotônico

Predomínio - sobrecarga de volume<sup>7</sup>:

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

7 - Prior, D. La Gerche, A. Heart 2012

## Adaptações Cardiovasculares ao Exercício Exercício Isométrico

Predomínio - Sobrecarga de pressão<sup>7</sup>:

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

7 - Prior, D. La Gerche, A. Heart 2012

# Adaptações Cardiovasculares ao Exercício

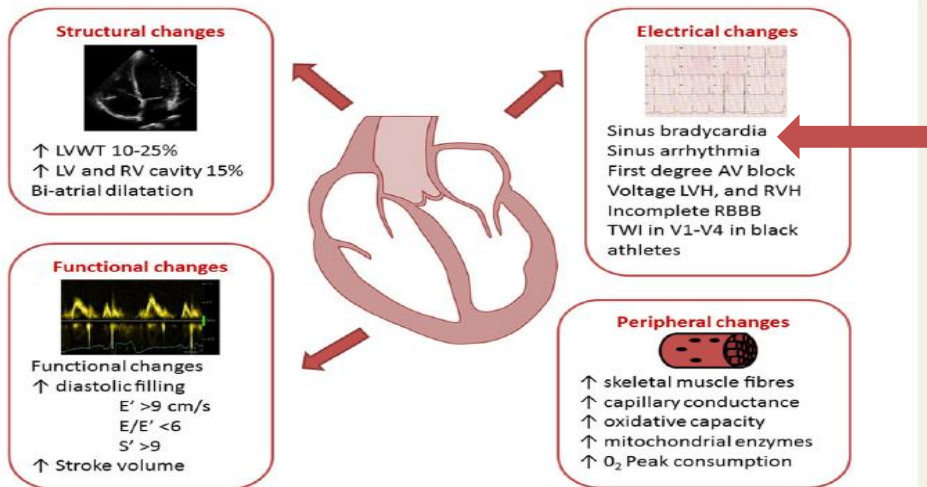
## Isotónico VS Isométrico ... não são dicotómicos!

**Table 1** Classification of training type by sport (adapted from Mitchell *et al*<sup>2</sup>)

		Dynamic component		
		Low	Medium	High
Static component	Low	Golf Cricket Bowling	Baseball Fencing Volleyball	Hockey Long distance running Football (soccer) Tennis
	Medium	Archery Diving Equestrian	American football Jumping events Sprinting Rugby	Middle distance running Swimming Basketball Ice hockey
	High	Throwing events Weight lifting Gymnastics Martial arts	Figure skating Downhill skiing Body building Snowboarding Wrestling	Cross country skiing Cycling Triathlon Rowing Boxing Canoe/kayak

7 - Prior, D. La Gerche, A. Heart 2012

# Adaptações Cardiovasculares ao Exercício



8 - Sharma, S. *et al.* European Heart Journal 2015



## Bradicardia sinusal em atletas

- Surge em 80% dos atletas (<60bpm)<sup>9</sup>
  - 20% - <50bpm
  - <41bpm severa; 41 a 50bpm moderada; 51 a 60bpm ligeira<sup>11</sup>
- Sistema Nervoso Autónomo<sup>9,10</sup>
  - ↑ Atividade Parassimpática
  - ↓ Atividade Simpática
- Adaptações na regulação intrínseca da FC (↓ da automaticidade)<sup>9,10</sup>
- + acentuada em atletas com treino predominantemente isotónico<sup>10</sup>

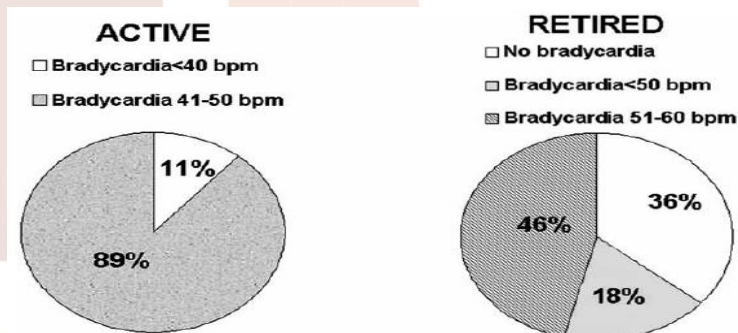
9 - Drezner JA, *et al.* Br J Sports Med 2013

10 - Serra-Grima *et al.* Int J Sports Medicine 2008

11 - Azevedo, L. *et al.* Int J Sports Medicine 2014

## Bradicardia sinusal em atletas

- Surge de forma progressiva<sup>10</sup>
- Com a diminuição do treino, ou com a sua interrupção, a FC aumenta<sup>10</sup>, mas...



10 - Serra-Grima *et al.* Int J Sports Medicine 2008

### Box 1 Normal ECG findings in athletes

1. Sinus bradycardia ( $\geq 30$  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.

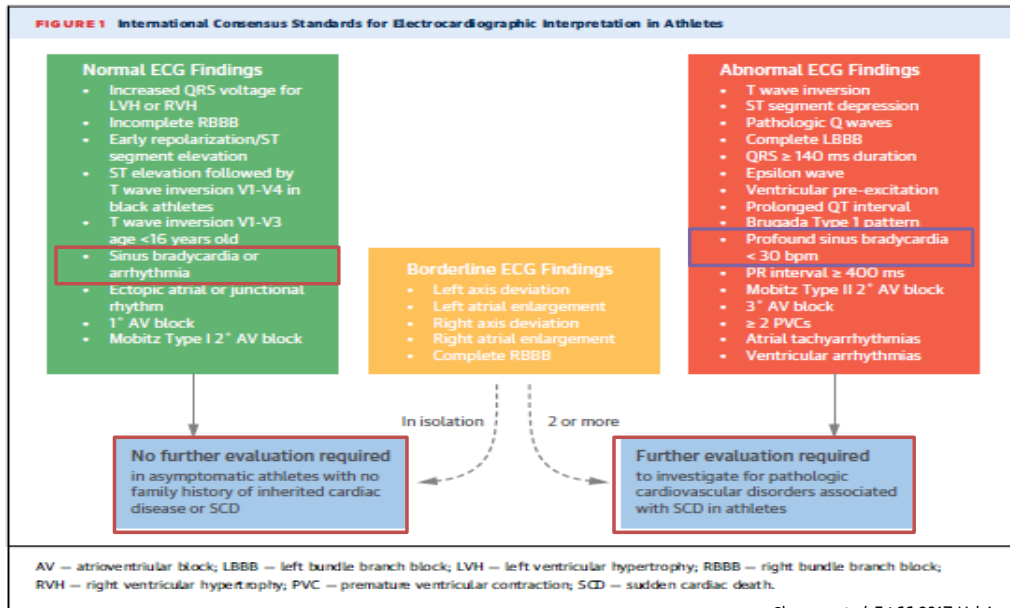
These common training-related ECG alterations are physiological adaptations to regular exercise, considered normal variants in athletes, and do not require further evaluation in asymptomatic athletes.

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

## Seattle Criteria

9 – Drezner JA, et al. Br J Sports Med 2013

**FIGURE 1** International Consensus Standards for Electrocardiographic Interpretation in Athletes



12 = Sharma et al. JACC 2017 Vol 6

# Coração do atleta...Ecg...processo gradual

*European Journal of Sport Science*, 2018  
<https://doi.org/10.1080/17461391.2018.1441910>



ORIGINAL ARTICLE

## The electrocardiographic manifestations of athlete's heart and their association with exercise exposure

BRAM BESSEM, MATTHIJS C. DE BRUIJN, WYBE NIEUWLAND,  
 JOHANNES ZWERVER, & MAARTEN VAN DEN BERG

13– Bessem, B. *et al.* European Journal of Sport Science 2018

# Coração do atleta...Ecg...processo gradual

- Use of **≥ 3 hours/week practicing** sports as a minimum value for the (electrocardiographic) development of an athlete's heart.<sup>9</sup>
- A **minimum of >3000 hours of lifetime exposure** is needed to lead to the electrocardiographic changes fitting athlete's heart.<sup>9</sup>
- **Sinus bradycardia appears to be an early sign of the development of athlete's heart.**<sup>9</sup>
- **First-degree AV-block** appears to occur as a late sign of the development of athlete's heart.<sup>9</sup>

13– Bessem, B. *et al.* European Journal of Sport Science 2018



## Coração do atleta...Ecg...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% <sub>a</sub>	35.1% <sub>b</sub>	38.6% <sub>b</sub>	32.9% <sub>b</sub>	34.4%	.000
Sinus arrhythmia	31.9% <sub>a</sub>	26.1% <sub>a</sub>	31.5% <sub>a</sub>	27.9% <sub>a</sub>	28.9%	.249
Rhythm						
Atrial	1.8% <sub>a</sub>	1.8% <sub>a</sub>	1.7% <sub>a</sub>	–	1.5%	.690
Junctional	–	0.2% <sub>a</sub>	0.4% <sub>a</sub>	0.7% <sub>a</sub>	0.3%	.690
AV-block						
1st degree	0.9% <sub>a,b</sub>	1.0% <sub>b</sub>	1.3% <sub>a,b</sub>	4.3% <sub>a</sub>	0.9%	.030
Incomplete RBBB	8.8% <sub>a</sub>	14.3% <sub>a</sub>	14.8% <sub>a</sub>	11.4% <sub>a</sub>	13.7%	.319
QRS voltage criteria for LVH						
Sokolow index ≥ 35mm	9.7% <sub>a</sub>	20.6% <sub>b</sub>	22.3% <sub>b</sub>	20.0% <sub>a,b</sub>	20.2%	.029
Early repolarisation	1.8% <sub>a</sub>	2.9% <sub>a</sub>	4.3% <sub>a</sub>	2.9% <sub>a</sub>	3.3%	.471
<b>Total training-related ECG changes</b>						
≥1 change	51.3% <sub>a</sub>	67.6% <sub>b</sub>	73.0% <sub>b</sub>	67.1% <sub>b</sub>	68.1%	.000
≥2 change	16.8% <sub>a</sub>	28.6% <sub>a,b</sub>	32.2% <sub>b</sub>	25.7% <sub>a,b</sub>	28.6%	.011

13 – Bessem, B. *et al.* European Journal of Sport Science 2018

## Coração do atleta...Ecg...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% <sub>a</sub>	33.5% <sub>a,b</sub>	40.7% <sub>b</sub>	42.7% <sub>b</sub>	40.4% <sub>b</sub>	36.1%	.000
Sinus arrhythmia	33.5% <sub>a</sub>	23.9% <sub>a</sub>	25.8% <sub>a</sub>	28.9% <sub>a</sub>	30.6% <sub>a</sub>	28.6%	.172
Rhythm							
Atrial	1.2% <sub>a</sub>	3.3% <sub>a</sub>	2.5% <sub>a</sub>	–	1.1% <sub>a</sub>	1.6%	.221
Junctional	–	0.5% <sub>a</sub>	0.4% <sub>a</sub>	0.4% <sub>a</sub>	0.5% <sub>a</sub>	0.4%	.221
AV-block							
1st degree	0.8% <sub>a</sub>	1.4% <sub>a</sub>	0.8% <sub>a</sub>	1.8% <sub>a</sub>	3.8% <sub>a</sub>	1.6%	.109
Incomplete RBBB	11.6% <sub>a</sub>	12.0% <sub>a</sub>	13.6% <sub>a</sub>	15.1% <sub>a</sub>	15.8% <sub>a</sub>	13.5%	.626
QRS voltage criteria for LVH							
Sokolow index ≥ 35mm	13.5% <sub>a</sub>	16.3% <sub>a,b</sub>	20.3% <sub>a,b</sub>	27.1% <sub>b</sub>	26.2% <sub>b</sub>	20.4%	.001
Early repolarisation	3.6% <sub>a</sub>	4.3% <sub>a</sub>	2.5% <sub>a</sub>	4.4% <sub>a</sub>	3.3% <sub>a</sub>	3.6%	.815
<b>Total training-related ECG changes</b>							
≥1 change	62.9% <sub>a</sub>	65.1% <sub>a</sub>	68.6% <sub>a,b</sub>	76.4% <sub>b</sub>	74.3% <sub>b</sub>	69.2%	.007
≥2 change	21.9% <sub>a</sub>	25.4% <sub>a,b</sub>	29.2% <sub>a,b</sub>	35.1% <sub>b</sub>	36.1% <sub>b</sub>	29.2%	.003

13 – Bessem, B. *et al.* European Journal of Sport Science 2018

## Modalidade...Treino...Bradycardia Sinusal

**Sport Modality Affects Bradycardia Level and Its Mechanisms of Control in Professional Athletes** <sup>11</sup>

**Sport Modality and Training Period Determines the Bradycardia Magnitude and their Mechanisms in Elite Athletes** <sup>14</sup>

11 - Azevedo, L. *et al.* Int Jornal Sports Medicine 2014

14 - Azevedo, L. *et al.* Medicine&Science in Sports&Exercise 2011

## Modalidade...Treino...Bradycardia Sinusal

**Table 1** Classification and training features and characteristics of runners and cyclists.

	Runners (N=13)	Cyclists (N=11)	P value
classification in national competition in the last 5 years before the evaluations	Top 10	Top 5	-
time engaged in competitive training (years)	7.4±1	9.6±1	0.144
days/week; sessions/week and averaged km/week covered in specific training during competitive period	7/week: 12/week and 185 km/week	7/week: 7/week and 826 km/week	-
age (years)	29±1.1	26±0.8	0.039
body fat (%)	5.2±0.4	6.6±1.0	0.176
BSA (m <sup>2</sup> )	1.73±0.03	1.86±0.04	0.015
VO <sub>2</sub> peak (ml.kg <sup>-1</sup> .min <sup>-1</sup> )	79.8±1.5	78.7±2.1	0.660
serum cortisol (µg.dL <sup>-1</sup> )	10.2±1.1	11.2±1.0	0.517

<41bpm severa    41 a 50bpm moderada    51 a 60bpm ligeira

Runners: 8%

77%

15%

Cyclists: 0%

55%

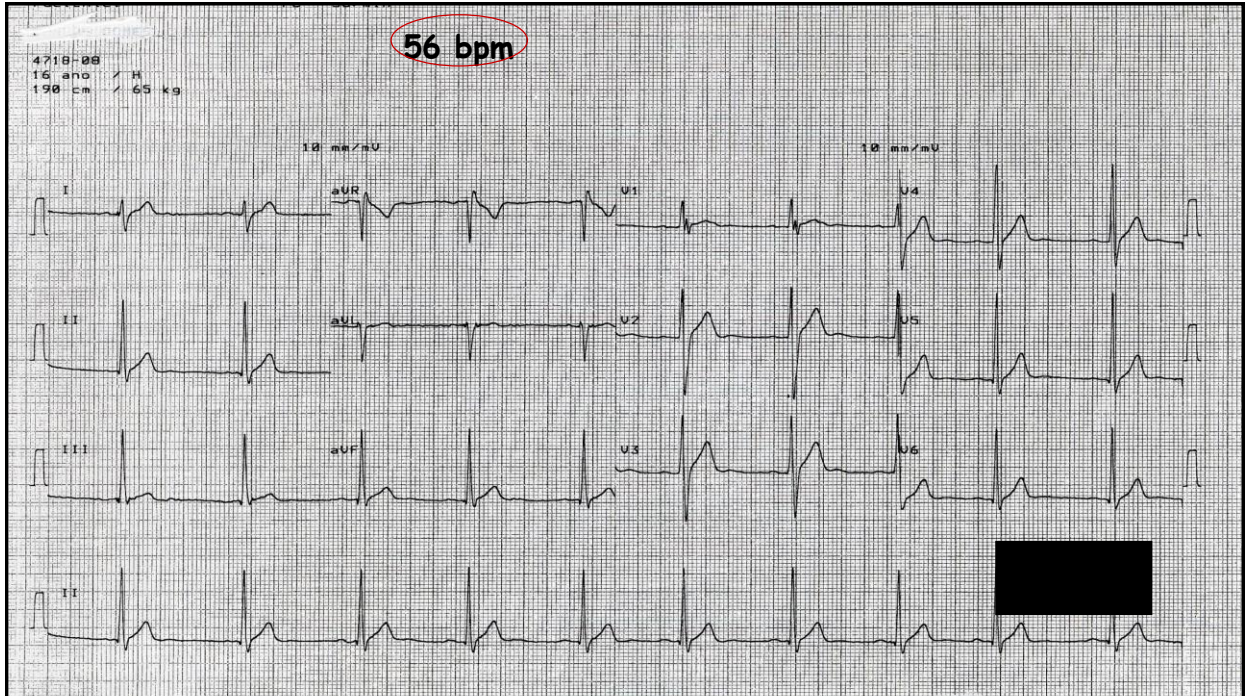
45%

11 - Azevedo, L. *et al.* Int Jornal Sports Medicine 2014

14 - Azevedo, L. *et al.* Medicine&Science in Sports&Exercise 2011

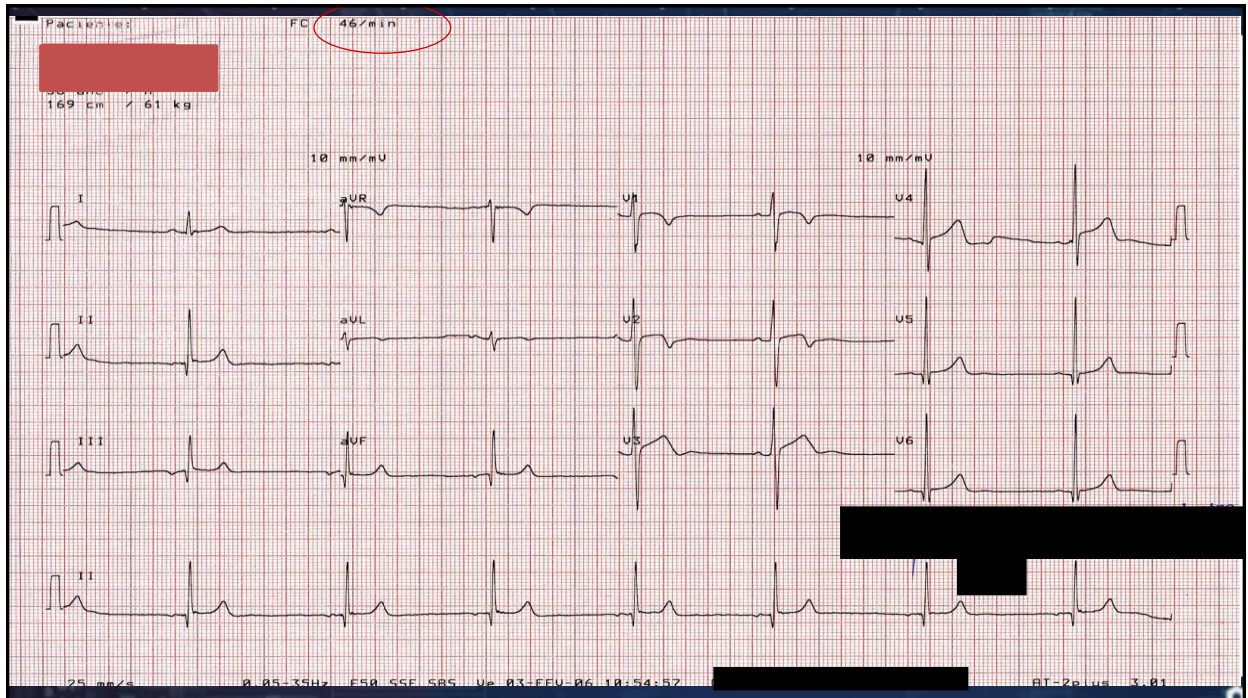
## Alguns exemplos....

- ♂
- 16 anos
- 190 cm e 65 kg (1.90m<sup>2</sup>)
- Caucasiano
- Futebol
- 4 anos na modalidade
- Carga de treino semanal: 7,5h



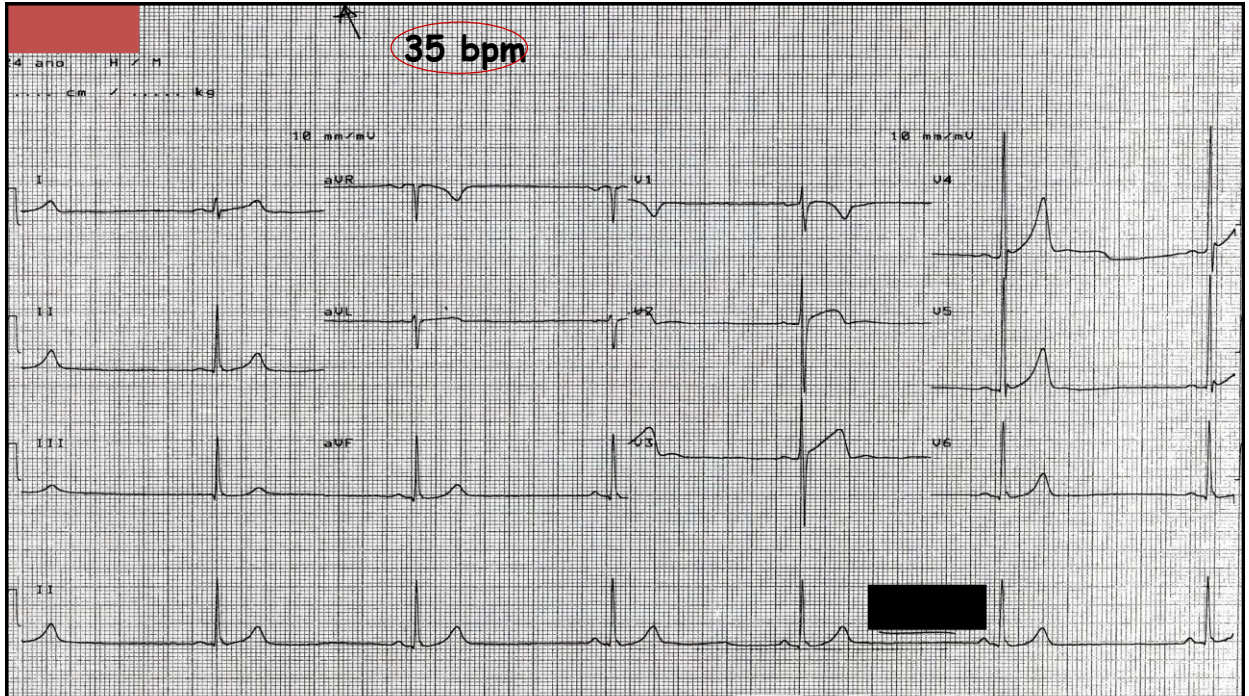
- ♂
- 18 anos
- 169 cm e 61 kg (1.70m<sup>2</sup>)
- Caucasiano
- Natação
- 6 anos na modalidade
- Carga de treino semanal: 12h



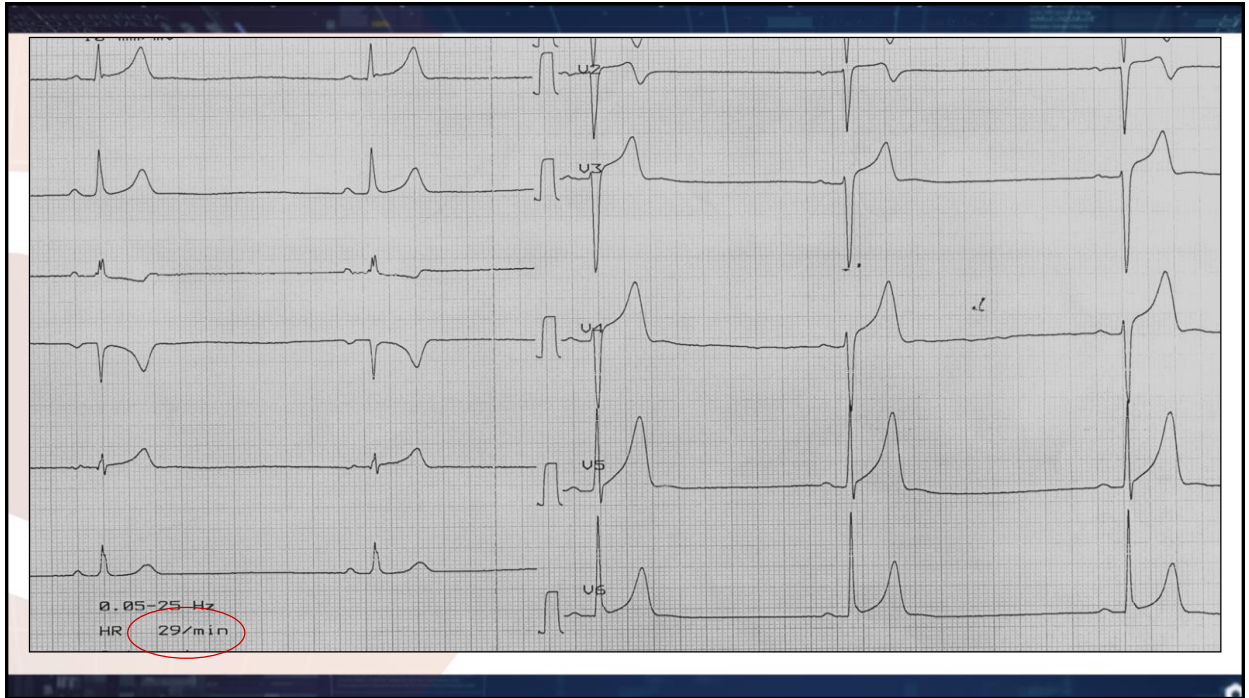


- ♂
- 24 anos
- 180 cm e 75 kg (1.94m<sup>2</sup>)
- Caucasiano
- Triatlo
- 6 anos na modalidade (iniciou natação aos 6 anos de idade)
- Carga de treino semanal: 20h - bidiário





- ♂
- 32 anos
- 169 cm e 61 kg (1.70m<sup>2</sup>)
- Caucasiano
- Ciclismo
- 14 anos na modalidade
- Carga de treino semanal: 24h



## Conclusão

- O coração do atleta apresenta alterações elétricas, estruturais e funcionais consequentes do exercício físico de longa duração e alta intensidade.
- A modalidade desportiva é um fator relevante e a ter em consideração, bem como o número de anos de prática desportiva.
- A bradicardia sinusal é resultado de mecanismos diversos.





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