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ORIGINAL ARTICLE

Abnormal electrocardiographic findings in athletes: Correlation with intensity of sport and level of competition

Hélder Dores[a,b,c,*], Aneil Malhotra[d], Nabeel Sheikh[d], Lynne Millar[d], Harshil Dhutia[d], Rajay Narain[d], Ahmed Merghani[d], Michael Papadakis[d], Sanjay Sharma[d]

[a] *Hospital das Forças Armadas, Lisboa, Portugal*
[b] *Hospital da Luz, Lisboa, Portugal*
[c] *NOVA Medical School, Lisboa, Portugal*
[d] *Department of Cardiovascular Sciences, St. George's University of London, London, United Kingdom*

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KEYWORDS
Electrocardiogram;
Athletes;
Type of sport;
Competitive level

Abstract
Introduction: Athletes can exhibit abnormal electrocardiogram (ECG) phenotypes that require further evaluation prior to competition. These are apparently more prevalent in high-intensity endurance sports. The purpose of this study was to assess the association between ECG findings in athletes and intensity of sport and level of competition.
Methods: A cohort of 3423 competitive athletes had their ECGs assessed according to the Seattle criteria (SC). The presence of abnormal ECGs was correlated with: (1) intensity of sport (low/moderate vs. at least one high static or dynamic component); (2) competitive level (regional vs. national/international); (3) training volume (≤20 vs. >20 hours/week); (4) type of sport (high dynamic vs. high static component). The same endpoints were studied according to the 'Refined Criteria' (RC).
Results: Abnormal ECGs according to the SC were present in 225 (6.6%) athletes, more frequently in those involved in high-intensity sports (8.0% vs. 5.4%; p=0.002), particularly in dynamic sports, and competing at national/international level (7.1% vs. 4.9%; p=0.028). Training volume was not significantly associated with abnormal ECGs. By multivariate analysis, high-intensity sport (OR 1.55, 1.18-2.03; p=0.002) and national/international level (OR 1.50, 95% CI 1.04-2.14; p=0.027) were independent predictors of abnormal ECGs, and these variables, when combined, doubled the prevalence of this finding. According to the RC, abnormal ECGs decreased to 103 (3.0%), but were also more frequent in high-intensity sports (4.2% vs. 2.0%; p<0.001).

* Corresponding author.
E-mail address: heldores@hotmail.com (H. Dores).

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Conclusions: There is a positive correlation between higher intensity of sports and increased prevalence of ECG abnormalities. This relationship persists with the use of more restrictive criteria for ECG interpretation, although the number of abnormal ECGs is lower.

PALAVRAS-CHAVE
Eletrocardiograma;
Atletas;
Tipo de desporto;
Nível competitivo

Alterações eletrocardiográficas em atletas: correlação com a intensidade de desporto e o nível de competição

Resumo
Introdução: O eletrocardiograma (ECG) do atleta pode apresentar alterações que requerem avaliações adicionais, aparentemente mais frequentes nos desportos de *endurance*. O objetivo deste trabalho foi avaliar a associação entre a presença de alterações no ECG do atleta com a intensidade de desporto e nível competitivo.
Métodos: Uma coorte de 3423 atletas de nível competitivo realizaram ECG que foi interpretado pelos critérios de Seattle (CS). A presença de alterações anormais foi correlacionada com: 1) intensidade de desporto (baixo/moderado *versus* pelo menos um componente elevado, estático ou dinâmico); 2) nível competitivo (regional *versus* nacional/internacional); 3) volume de treino (≤20 *versus* >20 horas/semana); 4) tipo de desporto (elevados componentes dinâmico *versus* estático). Os mesmos *endpoints* foram estudados pelos *Refined Criteria* (RC).
Resultados: De acordo com os SC, 225 (6,6%) atletas tinham alterações patológicas, mais frequentes nos envolvidos em desportos de elevada intensidade (8,0 *versus* 5,4%; p=0,002), sobretudo dinâmica, e em nível nacional/internacional (7,1 *versus* 4,9%; p=0,028). O volume de treino não esteve significativamente associado a estas alterações. Em análise multivariada, desporto de elevada intensidade (OR 1,55, IC 95% 1,18-2,03; p=0,002) e o nível nacional/internacional (OR 1,50, IC 95% 1,04-2,14; p=0,027) foram preditores independentes de ECG anormais, variáveis que combinadas duplicaram a prevalência. Com os RC o número de ECG patológicos decresceu para 103 (3,0%), também mais frequentes nos desportos de elevada intensidade (4,2 *versus* 2,0%; p<0,001).
Conclusões: Verificou-se uma correlação positiva entre desporto de elevada intensidade e nível competitivo com alterações ECG consideradas patológicas. Apesar do menor número destas alterações, esta relação persiste com o uso de critérios mais restritivos na sua interpretação.

Introduction

Repeated exercise training induces various cardiovascular adaptations that can manifest as changes in the resting 12-lead electrocardiogram (ECG). These changes can be classified as pathological in non-athletic individuals but considered physiological and training-related in athletes.[1] However, evaluation of the athlete's ECG is challenging because various physiological adaptations can overlap with conditions associated with an increased risk of sudden cardiac death.

The prevalence, pattern and degree of ECG changes are not uniform among athletes and are dependent on various factors including age,[2,3] gender[4–6] and ethnicity.[7,8] Although a higher prevalence of marked ECG changes has been reported in athletes engaged in high-intensity endurance sports, the association between the type of sport and the occurrence of abnormal ECG findings in athletes is not well established. The majority of existing studies reporting ECG changes according to the type of sport were performed in small populations, mainly covering endurance disciplines, and did not include sports characterized by different loading conditions.[2,9,10]

The conventional dual division between endurance/dynamic and static/strength sports seems rather simplistic. Many sporting disciplines combine elements of both types of exercise, and it can therefore be difficult to establish which is predominant. Additionally, factors such as duration of training and emotional stress related to competition are not taken into consideration.[11]

The purpose of the study was to assess the association between intensity of sport and level of competition with the presence of abnormal ECG findings in athletes.

Methods

Athletes

Between September 2006 and July 2012, 15 175 young individuals (aged between 14 and 35 years) underwent cardiac evaluation in the UK, as part of a pre-participation screening