



ORIGINAL ARTICLE

## Noninvasive predictors of cardiac arrhythmias in bodybuilders



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### KEYWORDS

Arrhythmias;  
Bodybuilding;  
Sport;  
Sudden cardiac death

### Abstract

**Introduction and Objective:** Arrhythmias are often recorded in strength training athletes without cardiovascular abnormalities but may also be a sign of an underlying cardiovascular disease which carries a risk of sudden cardiac death (SCD). Nowadays, bodybuilding is a popular sport among adolescents and young adults. There have been few studies of arrhythmias comparing bodybuilders with healthy controls and excluding anabolic steroid use. We aimed to assess the structural, functional and electrical characteristics of bodybuilders' hearts compared with control subjects.

**Methods:** In this study, we assessed 35 male competitive bodybuilders and 35 healthy control subjects matched for age, gender, and body mass index. A detailed cardiovascular and systemic examination was performed at the beginning of the study to collect demographic data and anthropometric measures. Biochemical and hematologic, echocardiographic, 24-h Holter, and ECG measurements were obtained from all participants.

**Results:** Ventricular arrhythmias were encountered significantly more frequently in bodybuilders than in the control group. QT and QTc were not significantly different between groups. Tp-e interval, Tp-e/QT ratio, and Tp-e/QTc ratio were significantly greater in bodybuilders than in the control group ( $p < 0.001$  for all). There was a positive correlation between Tp-e interval, Tp-e/QT ratio, and Tp-e/QTc ratio and right ventricular (RV) diameter and arrhythmias.

**Conclusion:** Prolonged repolarization is common in athletes, although its predictive value is unclear. In this study, alterations in ventricular repolarization were positively correlated with RV dimensions. Therefore, we postulate that arrhythmias in strength athletes may be predicted by assessing the right ventricle echocardiographically and dispersions of repolarization on the ECG, and that SCD could be avoided in strength athletes by careful application of this information.

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**PALAVRAS-CHAVE**

Arritmias;  
Fisiculturismo;  
Desporto;  
Morte súbita cardíaca

**Preditores não invasivos das arritmias cardíacas nos fisiculturistas****Resumo**

*Introdução e objetivo:* As arritmias são registadas muitas vezes nos atletas de alta competição sem alterações cardiovasculares, podendo no entanto ser um sinal de doença cardiovascular subjacente, o que constitui um prognóstico de risco de morte súbita cardíaca (MSC). Hoje em dia o fisiculturismo é um desporto popular praticado por muitos adolescentes e adultos jovens. Não são muitos os estudos comparativos entre os fisiculturistas e grupos de controlo saudáveis. Foi nosso objetivo avaliar as características estruturais, funcionais e elétricas do coração dos fisiculturistas comparadas com as do grupo controlo.

*Método:* Neste estudo avaliámos 35 fisiculturistas de competição do sexo masculino e 35 indivíduos saudáveis do grupo controlo, emparelhados por idade, género e índice de massa corporal. Foram realizados exames cardiovasculares e sistémicos no início do estudo, com registo de dados demográficos e medidas antropométricas. Foram obtidos registos bioquímicos e hematológicos, ecocardiográficos e do registo de Holter de 24 horas, bem como medições eletrocardiográficas de todos os participantes.

*Resultados:* As arritmias ventriculares encontradas foram significativamente mais frequentes nos fisiculturistas do que no grupo controlo. Os valores do QT e do QTc não foram significativamente diferentes entre os grupos. O intervalo Tp-e, a relação TP-e/QT e a relação Tp-e/QTc foram significativamente superiores no grupo dos fisiculturistas quando comparado com o grupo controlo ( $p < 0,001$ ). Verificou-se uma correlação positiva entre o intervalo Tp-e, a relação Tp-e/QT e a relação Tp-e/QT com o diâmetro do ventrículo direito (VD) e a arritmia.

*Conclusão:* A repolarização prolongada é comum nos atletas, mesmo quando o seu valor preditivo é pouco claro. Neste estudo, as alterações na repolarização ventricular foram positivamente correlacionadas com as dimensões do VD. Assim, admitimos que as arritmias nos atletas de alta competição possam ser previsíveis através de ecocardiografia do VD e por dispersões da repolarização no ECG. Por último, a MSC pode ser evitável nos atletas de alta competição com recurso a este tipo de interpretação, considerada razoável e passível de aplicação.

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**Introduction**

It is well established that moderate-intensity exercise reduces the risk of cardiovascular mortality and morbidity.<sup>1</sup> However, vigorous exercise can transiently increase the risk of sudden cardiac death (SCD).<sup>2</sup> Thus, moderate exercise is better than no exercise, but vigorous exercise may be harmful to some individuals. Nowadays, bodybuilding is a popular sport among adolescents and young adults. Bodybuilders perform principally high static and low dynamic work aiming to increase muscle mass. Dynamic exercise mainly induces volume load in the cardiac cavities, whereas static exercise causes mainly pressure load.<sup>3</sup> The types of exercises performed by bodybuilders increase stroke volume and cardiac output to a greater degree than in other athletes.<sup>4</sup>

Increased cardiac preload and afterload is associated with symmetrical enlargement of all cardiac chambers.<sup>5</sup> Athlete's heart, which is characterized by hypertrophy and/or dilatation of the cardiac chambers with normal or enhanced function, may be induced by chronic physical training. However, slight differences in echocardiographic patterns are observed consistent with the type of training.<sup>1</sup>

Cardiac hypertrophy is associated with alterations in the electrophysiological properties of the heart, which may thus

become more susceptible to malignant tachyarrhythmias. Several mechanisms have been proposed to explain the vulnerability of the hypertrophied ventricle to life-threatening arrhythmias. Furthermore, in some individuals long-term exercise training may cause adverse structural and electrical cardiac remodeling, including fibrosis and stiffening of the atria, right ventricle, and large arteries.<sup>6</sup> Also, the combination of interstitial fibrosis and stiffening leads to abnormalities in ventricular repolarization.<sup>7,8</sup>

Myocardial repolarization can be assessed by various methods on the electrocardiogram (ECG) including QT interval dispersion, corrected QT dispersion (QTc), the interval between the peak and the end of the T wave (Tp-e) and novel indices, the Tp-e/QT ratio and Tp-e/QTc ratio.<sup>9,10</sup> An increased Tp-e interval may also be a useful index to predict ventricular arrhythmias (VAs) and cardiovascular mortality.<sup>11,12</sup> Frequent premature ventricular complexes (PVCs) are often recorded in trained athletes without cardiovascular abnormalities but may also be a sign of underlying cardiovascular disease and predict risk of SCD.<sup>13-17</sup>

Although ventricular repolarization and VAs have been widely assessed in bodybuilders using anabolic steroids, there have been few studies of arrhythmias comparing bodybuilders with healthy controls and excluding anabolic steroid use.<sup>18</sup> We aimed to assess the structural, functional and

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