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ORIGINAL ARTICLE

Heart rate variability estimates ventilatory threshold regardless body mass index in young people

La variabilité de la fréquence cardiaque estime le seuil ventilatoire indépendamment de l'indice de masse corporelle chez les jeunes

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Summary

Objective. — To compare ventilatory threshold (VT) and heart rate variability threshold (HRVT) in normal weight (NW: 22.75 ± 1.66 kg/m^2), overweight (Ov: 27.03 ± 1.48) and obese (O: 33.26 ± 2.39) young people (21.46 ± 2.06 years old).

Methods. — The HRVT was determined at the first intensity with a SD1 index (HRVT$_{SD1}$) and RMSSD (HRVT$_{RMSSD}$) lower than 3 ms and with a visual deflection in the curve of intensity versus SD1 (HRVT$_{SD1-v}$) and RMSSD (HRVT$_{RMSSD-v}$) indexes.

Results. — The HRVT$_{SD1}$, HRVT$_{SD1-V}$ and HRVT$_{RMSSD-V}$ were identified in 100% of individuals and the HRVT$_{RMSSD}$ in 90.32%. The VT was identified at similar workloads (NW: 109.50 ± 36.09; Ov: 90.00 ± 16.20; O: 96.00 ± 25.69 W) and VO$_2$ (NW: 20.52 ± 6.01; Ov; 18.01 ± 4.35; O: 15.14 ± 2.45 mL/kg/min), no differences ($P > 0.05$) among the HRVT and groups. Despite the correlations between VT and the diverse HRVT were from low to moderate for workload (r: $0.25 - 0.42$) and VO$_2$ (r: $0.38 - 0.62$), there was a good agreement between them, mainly HRVT$_{SD1}$.

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Conclusion. — The criteria and indexes of determination of VT by HRV, especially the HRVT$_{SD1}$, can be used, in overweight and obese young people in the evaluation of aerobic fitness and in exercise prescription for this population.

Résumé

Objectif. — Pour comparer le seuil ventilatoire (SV) et le seuil de la variabilité du rythme cardiaque (SVRC) en poids normal (PN : $22,75 \pm 1,66$ kg/m^2), surpoids (S : $27,03 \pm 1,48$) et obèses (O : $33,26 \pm 2,39$) jeune personnes ($21,46 \pm 2,06$ ans).

Méthode. — Le SVRC a été déterminée à la première intensité avec un indice SD1 (SVRC$_{SD1}$) et RMSSD (SVRC$_{RMSSD}$) inférieure à 3 ms et avec une déviation visuelle de la courbe d'intensité contre les indices SD1 (SVRC$_{SD1-v}$) et RMSSD (SVRC$_{RMSSD-v}$).

Résultats. — Le SVRC$_{SD1}$, SVRC$_{SD1-v}$ et SVRC $_{RMSSD-v}$ ont été identifiés dans 100 % des individus avec la SVRC$_{RMSSD}$ à 90,32 %. Le SV a été identifié en charges de travail similaires (PN : $109,50 \pm 36,09$; S : $90,00 \pm 16,20$; O : $96,00 \pm 25,69$ W) et VO$_2$ (PN : $20,52 \pm 6,01$; S : $18,01 \pm 4,35$; O : $15,14 \pm 2,45$ mL/kg/min), aucune différence ($p > 0,05$) entre les groupes et le SVRC. Malgré les corrélations entre le SV et les diverses SVRC étaient de faible à modérée pour la charge de travail ($r : 0,25-0,42$) et VO$_2$ ($r : 0,38-0,62$), il y avait un bon accord entre eux, principalement le SVRC$_{SD1}$.

Conclusion. — Les critères et indices de détermination du SV par VRC, en particulier les SVRC$_{SD1}$, peuvent être utilisés, chez les personnes jeunes en surpoids et obèses, dans l'évaluation de l'aptitude aérobie et la prescription d'exercices pour cette population.

1. Introduction

Aerobic fitness markers, such as maximum oxygen uptake (VO$_2$max) and anaerobic threshold, have been widely used for evaluation and prescription, aimed at improving power and aerobic capacity in different populations [1–8].

On the other hand, for training prescription using aerobic power parameters (VO$_2$max), it is necessary to apply maximum effort tests. Thus, the use of the anaerobic threshold seems to be an interesting alternative, especially for special groups such as individuals with excess body weight (overweight and obese). Since the intensity the anaerobic threshold occurs, a withdrawal of the parasympathetic nervous system followed by an increase of the sympathetic nerve activity [1,4,6], increasing the likelihood of the occurrence of cardiovascular events in this population (obese).

Traditionally, the anaerobic threshold is identified using the blood lactate kinetics [2], ventilation — ventilatory threshold (VT) [1,9], blood glucose [10] and more recently, by heart rate variability (HRV). The HRV is the interval temporal variability between successive heartbeats, measured by R-R interval. In evaluation protocols, the HRV is used as a parasympathetic activity indicator, and during the physical exercise the HRV threshold (HRVT), determined by various indexes, is used as an indicator of the transition from the predominance of the parasympathetic nervous system activity, which occurs between 50 to 65% of VO$_2$max, to the prevalence of sympathetic nervous system activity [1,5,8,11]. In this way, researches have shown that the HRVT was identified at intensities similar to that of the first threshold of lactate [1,2] and the first VT [1,4–6,12,13], besides being a noninvasive procedure, easy to interpret, low-cost [1] and with huge clinical implication, since there is also a vagal protective action at this intensity, so that physical exercise practiced at intensities up to the threshold seems to be safer considering the possible cardiovascular risks.

The HRVT was already identified in young individuals [2,5,14], type 2 diabetics [1], elderly [8,13], obese children and adolescents [4,6,7], overweight and/or obese adults [15] and athletes [11,12,16], being sensitive to the effects of physical training [4,6,17], using non-linear indexes, in the time domain [1–4,6,8,13,14,17], or frequency domain [11,12,18], and using different criteria for determination. However, limited studies have evaluated young obese at early adulthood, especially analyzing the use of different criteria and/or indexes of HRV to estimate the VT.

The hypothesis of the present study is that it is possible to estimate the VT by different criteria and indexes of HRVT, regardless of body mass index (BMI) and so, to enable the choice by the most objective criteria. Thus, this study aimed to compare VT and HRVT, in overweight and obese young people.

2. Methods

2.1. Subjects

Thirty men between 18 and 25 years old, apparently healthy and considered untrained for having not practiced any kind of physical exercise for three months prior to the beginning of the study were evaluated. These individuals were divided into three subgroups according to the BMI. Ten normal weight (≥ 20 and ≤ 24.9 kg/m^2), 10 overweight (≥ 25 and ≤ 29.9 kg/m) and 10 obese (≥ 30 and ≤ 39.9 kg/m). No participants shown elevated blood pressure (> 140/90 mmHg), fasting glucose (> 100 mg/dL) or plasma lipids (total cholesterol > 200 mg/dL; triglycerides > 150 mg/dL). Exclusion