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ORIGINAL ARTICLE

Prediction of the velocity associated with maximal heart rate in recreational runners from different relative submaximal running intensities

Prédiction de la vitesse associée à la fréquence cardiaque maximale chez des coureurs occasionnels à partir de différentes intensités relatives d'exercice sous-maximal

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Heart rate;
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Summary
Objective. — The objective of this study was to identify the optimal relative intensity to predict speed associated with maximal heart rate (vHR_{max}) in recreational runners during 10-km race.
Equipment and methods. — Fifty-nine male, recreational runners volunteered to participate. Participants were submitted to a maximal incremental test to determine peak treadmill speed (V_{peak}) and vHR_{max} (75, 80, 85 and 90% HR_{max}) based on di Prampero (1986) and Lacour et al. (1990, 1991) methods. They also performed a 10-km performance in track.
Results. — No differences were observed between percentages of HR_{max} for vHR_{max} based on Lacour et al. (1990, 1991), except for the $vHR_{max\text{-}75\%}$ that was higher than the other percentages. The vHR_{max} determined by the di Prampero (1986) method was lower than both V_{peak} and vHR_{max} of Lacour et al. (1990, 1991) method for all percentages of HR_{max}. The $vHR_{max\text{-}75\%}$ of Lacour et al. (1990, 1991) method was different from V_{peak}. The $vHR_{max\text{-}85\%}$ and $vHR_{max\text{-}90\%}$, independently of the method, were highly correlated to 10-km running velocity. In conclusion, $vHR_{max\text{-}85\%}$ and

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$vHR_{max-90\%}$ calculated by Lacour et al. (1990, 1991) method appears to be the most adequate method to determine vHR_{max}, since it was closer to V_{peak} and highly correlated to performance.

MOTS CLÉS
Fréquence cardiaque ;
Course ;
Test de l'exercice ;
Endurance

Résumé
Objectif. — Le but de cette étude était d'identifier l'intensité relative optimale pour prédire la vitesse associée à la fréquence cardiaque maximale (vFC_{max}) chez les coureurs occasionnels lors d'une course de 10 km.
Matériel et méthodes. — Cinquante-neuf hommes, coureurs occasionnels, ont été volontaires pour participer à cette étude. Ils ont réalisé un test maximal sur tapis roulant pour déterminer la vitesse pic (V_{peak}) et la vFC_{max} (75, 80, 85 et 90 % FC_{max}) selon les méthodes de di Prampero (1986) et Lacour et al. (1990, 1991) puis ils ont ensuite effectué un course de 10 km sur une piste.
Résultats. — Aucune différence n'a été observée entre les différents pourcentages de FC_{max} pour la vFC_{max} déterminée avec la méthode de Lacour et al. (1990, 1991), sauf pour la vFC_{max} à 75 %, qui était significativement plus élevée que les autres pourcentages. La vFC_{max} déterminée à l'aide de la méthode de di Prampero (1986) était inférieure à V_{peak} et vFC_{max} obtenues avec la méthode de Lacour et al. (1990, 1991) pour chaque pourcentage de FC_{max}. La $vFC_{max-75\%}$ selon Lacour et al. (1990, 1991) était différente de V_{peak}. La $vFC_{max-85\%}$ et $vFC_{max-90\%}$, quelle que soit la méthode de calcul utilisée, étaient corrélées à 10 km vitesse de course. En conclusion, vFC_{max} à 85 % et 90 % calculées selon la méthode de Lacour et al. (1990, 1991) semble être la méthode la plus adéquate pour déterminer la vFC_{max}, et est significativement corrélée à la performance lors du 10 km.

1. Introduction

The running velocity associated with the occurrence of maximal oxygen uptake (vVO_{2max}) can be determined based on the oxygen cost of running, according to the proposal of di Prampero [1] and Lacour et al. [2,3]. Basically, the difference between both proposals is that di Prampero [1] calculated oxygen cost dividing the oxygen uptake in a submaximal intensity by its correspondent speed and Lacour et al. [2,3] subtracted the resting oxygen uptake from the oxygen uptake in a submaximal intensity before dividing by that velocity. This intensity of effort (i.e., vVO_{2max}) has been showed to be a predictor of endurance running performance [4,5].

The utilization of heart rate in this di Prampero [1] method, instead of the oxygen uptake, has also been proposed for maximal aerobic speed (MAV) prediction [6]. These authors assumed that increases in both oxygen consumption and heart rate occur in a similar way in response to running velocity increments up to the VO_{2max}, maximal heart rate (HR_{max}) and MAV attainment [7,8]. It was argued that from submaximal running velocities to the MAV attainment, both heart rate and the cardiac output are directly related to the oxygen uptake in the attained intensity. In this way, the ''heart rate cost of running'' has been proposed to determine the velocity associated with the HR_{max} (vHR_{max}) [6]. da Silva et al. [6] evidenced that the adapted method of Lacour et al. [2,3] (i.e., changing VO_2 for HR but keeping the calculation method) was feasible to estimate the vHR_{max}, presenting higher agreement than the vHR_{max} calculated based on di Prampero [1] method to predict the peak treadmill speed (V_{peak}). The V_{peak} is considered a direct measure of MAV, is a good predictor of endurance running performance [9], is not dependent of expensive measurements (e.g., lactate concentrations and respiratory parameters) and is reliable [10].

Despite these results, to our knowledge, the effect of relative submaximal intensity performed to calculate the heart rate cost has not been studied. da Silva et al. [6] used the velocity associated with 75% of VO_{2max} [11] and observed that this intensity corresponded to $85.2 \pm 3.9\%$ of HR_{max}. Considering the large inter-subject variability of the HR curve during incremental tests, which may reflect in a concave, convex or linear curve behavior [12], it is relevant to compare different percentages of HR_{max} to determine heart rate cost and, consequently, vHR_{max}.

Based on that, the presented study aimed to analyze what is the best intensity to predict vHR_{max} in runners, knowing that the HR-velocity relationship is not always linear. Additionally, it was aimed to correlate the different vHR_{max} with 10-km running performance. We hypothesized that the different percentages used to calculate heart rate cost of running would influence vHR_{max} and its relationship with performance.

2. Methods

2.1. Participants

Fifty-nine male, recreational runners with experience in 10-km running races and involved in systematic training volunteered to participate in this study (age: 34.8 ± 11.1 years; height: 180 ± 10 cm; body mass: