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ORIGINAL ARTICLE

Analysis of cardiopulmonary and metabolic variables measured during laboratory and sport-specific incremental tests for table tennis performance prediction



Analyses des variables cardiorespiratoires et métaboliques mesurées lors de tests en laboratoire et de tests spécifiques pour prédire la performance en tennis de table

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KEYWORDS

Peak oxygen uptake;
Blood lactate;
Respiratory
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Specificity;
Gas exchange

Summary

Purpose. – The purposes of this study were: i) to compare the physiological responses measured during a specific table tennis incremental test with the physiological responses measured during cycling, arm cranking, and treadmill running tests; and ii) to verify the accuracy of table tennis performance prediction based on the physiological responses from these tests.

Methods. – Eleven national level male table tennis players participated in the study and undertook incremental tests using ergometers. Table tennis performance was defined as the ranking obtained during a simulated tournament between the participants.

Abbreviations: $\dot{V}O_{2PEAK}$, Peak oxygen uptake; RCP, Respiratory compensation point; GXT, Graded exercise test; $\dot{V}O_2$, Oxygen uptake; $\dot{V}CO_2$, Carbon dioxide production; RER, Respiratory exchange ratio; \dot{V}_E , Pulmonary ventilation; HR, Heart rate; [La], Blood lactate; RPE, Rate of perceived exertion; $I\dot{V}O_{2PEAK}$, Intensity associated to $\dot{V}O_{2PEAK}$; $\dot{V}_E/\dot{V}O_2$, Ventilation equivalent of O_2 ; $\dot{V}_E/\dot{V}CO_2$, Ventilation equivalent of CO_2 ; TTp, Table tennis performance; ES, Effect size; CI95%, 95% confidence interval; [La]PEAK, Peak lactate; HRPEAK, Peak heart rate.

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MOTS CLÉS

Absorption maximale d'oxygène ;
Lactate dans le sang ;
Point de compensation respiratoire ;
Spécificité ;
Échange de gaz

Results. – In general, peak values for physiological variables (e.g., $\dot{V}O_{2PEAK}$ and [La]PEAK) were significantly lower ($P < 0.05$) in the specific test (e.g., $\dot{V}O_{2PEAK} = 39.9 \pm 1.5 \text{ ml}\cdot\text{kg}^{-1}$ per minute and [La]PEAK = $6.4 \pm 0.5 \text{ mmol}\cdot\text{L}^{-1}$) than during cycling (e.g., $\dot{V}O_{2PEAK} = 41.3 \pm 1.4 \text{ ml}\cdot\text{kg}^{-1}$ per minute and [La]PEAK = $10.2 \pm 0.7 \text{ mmol}\cdot\text{L}^{-1}$) or running (e.g., $\dot{V}O_{2PEAK} = 43.9 \pm 1.5 \text{ ml}\cdot\text{kg}^{-1}$ per minute and [La]PEAK = $10.0 \pm 0.7 \text{ mmol}\cdot\text{L}^{-1}$), but higher than during arm cranking (e.g., $\dot{V}O_{2PEAK} = 26.6 \pm 1.6 \text{ ml}\cdot\text{kg}^{-1}$ per minute and [La]PEAK = $8.9 \pm 0.6 \text{ mmol}\cdot\text{L}^{-1}$). At respiratory compensation point intensity (RCP), only the variables measured on arm cranking were lower ($P < 0.05$) than on the other ergometers. Stepwise multiple regression analysis showed significant correlation between table tennis performance and lactate concentration ([La]) and also rate of perceived effort (RPE) at RCP during cycling ($r = 0.89$; $P < 0.05$).

Conclusion. – In conclusion, the significant differences obtained between the specific and laboratory ergometers demonstrate the need to use a specific test to measure physiological parameters in table tennis and the physiological parameters measured, independent of the ergometer used, are unable to predict table tennis performance.

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Résumé

Objectif. – Les objectifs de cette étude étaient : i) de comparer les réponses physiologiques mesurées lors d'un test spécifique à incréments en tennis de table avec les réponses physiologiques mesurées au cours de test de cyclisme, de pédalage de bras et de tests sur tapis roulant ; et ii) de vérifier la précision de la prédiction de la performance en tennis de table basée sur les réponses physiologiques mesurées lors de ces tests.

Méthodes. – Onze joueurs de tennis de table masculins de niveau national ont participé à l'étude et réalisé des tests à incréments sur ergomètres. La performance en tennis de table a été définie comme le classement lors d'un tournoi réalisé entre les participants.

Résultats. – De manière générale, les valeurs maximales pour les variables physiologiques ont été significativement plus faibles ($p < 0,05$) dans le test spécifique ($\dot{V}O_{2PIC} = 39,9 \pm 1,5 \text{ ml}\cdot\text{kg}^{-1}$ par minute et [La]PIC = $6,4 \pm 0,5 \text{ mmol}\cdot\text{L}^{-1}$) que durant le test de cyclisme ($\dot{V}O_{2PIC} = 41,3 \pm 1,4 \text{ ml}\cdot\text{kg}^{-1}$ par minute et [La]PIC = $10,2 \pm 0,7 \text{ mmol}\cdot\text{L}^{-1}$) ou de course ($\dot{V}O_{2PIC} = 43,9 \pm 1,5 \text{ ml}\cdot\text{kg}^{-1}$ par minute et [La]PIC = $10,0 \pm 0,7 \text{ mmol}\cdot\text{L}^{-1}$), mais plus élevées que pendant le test de pédalage de bras ($\dot{V}O_{2PIC} = 26,6 \pm 1,6 \text{ ml}\cdot\text{kg}^{-1}$ par minute et [La]PIC = $8,9 \pm 0,6 \text{ mmol}\cdot\text{L}^{-1}$). Au point de compensation respiratoire, seules les variables mesurées lors du pédalage de bras étaient plus faibles ($p < 0,05$) que les autres réalisées sur ergomètres. L'analyse de régression multiple pas à pas a montré une corrélation significative entre la performance en tennis de table et la concentration en lactate ([La]) mais également avec le taux d'effort aperçu (RPE) et le point de compensation respiratoire (RCP) pendant le cyclisme ($r = 0,89$; $p < 0,05$).

Conclusion. – En conclusion, les différences significatives entre les ergomètres spécifiques et de laboratoire démontrent la nécessité d'utiliser un test spécifique pour mesurer les paramètres physiologiques en tennis de table, et les paramètres physiologiques mesurés, indépendamment de l'ergomètre utilisé, ne sont pas capables de prédire la performance en tennis de table.

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1. Introduction

In racket-sports matches, predominantly tennis, a player's aerobic fitness is considered as a major determinant in the game outcome. It enables generation of repeated powerful strokes, rapid on-court movements, and ensures fast recovery for the next effort during the match [1–4].

Aerobic fitness, which can be estimated by peak oxygen uptake ($\dot{V}O_{2PEAK}$) (i.e., an index of aerobic power) and by the respiratory compensation point (RCP) (i.e., an index of aerobic endurance), is often determined in laboratory settings, usually with a cycle ergometer or a treadmill. However, the muscular activity employed on conventional ergometers does not simulate the motor patterns used in racket-sports [1]. Although some studies have compared the

physiological responses of specific racket-sport tests and laboratorial ergometers [1,5–7], they showed contradictory findings, with some studies describing higher $\dot{V}O_{2PEAK}$ values on laboratorial ergometers [8] while others report higher $\dot{V}O_{2PEAK}$ values in the specific test [1,5–7].

The importance of the aerobic system in racket-sports has been widely investigated [1,5,6,8–13], and it is also used to prescribe training intensities. In table tennis, aerobic fitness has been estimated during a specific test by measuring the intensity corresponding to the respiratory compensation point using a ball-throwing machine [10–13]. These studies however did not include a direct comparison between the physiological responses obtained using the different tests [4,10,13]. Although there are recent scientific studies in table tennis [4], they are mostly concerned with evaluating aerobic capacity using specific procedures by

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