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BRIEF NOTE

Anaerobic speed reserve in young female rugby players: Methods and applications

Réserve de vitesse anaérobie chez les jeunes joueuses de rugby : méthodes et applications

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Summary
Introduction. — This study aimed to identify differences and concordances among anaerobic speed reserve calculated considering different tests of maximal sprint speed and aerobic fitness in young female athletes.
Summary of facts and results. — Ten female rugby players (15.00 ± 0.21 years) performed sprint tests (20 m, 30 m and 40 m) to measure maximal sprint speed and aerobic tests to measure speed associate to maximum oxygen uptake, maximal aerobic speed and speed associated to intermittent fitness test. Nine combinations of anaerobic speed reserve were calculated. Anaerobic speed reserve using 20 m (speed associate to maximum oxygen uptake = $2.01 \pm 0.59\,m{\cdot}s^{-1}$, maximal aerobic speed = $1.84 \pm 0.59\,m{\cdot}s^{-1}$, speed associated to intermittent fitness test = $2.09 \pm 0.46 m{\cdot}s^{-1}$) showed lower values when anaerobic speed reserve was determined with 30 m (speed associate to maximum oxygen uptake = $2.20 \pm 0.63 m{\cdot}s^{-1}$, maximal aerobic speed = $2.03 \pm 0.52\,m{\cdot}s^{-1}$, speed associated to intermittent fitness test = $2.28 \pm 0.51\,m{\cdot}s^{-1}$; $p = 0.009$) and 40 m (speed associate to maximum oxygen uptake = $2.21 \pm 0.60\,m{\cdot}s^{-1}$, maximal aerobic speed = $2.04 \pm 0.48 m{\cdot}s^{-1}$, speed associated to intermittent fitness test = $2.29 \pm 0.41\,m{\cdot}s^{-1}$; $p = 0.037$).
Conclusion. — Also, the methods presented concordance among maximal sprint speed tests and aerobic tests. This suggests the viability of different tests to evaluate anaerobic speed reserve, and sprint tests of at least 30 m are more suitable for calculating anaerobic speed reserve.

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Résumé

Introduction. — Cette étude visait à identifier les différences et les concordances entre la réserve de vitesse anaérobie calculée en tenant compte de différents tests de vitesse maximale de sprint et de capacité aérobie chez de jeunes athlètes féminines.

Synthèse des faits et résultats. — Dix joueuses de rugby (15,00 ± 0,21 ans) ont effectué des tests de sprint (20 m, 30 m et 40 m) pour mesurer la vitesse maximale de sprint et des tests aérobies pour mesurer la vitesse associée à la consommation maximale d'oxygène, la vitesse aérobie maximale et la vitesse associée à test de condition physique intermittent. Neuf combinaisons de réserve de vitesse anaérobie ont été calculées. Réserve de vitesse anaérobie utilisant 20 m (vitesse associée à la consommation maximale d'oxygène = 2,01 ± 0,59 $m{\cdot}s^{-1}$, vitesse maximale aérobie = 1,84 ± 0,59 $m{\cdot}s^{-1}$, vitesse associée au test de condition physique intermittent = 2,09 ± 0,46 $m{\cdot}s^{-1}$) ont montré des valeurs inférieures lorsque la réserve de vitesse anaérobie a été déterminée avec 30 m (vitesse associée à la consommation maximale d'oxygène = 2,20 ± 0,63 $m{\cdot}s^{-1}$, vitesse aérobie maximale = 2,03 ± 0,52 $m{\cdot}s^{-1}$, vitesse associée au test de condition physique intermittent = 2,28 ± 0,51 $m{\cdot}s^{-1}$; p = 0,009) et 40 m (vitesse associée à la consommation maximale d'oxygène = 2,21 ± 0,60 $m{\cdot}s^{-1}$, vitesse maximale aérobie = 2,04 ± 0,48 $m{\cdot}s^{-1}$, vitesse associée au test de condition physique intermittent = 2,29 ± 0,41 $m{\cdot}s^{-1}$; p = 0,037).

Conclusion. — De plus, les méthodes présentaient une concordance entre les tests de vitesse maximale de sprint et les tests aérobies. Cela suggère la viabilité de différents tests pour évaluer la réserve de vitesse anaérobie, et les tests de sprint d'au moins 30 m sont plus appropriés pour calculer la réserve de vitesse anaérobie.

1. Introduction

Among the different control variables to manipulate during the rugby training session, some allow a better individualization of the intensity, as maximal aerobic speed (MAS), the speed associated to the maximal oxygen uptake (vVO2max), maximal sprinting speed (MSS) and anaerobic speed reserve (ASR) [1]. Recently, ASR has been investigated in the literature, and it is calculated through the difference between MSS and MAS, and this variable allows the optimization and the individualization of training process according to the athlete's capacity. Indeed, a previous study demonstrated that changes in repeat sprints results are moderately related to vVO2max, MSS and ASR [2]. In this sense, the ASR could be a combination of MSS and MAS, and very useful for individualize exercise intensity. Broadly, tests to determine ASR are easy to apply; however, the standardization that determines which tests are the best for their determination are still unclear in the scientific literature. Therefore, this study aimed to identify differences and concordances among ASR combinations calculated by different methods.

2. Materials and methods

A randomized cross-sectional study was used to determine different ASR. As the dependent variable, the ASR was considered, while as independent variables, MSS and maximal aerobic speed (MAS) were measured. Aerobic fitness tests were conducted in different days separated by 48 hours. Sprint tests were conducted in the same session, separated by at least 5 minutes interval between them [3]. The participants were previously familiarized with the tests, and they performed 10-minute of warm-up, including mobility and running exercises.

Ten young female rugby players (age = 15.00 ± 0.21 years, height = 1.59 ± 0.64 cm and weight = 58.99 ± 8.30 kg) were enrolled in this study. The participants were in the development period in the sport, with experience of at least four months, and they participated in at least one rugby competition. Additionally, the athletes practice rugby regularly thrice a week, including tactical-technical and physical training. Athletes with musculoskeletal injuries or undergoing rehabilitation, with respiratory diseases, heart disease and those who did not complete all procedures were excluded. All participants read and signed the informed consent form, and the local ethics and research committee approved this study (protocol #2.243.675).

The sprint tests were carried out on the grass field, with rugby boots and game uniform, in which the participants were instructed to move at maximum speed from the first photocell (starting point) until they passed the second photocell (Multisprint, Hidrofit®, Brazil), according to with the different distances [3]. Three attempts for each distance (20 m, 30 m and 40 m) with static start were carried out. The best trial from each distance was considered for data analysis, and the MSS variable ($m{\cdot}s^{-1}$) was previously determined (test-retest of r = 0.89) [3].

The vVO2max was determined through incremental test on a treadmill (Kikos, KX9000, São Paulo, Brazil), with an initial speed of 7 $km{\cdot}h^{-1}$ and increments of 1 $km{\cdot}h^{-1}$ every 1 minute of effort completed, with end the test when the participant reaches exhaustion [4]. Concomitantly, gas exchange collection through an open circuit analyzer (VO2000, Medgraphics™, Minnesota, EUA) was conducted. The first speed at which the individual reaches the highest oxygen consumption plateau lasting 30 s was considered

Table 1 Concordance of Bland-Altman among aerobic tests.

Variables	Bias ± SD	Limits of Agreement (95%)
ASR 20—vVO2/ASR 20—MAS	0.600 ± 0.966	−1.294—2.494
ASR 20—vVO2/ASR 20—IFT	−0.300 ± 1.889	−4.002—3.402
ASR 20—MAS/ASR 20—IFT	−0.900 ± 1.595	−4.026—2.226
ASR 30—vVO2/ASR 30—MAS	0.600 ± 0.966	−1.294—2.494
ASR 30—vVO2/ASR 30—IFT	−0.300 ± 1.889	−4.002—3.402
ASR 30—MAS/ASR 30—IFT	−0.900 ± 1.595	−4.026—2.226
ASR 40—vVO2/ASR 40—MAS	0.600 ± 0.966	−1.294—2.494
ASR 40—vVO2/ASR 40—IFT	−0.300 ± 1.889	−4.002—3.402
ASR 40—MAS/ASR 40—IFT	−0.900 ± 1.595	−4.026—2.226

ARS: anaerobic reserve speed; vVO2max: speed associated with maximum oxygen consumption; MAS: maximum aerobic speed; IFT: Intermittent fitness test.

Table 2 Concordance of Bland-Altman among sprint tests.

Variables	Bias ± SD	Limits of Agreement (95%)
ASR 20—vVO2/ASR 30—vVO2	−0.709 ± 0.548	−1.784—0.365
ASR 20—vVO2/ASR 40—vVO2	−0.713 ± 0.724	−2.133—0.706
ASR 30—vVO2/ASR 40—vVO2	−0.004 ± 0.724	−1.423—1.415
ASR 20—MAS/ASR 30—MAS	−0.709 ± 0.548	−1.784—0.365
ASR 20—MAS/ASR 40—MAS	−0.713 ± 0.724	−2.133—0.706
ASR 30—MAS/ASR 40—MAS	−0.004 ± 0.724	−1.423—1.415
ASR 20—IFT/ASR 30—IFT	−0.709 ± 0.548	−1.784—0.365
ASR 20—IFT/ASR 40—IFT	−0.713 ± 0.724	−2.133—0.706
ASR 30—IFT/ASR 40—IFT	−0.713 ± 0.724	−2.133—0.706

ARS: anaerobic reserve speed; vVO2max: speed associated with maximum oxygen consumption; MAS: maximum aerobic speed; IFT: Intermittent fitness test.

a valid variable [4]. The MAS was obtained from the same incremental test, in which the last speed where the exhaustion was reached. Exhaustion was defined as an inability to maintain the speed determined or voluntary waiver.

The Intermittent Fitness Test (IFT) consists of a 30-second running with 15-second passive recovery on a field with a total distance of 40 m. The initial speed was 8 km·h^{-1}, and increases of 0.5 km·h^{-1} every 30 seconds of the stage were conducted [5]. The test ended when the participant was unable to maintain speed or failed to reach the 3-meter zone in the audio signal three consecutive times. Speed achieved during the last completed stage was recorded to determine IFT speed (vIFT) [5].

Data were described as mean and standard deviation (SD). ANOVA two-way with Bonferroni post-hoc was carried out to identify differences between ASR methods. Bland-Altman was conducted to observe concordances between the different combinations of ASR. The level of significance adopted was 5%.

3. Results

ASR values were calculated by the difference between MSS and MAS, found in different tests. The following ASR combinations were found: 20 m sprint and vVO2max = 2.01 ± 0.59 ,m·s^{-1}; 30 m sprint and vVO2max = 2.20 ± 0.63 m·s^{-1}; 40 m sprint and vVO2max = 2.21 ± 0.60 m·s^{-1}; 20 m sprint and MAS = 1.84 ± 0.59 ,m·s^{-1}; 30 m sprint and MAS = 2.03 ± 0.52 m·s^{-1}; 40 m sprint and MAS = 2.04 ± 0.48 m·s^{-1}; 20 m sprint and vIFT = 2.09 ± 0.46 m·s^{-1}; 30 m sprint and vIFT = 2.28 ± 0.51 m·s^{-1}; 40 m sprint and vIFT = 2.29 ± 0.41 m·s^{-1}.

Analysis of variance did not identify sprint distance vs aerobic test interactions ($F = 2.729$; $p = 0.124$) as well as differences between aerobic tests ($F = 3.246$; $p = 0.093$). However, differences between MSS were observed ($F = 8.442$; $p = 0.11$), with differences in ASR calculated using sprints of 20 and 30 m ($p = 0.009$), and 20 and 40 m ($p = 0.037$). Additionally, ASR performed with 30 and 40 m did not show significant differences ($p = 1.000$).

Tables 1 and 2 present bias, SD, and the limits of agreement (LoA) obtained through the Bland-Altman analysis of ASR data derived from different sprint and aerobic tests.

4. Discussion

This study aimed to identify differences and concordances among ASR with different evaluation methods. Highlights of the study include:

- the viability of different tests to evaluate ASR;
- information on reserve anaerobic speed values in young female athletes in development to clarify the scientific literature about crucial information for the long-term athlete development;

- the identification of reference values to assist rugby physical training planning.

Different aerobic tests to evaluate MAS are used for ASR determination in the literature. Related to sprint tests for MSS measurement, 30 m is commonly used in different studies [3,6]. Also, the present study observed that aerobic treadmill and field tests did not significantly influence the ASR. Given this, and as reinforced in the scientific context, for measuring maximal aerobic speeds, incremental field tests should be prioritized as they can minimize the bias of assessing aerobic fitness in athletes in field sports [7], as well as being better suited to the reality of team sports training, regarding the number of evaluations, practicality, and specificity. In the present study, the faster sprints were observed in young female rugby players, considering the acceleration phase. Acceleration and sprint speeds are essential for collective performance in terms of the number of options and opportunities in decision-making situations [8]. However, as observed in this study, the acceleration phase may underestimate the anaerobic reserve speed, and corroborating with the studies described in the literature, the sprint tests to assess maximum sprinting speed should start from 30 m.

The results of this study demonstrated necessary implications as to the most appropriate methods for assessing ASR. The manuscript supports the scientific literature suggesting that ASR identification can succeed through the integration of different aerobic and maximum speed tests. The use of MAS from treadmill or field test do not affect the ASR performance, however, professionals should to choose distances equal or higher than 30 m for MSS evaluation.

Disclosure of interest

The authors declare that they have no competing interest.

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