Running-based Anaerobic Sprint Test as a Procedure to Evaluate Anaerobic Power

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Key words
- maximal accumulated oxygen deficit
- anaerobic metabolism
- anaerobic performance
- maximal sprint

Abstract
The aim of this study was to evaluate the use of the running anaerobic sprint test (RAST) as a predictor of anaerobic capacity, compare it to the maximal accumulated oxygen deficit (MAOD) and to compare the RAST’s parameters with the parameters of 30-s all-out tethered running on a treadmill. 39 (17.0 ± 1.4 years) soccer players participated in this study. The participants underwent an incremental test, 10 submaximal efforts [50–95% of velocity correspondent to VO2MAX (vVO2MAX)] and one supramaximal effort at 110% of vVO2MAX for the determination of MAOD. Furthermore, the athletes performed the RAST. In the second stage the 30-s all-out tethered running was performed on a treadmill (30-s all-out), and compared with RAST. No significant correlation was observed between MAOD and RAST parameters. However, significant correlations were found between the power of the fifth effort (PS) of RAST with peak and mean power of 30-s all-out (r = 0.73 and 0.50; p < 0.05, respectively). In conclusion, the parameters from RAST do not reinforce the RAST as an evaluation method of anaerobic capacity, such as anaerobic power.

Introduction
In various sports, including soccer, the aerobic metabolism predominates during training and competitions. However, the most decisive skills, such as jumping, kicking and tackling, are related to high-intensity and short-duration efforts, which places high demands on the anaerobic systems (i.e., alactic and lactic) during soccer play [34]. Thus, parameters related to the anaerobic capacity (i.e., the total amount of energy that can be resynthesized by anaerobic metabolism) and anaerobic power (i.e., maximum amount of anaerobic energy produced per unit of time) should be measured in order to monitor the athletes’ training status [12]. Despite the criticisms about the maximum accumulated oxygen deficit (MAOD) [2, 8, 24, 27], this method has been considered the most accepted to measure anaerobic capacity [8, 13, 22, 26, 28]. Thus, the use of MAOD to measure anaerobic capacity in the sports training routine is hampered due to the high number of exercise sessions required for its determination [1, 2]. In addition, the MAOD determination requires a gas analyzer that demands a high financial investment and trained personnel to operate it. Based on these limitations, it is necessary to standardize methods of low cost and easy application to estimate the anaerobic capacity in sports modalities. Some studies have showed a significant association between the parameters determined by the Wingate anaerobic test (WAnT) and anaerobic capacity estimated by MAOD [25, 32]. Some authors have assumed that the total work [35], the average power [25, 35] and the fatigue index performed during WAnT [25, 35] can be used to estimate anaerobic capacity [25]. However, in order to respect the specificity principle, the WAnT should be applied in sports modalities that include cycling, but it is not a good procedure to mimic the exercise pattern performed in running. On the other hand, the running-based anaerobic sprint test (RAST) [38] is an evaluation that respects the specificity principle when we consider the collective and individual sports modalities.

Thus, the use of MAOD to measure anaerobic capacity in the sports training routine is hampered due to the high number of exercise sessions required for its determination [1, 2]. In addition, the MAOD determination requires a gas analyzer that demands a high financial investment and trained personnel to operate it. Based on these limitations, it is necessary to standardize methods of low cost and easy application to estimate the anaerobic capacity in sports modalities. Some studies have showed a significant association between the parameters determined by the Wingate anaerobic test (WAnT) and anaerobic capacity estimated by MAOD [25, 32]. Some authors have assumed that the total work [35], the average power [25, 35] and the fatigue index performed during WAnT [25, 35] can be used to estimate anaerobic capacity [25]. However, in order to respect the specificity principle, the WAnT should be applied in sports modalities that include cycling, but it is not a good procedure to mimic the exercise pattern performed in running. On the other hand, the running-based anaerobic sprint test (RAST) [38] is an evaluation that respects the specificity principle when we consider the collective and individual sports modalities.
ties that use running as the main activity [38]. Although the RAST was an adaptation of WAnT to running [38], significant differences were observed between the parameters obtained by these methodologies [15, 38]. These results can be explained by the differences in motor pattern in efforts applied during RAST and WAnT [15, 38]. The current literature demonstrates that RAST is a reliable test [6, 38] and can be used to predict performance in short-distance races (35–400 m) [38], but in order to state that this methodology is a good tool for anaerobic power assessment, its parameters should be compared with a running test (e.g., 30-s all-out tethered running [39]). In contrast, Kaminagakura et al. [14] did not find any correlation between MAOD and RAST in runners, indicating that perhaps the RAST is not a good method for assessing anaerobic capacity. However, these authors used only 4 submaximal exercise bouts to determine MAOD, which is considered inappropriate according Noordhof et al. [26]. In addition, the use of MAOD relative to active mass is considered better to verify the associations with the anaerobic performance/parameters obtained in other evaluations [25] and will result in more robust findings.

Considering the previously mentioned limitations, the main aims of the present investigation were to verify the association between the RAST parameters (i.e., peak power, mean power, and fatigue index) with MAOD determined according to Noordhof et al. [26] and to compare the RAST’s parameters with the parameters of 30-s all-out tethered running on a treadmill. In addition, as suggested by Minahan et al. [25], the MAOD was presented in absolute values and relative to body mass and fat-free mass.

Materials & Methods

Participants and design

39 male soccer players from the under-20 category participated in this study. All the athletes had at least 2 years of systematic training and participated in state and national competitions. All procedures were approved by the University’s Institutional Review Board for Human Subjects (Human Research Ethics Committee) and were conducted according to the Declaration of Helsinki. Athletes and their parents, when pertinent, were informed about experimental procedures and risks, and signed an informed consent before their participation in the study. This study was performed in accordance with the ethical standards of this journal [11].

Experimental procedures

The experimental procedures were performed in 2 stages. The first stage aimed to verify the association of RAST parameters with MAOD, while the second stage aimed to compare the RAST with 30-s all-out tethered running on a treadmill. Different groups of subjects performed these stages (characteristics demonstrated in results section). The first stage (Group 1; n = 29) of the study lasted 8 days, with a minimum interval of 24 h between each test. During the evaluation period before the determination of MAOD, on the first day participants underwent a graded exercise test (GXT) to measure minimal velocity at which maximal oxygen consumption was attained (\(\text{VO}_{2\text{MAX}}\)). From the second to the sixth day, the athletes performed 10 submaximal efforts (50–95% \(\text{VO}_{2\text{MAX}}\)) and one supramaximal effort corresponding to 110% of \(\text{VO}_{2\text{MAX}}\) in order to determine MAOD. It is important to point out that besides the 10 submaximal exercise bouts, we used a fixed value of the y-intercept (5.1 ml·kg\(^{-1}\)·min\(^{-1}\)) for the construction of a robust \(\text{VO}_2\)-velocity relationship in order to increase the valid and reliable results of MAOD determination [26]. For the RAST, all athletes performed 6 maximal efforts of 35 m separated by 10-s intervals. On day 7, all participants were adapted to RAST. On day 8, all participants underwent a RAST for correlation analysis with MAOD. All 29 subjects completed all procedures involved in determining the MAOD and RAST. The second stage (Group 2; n = 10) lasted 6 days, the first 2 days of which were used to familiarize subjects with and apply RAST, while from the third day onwards the 30-s all-out was performed. All 10 subjects completed all procedures involved in determining the RAST and 30-s all-out.

The interval between the first and second stage of study was around 2 months.

Estimation of body composition

The body composition was estimated by a DEXA scanner (Lunar DPX-NT; General Electric Healthcare, Little Chalfont, Buckinghamshire) using the ENCORE® software, version 12.20.023. The subjects remained in a supine position throughout the scan, wearing light clothing while lying down with arms at their sides, without moving during the measurement. The percent of body fat (%BF) and total fat-free mass (FFM) was calculated automatically by the DEXA. Lower limbs fat-free mass (LLFFM) was assumed as the active fat-free mass [25]. For this, the lower limits were defined as an upper limit represented by a horizontal line between the femur and the tibia, a lower limit represented by the horizontal line through the tibio-talar articulation, and lateral limits were considered the outer sides of leg sections. All data were collected by trained staff as described by Lohman et al. [19]. All measurements were made at the laboratory of the University, in a room with controlled temperature. Each morning, before the beginning of the measurements, the DEXA equipment was calibrated by the same researcher according to the references provided by the manufacturer.

Cardiac and respiratory variables

The submaximal and supramaximal efforts used to determine MAOD were performed on a running treadmill and the respiratory and ventilatory variables were monitored by breath by using the metabolic analyzer True-One 2400 (ParvoMedics, East Sandy, Utah, USA). The gas analyzer was calibrated before each effort using known gas samples (15.09% \(\text{O}_2\), 6.01% \(\text{CO}_2\)) and the spirometer was calibrated according to the manufacturer’s specifications using a 3 L syringe (Hans Rudolf 5530). The respiratory and ventilatory data were smoothed to remove the outliers points and then interpolated to obtain values for each second using OriginPro 8.0 software (OriginLab Corporation, Microcal, Massachusetts, USA). In addition, during all efforts the heart rate was monitored continuously (Polar Electro Oy, Kempele, Finland) using an interface with the gas analyzer (True-One system – ParvoMedics, East Sandy, Utah, USA).

Graded exercise test (GXT)

The graded exercise test was performed to measure maximal oxygen consumption (\(\text{VO}_{2\text{MAX}}\)) and \(\text{vVO}_{2\text{MAX}}\). The initial velocity corresponded to 9 km·h\(^{-1}\) and increments of 1 km·h\(^{-1}\) were performed every 2 min until voluntary exhaustion. \(\text{VO}_{2\text{MAX}}\) was defined as the highest average \(\text{VO}_2\) over the last 30s of the test, considering at least 3 criteria: Blood lactate ≥ 8.0 mM; heart rate (HR) ≥ age-predicted HR maximal (220–age); respiratory exchange
ratio (RER) ≥ 1.10; and VO\textsubscript{2} plateau (VO\textsubscript{2} change ≤ 2.1 mL·kg\textsuperscript{-1}·m\textsuperscript{-1} between the 2 last exercise stages). The vVO\textsubscript{2MAX} was considered the lowest velocity in which VO\textsubscript{2MAX} was achieved.

Maximal accumulated oxygen deficit (MAOD)

10 submaximal efforts of 7 min each were performed at intensities between 50 and 95 % of vVO\textsubscript{2MAX} [26]. In each evaluation session, 2 submaximal efforts were performed with a recovery of 15 min to allow return of VO\textsubscript{2} to resting levels. The mean VO\textsubscript{2} during the last minute of each bout was assumed as the steady-state VO\textsubscript{2} for the corresponding velocity and was used for the construction of the velocity-VO\textsubscript{2} relationship. In addition, the athletes performed a supramaximal effort corresponding to 110% of the vVO\textsubscript{2MAX} to measure the time to exhaustion (tlim) and the VO\textsubscript{2} during a supramaximal exercise.

A linear regression was constructed based on the velocity-VO\textsubscript{2} relationship to estimate the oxygen demand to 110% of the vVO\textsubscript{2MAX} (D\textsubscript{T}) using 10 submaximal bouts. The linear regression was constructed fixing the y-intercept at 5.1 mL·kg\textsuperscript{-1}·min\textsuperscript{-1} [22,26]. MAOD was taken as the difference between the area of D\textsubscript{T} (estimated by the product between the D\textsubscript{T} by the tlim) and the integral of VO\textsubscript{2} observed throughout the exercise performed at 110% of vVO\textsubscript{2MAX}.

30-s Maximal tethered running on a treadmill (30-s all-out)

In the determination of peak power (PP), mean power (MP) and fatigue index (FI) in 30-s all-out tethered running (30-s all-out), the protocol proposed by Zemková & Hamar [39] was adapted. This protocol consists of a period of 30-s all-out tethered running on a treadmill at a velocity of 13 km·h\textsuperscript{-1}. During the session on the treadmill, the subjects, in addition to running, had to pull a rope attached by means of a belt to the waist and anchored to the wall behind the device. A simple computer-based system consisting of a strain gauge and AD converter was employed to register the horizontal drag force, running velocity and to calculate the power. From the raw data sampled at 400 Hz, 5-s-interval values were calculated to plot the power/time charts. The PP was assumed to be the mean force of the initial 5-s period, MP was obtained using the average value calculated from the entire 30-s test, and FI was determined as the ratio of power decline (%).

Running anaerobic sprint test (RAST)

The RAST consisted of 6 maximal efforts of 35 m, separated by a passive recovery period of 10s. The time of each effort of 35 m was recorded using a system of photocells (CEFISE\textsuperscript{®}, Nova Odessa, Brazil) located at the beginning and at the end of the 35 m.

Using the time of each effort, it was possible to determine the power (P) in each effort (P = total body mass × distance\textsuperscript{3}/time\textsuperscript{2}) [38]. As variables of RAST, the peak power (PP), defined as the greater power achieved among the 6 efforts, the mean power (MP), defined as mean power among the 6 efforts, and minimum power (Pmin), defined as minimum power achieved among the 6 efforts, were determined and shown in units relative to body mass (PP\textsubscript{REL}, MP\textsubscript{REL}, Pmin\textsubscript{REL}) and absolute values (PP\textsubscript{ABS}, MP\textsubscript{ABS}, Pmin\textsubscript{ABS}), as well as the fatigue index (FI) [FI (%) = ((PP – Pmin)/PP) × 100].

All efforts were performed on a football field, with participants wearing soccer shoes. Blood samples were taken from the earlobes in 25-μL heparinized capillary tubes after the sixth effort of RAST and monitored at minutes 1, 3, 5, and 7 to determine the lactate peak concentrations ([LAC\textsubscript{PEAK}] using a lactate analyzer (YSI 1500 Sport, Yellow Spring Instruments, Ohio, USA).

Statistical treatment

The Shapiro-Wilk test was used to test the normality of data. The descriptive results are presented as mean ± standard deviation and the 95 % confidence intervals (95 % CI). In the first stage, the correlations between RAST variables with MAOD variables, absolute and related to fat-free mass and lower-limb fat-free mass were analyzed using the Pearson product-moment correlation coefficient. In the second stage of study, the comparison between the parameters from the RAST from the 30-s all-out were compared using the paired t test, while the Pearson product-moment test was used to verify the association between them. For both study stages, the correlation coefficients (r) were also classified as very weak (0.0–0.2), weak (0.2–0.4), moderate (0.4–0.7), strong (0.7–0.9) or very strong (0.9–1.0) [30]. All analyses were performed using the statistical package STATISTICA 7 (Statsoft, USA) and the level of significance was set at 5 %.

Results

First stage (Group 1)

Table 1 summarizes the physical characteristics of the subjects and the values measured during the graded exercise test. At all submaximal intensities, the oxygen consumption remained stable in the last minute and the linear coefficient obtained from the relationship between intensity and steady-state of O\textsubscript{2} was 0.94 ± 0.04 L·min\textsuperscript{-1}·km·h\textsuperscript{-1}. The tlim was 233.2 ± 87 s in the effort corresponding to 110% of vVO\textsubscript{2MAX} (16.4 ± 1.3 km·h\textsuperscript{-1}) and the oxygen consumption observed in the last minute of this effort (51.0 ± 5.5 mL·kg\textsuperscript{-1}·min\textsuperscript{-1}) was not statistically different from the VO\textsubscript{2MAX} obtained in the incremental test (51.1 ± 5.1 mL·kg\textsuperscript{-1}·min\textsuperscript{-1}).

The parameters from RAST and MAOD were expressed in absolute values and relative to body weight (BW), FFM, and LLFFM. MAOD values are shown in Table 2 and RAST values in Table 3.

Table 4 shows the correlation coefficients obtained between the variables from the running anaerobic sprint test (RAST) and the maximum accumulated oxygen deficit (MAOD). Only the [LAC\textsubscript{PEAK}] obtained after the sixth effort of RAST presented a significant but moderate correlation with the absolute MAOD.
Table 2: Values of the maximum accumulated oxygen deficit (MAOD) expressed in absolute (L) terms, and relative to body weight (MAODBW), total fat-free mass (MAODFFM) and active lean mass (MAODLLFFM) (n = 29).

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>SD</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAOD</td>
<td>3.2</td>
<td>0.7</td>
<td>2.8–3.4</td>
</tr>
<tr>
<td>MAODBW (mL·kg⁻¹)</td>
<td>43.5</td>
<td>9.8</td>
<td>39.7–47.3</td>
</tr>
<tr>
<td>MAODFFM (mL·FFM⁻¹)</td>
<td>55.4</td>
<td>13.7</td>
<td>49.9–60.8</td>
</tr>
<tr>
<td>MAODLLFFM (mL·LLFFM⁻¹)</td>
<td>146.9</td>
<td>38.5</td>
<td>131.6–162.1</td>
</tr>
</tbody>
</table>

Table 3: Values of variables from RAST expressed in absolute (W) terms, and relative to body weight (W·kg⁻¹), total fat-free mass (W·FFM⁻¹) and lower-limb fat-free mass (W·LLFFM⁻¹) (n = 29).

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>SD</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peak Power (W)</td>
<td>723.7</td>
<td>134.0</td>
<td>668.3–778.9</td>
</tr>
<tr>
<td>W·kg⁻¹</td>
<td>9.8</td>
<td>1.5</td>
<td>9.1–10.3</td>
</tr>
<tr>
<td>W·FFM⁻¹</td>
<td>12.4</td>
<td>1.7</td>
<td>11.6–13.1</td>
</tr>
<tr>
<td>W·LLFFM⁻¹</td>
<td>32.9</td>
<td>5.2</td>
<td>30.6–35.0</td>
</tr>
<tr>
<td>Mean Power (W)</td>
<td>562.4</td>
<td>95.9</td>
<td>522.8–601.9</td>
</tr>
<tr>
<td>W·kg⁻¹</td>
<td>7.6</td>
<td>1.1</td>
<td>7.1–7.9</td>
</tr>
<tr>
<td>W·FFM⁻¹</td>
<td>9.6</td>
<td>1.1</td>
<td>9.1–10.1</td>
</tr>
<tr>
<td>W·LLFFM⁻¹</td>
<td>25.5</td>
<td>4.0</td>
<td>24.0–27.0</td>
</tr>
<tr>
<td>Fast Speed (m·s⁻¹)</td>
<td>7.0</td>
<td>0.4</td>
<td>6.8–7.1</td>
</tr>
<tr>
<td>Mean Speed (m·s⁻¹)</td>
<td>6.4</td>
<td>0.3</td>
<td>6.2–6.4</td>
</tr>
<tr>
<td>FI (%)</td>
<td>39.6</td>
<td>8.7</td>
<td>36.0–43.2</td>
</tr>
<tr>
<td>Total Time (s)</td>
<td>31.3</td>
<td>3.1</td>
<td>30.0–32.6</td>
</tr>
<tr>
<td>Minimum Time Per Run (s)</td>
<td>5.0</td>
<td>0.3</td>
<td>4.9–5.1</td>
</tr>
<tr>
<td>Mean Time Per Run (s)</td>
<td>5.5</td>
<td>0.2</td>
<td>5.4–5.5</td>
</tr>
</tbody>
</table>
| FI: fatigue index; [LAC]PEAK: lactate concentrations peak

Second stage (Group 2)

Table 5 summarizes the physical characteristics of the subjects in the second group.

Table 6 shows that the peak power and mean power from RAST were statistically higher than 30-s all-out while the fatigue index (FI) on 30-s all-out was statistically higher.

The correlation coefficient between RAST parameters and 30-s all-out tethered running on a treadmill (and significant correlation with mean power on 30-s all-out). When the analysis was done using values relative to body mass, moderate significant correlations were found between the variables from the running anaerobic sprint test (RAST) and the maximum accumulated oxygen deficit (MAOD) (n = 29).

Table 4: Correlation coefficients obtained between the variables from the running anaerobic sprint test (RAST) and the maximum accumulated oxygen deficit (MAOD) (n = 29).

<table>
<thead>
<tr>
<th></th>
<th>MAOD</th>
<th>MAOD_bw</th>
<th>MAOD_FF</th>
<th>MAOD_LFF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peak Power</td>
<td>0.13</td>
<td>−0.25</td>
<td>−0.19</td>
<td>−0.13</td>
</tr>
<tr>
<td>W·kg⁻¹</td>
<td>−0.13</td>
<td>−0.20</td>
<td>−0.25</td>
<td>−0.22</td>
</tr>
<tr>
<td>W·FFM⁻¹</td>
<td>0.10</td>
<td>−0.09</td>
<td>−0.03</td>
<td>0.00</td>
</tr>
<tr>
<td>W·LLFFM⁻¹</td>
<td>0.21</td>
<td>0.00</td>
<td>0.06</td>
<td>0.19</td>
</tr>
</tbody>
</table>

Table 5: Physical characteristics of the subjects in the second stage group 2 (n = 10).

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>SD</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (yr)</td>
<td>18.6</td>
<td>0.96</td>
<td>17.9–19.3</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>169.7</td>
<td>4.21</td>
<td>169.7–166.6</td>
</tr>
<tr>
<td>Body mass (kg)</td>
<td>64.0</td>
<td>8.10</td>
<td>58.3–69.8</td>
</tr>
</tbody>
</table>

Discussion

The main finding of the present investigation was that despite that the RAST does not present significant correlations with the variables of MAOD, it does present outcomes significantly higher than 30-s all-out tethered running on a treadmill (and significant correlation with mean power on 30-s all-out).

In comparison with Kaminagamurap's et al. [14] investigation the main advances of the present study were the determination of MAOD according to the suggestions of Noordhof et al. [26], and the presentation of both RAST and MAOD results expressed by the athletes’ body composition. In addition, our study was conducted in 2 stages with 2 groups of subjects to verify the correlation of RAST with anaerobic capacity represented by MAOD (i.e., first stage) while the second stage compared and correlated the RAST parameters with anaerobic power estimated using the 30-s all-out tethered running on a treadmill.

The relations between the indices of anaerobic power and anaerobic capacity in the literature are contradictory [31, 32]. The discrepancies between these findings may be explained by different methodologies involved in the determination of MAOD. In this sense, Medbo et al. [22] advocated 10–20 submaximal efforts for the construction of the linear relationship between capacity and anaerobic power parameters. Thus, in order to determine MAOD in the present investigation, the linear adjustment to estimate energy demand in supra maximal intensities. Thus, the use of fewer than 10 submaximal loads [25, 32] may influence the values of MAOD and consequently the relationship between capacity and anaerobic power parameters. Furthermore, the use of athletes submitted to different regimens of training (e.g., sprinters vs. runners) and the use of different ergometers [32] are also considered factors that may influence the relationship between power and anaerobic capacity parameters [25]. In this regard, as in the study of Minahan et al. [25], both MAOD and the variables from RAST were normalized according to the characteristics of body composition of individuals. In addition, in order to diminish the inter-individual differences and the possible influences of the training state, we only...
included athletes who were in the beginning of the season in the analyses.

The anaerobic power (i.e., maximum amount of anaerobic energy produced per unit of time) and the anaerobic capacity (i.e., the total amount of energy that can be resynthesized by anaerobic metabolism) are considered different physiological variables that may be related [21, 32].

The findings of the first stage of the present study demonstrate a significant but moderate correlation only between MAOD and \([\text{LAC}]_{\text{PEAK}}\) after the RAST. These elements must be interpreted with caution, given that the same did not occur with the relative values of MAOD (\(\text{mL} \cdot \text{kg}^{-1} \cdot \text{FFM}\) and \(\text{mL} \cdot \text{LLFFM}^{-1}\)). The \([\text{LAC}]_{\text{PEAK}}\) found after performing the RAST is indicative of an increased share of such metabolism during efforts. There is also the possibility of high participation of anaerobic glycolytic metabolism. There is also the possibility of high participation of anaerobic glycolytic metabolism during efforts. There is also the possibility of high participation of anaerobic glycolytic metabolism during subsequent efforts [8, 14]. Thus, the relative values of MAOD, when correlated with \([\text{LAC}]_{\text{PEAK}}\), a non-correlation probably does not reflect actual physiological conditions [27].

Another finding was that the PP, determined by means of WAnT, and MAOD determined on a treadmill. However, Minahan et al. [25] evaluated active individuals (7 men and 7 women) on a cycle ergometer and did not observe significant correlations between PP and MAOD even when variables were expressed in relation to individual characteristics (BW, FFM, and LLFFM). It is important to point out that the authors controlled the influence of gender in this investigation [25]. Thus, in accordance with Minahan’s [25] study, the PP determined using the RAST was not related with the anaerobic capacity (i.e., MAOD). Therefore, a lack of significant correlation between PP and MAOD would be expected even though both represent parameters from the anaerobic energy systems (i.e., anaerobic power vs anaerobic capacity, respectively).

In addition to PP, MP expressed in absolute and relative values (BW, FFM, and LLFFM) did not present significant correlation with MAOD in the present investigation. When measured during the WAnT, the MP expressed in absolute values presented significant correlation with MAOD [25] and was related to the amount of anaerobic energy required to perform the 30-s of WAnT [5]. However, the use of this variable to estimate the anaerobic contribution has been discussed mainly due to the duration of WAnT, and the aerobic contribution to perform this effort is usually not considered [21, 25, 33]. In this sense, the total time performed during RAST (31.5 ± 3.1 s) may have been sufficient for a significant depletion of the anaerobic supplies as well as in WAnT [23]. Furthermore, by the intermittent characteristic, the aerobic contribution in RAST is probably superior to WAnT, especially due to the fact that during the periods of passive recovery (i.e., 10 s) between the efforts, the oxygen consumption can be high to remove the metabolites as intracellular inorganic phosphate and lactate, as well as for phosphocreatine resynthesis and oxygen supply for myoglobin [9]. Thus, the correlations between MP, measured by RAST, and MAOD may have been influenced by the total duration of RAST and by the aerobic contribution involved in this methodology, precluding the use of MP and RAST as predictors of anaerobic capacity.
The findings of the second stage of the study, the higher values on RAST than 30-s all-out associated with significant correlation between peak power and mean power of RAST with mean power of 30-s all-out, reinforce the use of RAST as an anaerobic procedure. However, as the 30-s all-out procedure was performed without interval recovery while the RAST was performed with 10s of recovery between each run, this probably affected some correlations between RAST and 30-s all-out such as the peak power, resulting in a physiological recovery during the interval periods and allowing a higher power output during RAST efforts. Based on the data of the present investigation, we can conclude that the parameters from RAST should not be used to evaluate anaerobic capacity but should be used to evaluate anaerobic power in soccer players. To measure anaerobic capacity, a longer test would be better (60–120s) where the anaerobic lactic energy system can be stressed to its maximum.

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Affiliations

References


