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DO CAN THE RUNNING-BASED ANAEROBIC SPRINT TEST (RAST) BE USED TO ASSESS ANAEROBIC PERFORMANCE FOR AMPUTEE FOOTBALL PLAYERS? A PRELIMINARY STUDY

O RUNNING-BASED ANAEROBIC SPRINT TEST (RAST) PODE SER USADO PARA AVALIAR O DESEMPENHO ANAERÓBIO DE JOGADORES DE FUTEBOL AMPUTADOS? UM ESTUDO PRELIMINAR

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O RUNNING-BASED ANAEROBIC SPRINT TEST (RAST) PODE SER USADO PARA AVALIAR O DESEMPENHO ANAERÓBIO DE JOGADORES DE FUTEBOL AMPUTADOS? UM ESTUDO PRELIMINAR

RESUMO

Introdução: O futebol para amputados é um esporte intermitente de alta intensidade que exige altos níveis de produção de energia anaeróbica.

Objetivo: Testar se o Running-based Anaerobic Sprint Test (RAST) pode avaliar o desempenho anaeróbio de jogadores de futebol amputados.

Metodologia: Participaram seis jogadores de futebol amputados do sexo masculino (idade: 28±4 anos; estatura: 1,68±0,09 cm; massa corporal: 76,7±10,2 kg; percentual de gordura: 15,6±9,9%; 01 zagueiro, 03 meio-campistas e 02 atacantes) com amputação unilateral de membro inferior. Todos os participantes foram submetidos a avaliações antropométricas e a duas sessões experimentais separadas por 1 semana. No primeiro dia foi realizada a caracterização do participante, seguida de atividade preparatória, realização do WanT e familiarização com o teste RAST. No segundo dia, foram realizadas atividades preparatórias e o RAST. As variáveis de resultado incluíram o pico de potência (PPO), a potência média (MPO), tanto absoluta quanto relativa, e o índice de fadiga (FI). A confiabilidade foi avaliada por meio de regressão, correlação de Pearson e coeficientes de correlação intraclasse. A concordância entre os índices WanT e RAST foi analisada com o método de Bland-Altman. As confiabilidades absolutas e relativas foram examinadas usando o erro padrão de medição, mínima mudança válida importante e a mudança mínima detectável. As diferenças entre os índices WanT e RAST foram avaliadas usando a média, o intervalo de confiança de 90%, o teste t pareado e os tamanhos de efeito.

Resultados: Os nossos resultados indicam que o RAST teste é confiável na avaliação dos índices de potência média (MPO) e MPO relativa (rMPO). O MPO e o rMPO do RAST foram responsáveis por mais de 59,6% da variância no WanT. Estes resultados sugerem que o RAST é adequado para avaliar o desempenho anaeróbio de jogadores de futebol amputados.

Conclusão: Sugerimos que o RAST é adequado para testar o desempenho anaeróbio em jogadores de futebol amputados.

Palavras-chave: Para-desporto. Para-futebol. Testes de Campo

CAN THE RUNNING-BASED ANAEROBIC SPRINT TEST (RAST) BE USED TO ASSESS ANAEROBIC PERFORMANCE FOR AMPUTEE FOOTBALL PLAYERS? A PRELIMINARY STUDY

ABSTRACT

Introduction: Amputee football is an intermittently high-intensity modality that demands high levels of anaerobic energy production.

Objective: The purpose of this study was to test whether the Running-based Anaerobic Sprint Test (RAST) can assess the anaerobic performance of amputee football players.

Methodology: Six male amputee football players (age: 28±4 years; height: 1.68±0.09 cm; body mass: 76.7±10.2 kg; fat mass percentage: 15.6±9.9%; 01 defenders, 03 midfielders, and 02 forwards) with unilateral lower limb amputation participated in this study. All participants experienced anthropometric evaluations and two experimental sessions separated by 1 week. On the first day, the participants were characterized, followed by preparatory activity, performance of the Wingate Anaerobic Test (WanT), and familiarization with the RAST test. On the second day, preparatory activities and the RAST were conducted. The outcome variables included peak power output (PPO), mean power output (MPO), both absolute and relative, and the fatigue index (FI). Reliability was assessed via regression, Pearson's correlation, and intraclass correlation coefficients. Agreement between WanT and RAST indices was analyzed with the Bland-Altman method. Absolute and relative reliabilities were examined using standard error of measurement, smallest worthwhile change, and minimal detectable change. Differences between WanT and RAST indices were assessed using mean, 90% confidence interval, paired t-test, and effect sizes.

Results: Our results indicate that the test is reliable for the MPO and relative MPO indices. The MPO and rMPO of the RAST were responsible for more than 59.6% of the variance in the WanT. These findings suggest that the RAST is adequate for assessing the anaerobic performance of amputee football players.

Conclusion: We suggest that the RAST is a suitable tool for assessing anaerobic performance in amputee football players.

Keywords: Parasports. Para-Footballers. Field Tests.

1. INTRODUCTION

Amputee football is one of the fastest-growing disabled sports globally. Matches are divided into two 25-minute periods, characterizing a sport with a predominance of aerobic metabolism[1-3]. However, during practice, amputee football players are subjected to various high-intensity, short-duration situations in which they arrive sooner or jump higher than their opponents or win possession of the ball[2]. The exigencies of amputee football necessitate a rigorous reliance on anaerobic metabolism, both alactic and lactic[4, 5]. Given the substantial contribution of anaerobic processes, precise measurement of this component is indispensable for effectively monitoring the training status of amputee football players.

In this context, the Wingate test (WAnT) is the most widely used and well-known test for assessing anaerobic performance. The WAnT lasts 30 s and uses an external load based on the individual's body mass[6]. This test provides information regarding peak power, mean power, and fatigue index[6]. Although the WAnT is considered a valid and accurate test for assessing anaerobic performance, the main limitation of applying the WAnT in amputee football is that it does not respect the sport's ecological validity. One of the alternatives to solve this issue is the use of indirect methods to measure anaerobic performance, such as the Repeated Sprint Ability Test[7], and Running-based Anaerobic Sprint Test (RAST)[8].

The RAST is akin to the WanT in that it furnishes coaches with assessments of their anaerobic performance. The RAST was developed by Draper and Whyte[9] to evaluate anaerobic performance. This test consists of performing six maximal efforts with a fixed distance interspersed by a 10s passive recovery period. RAST is extensively used in several sports, such as soccer, basketball, hockey, cycling, football, sprint events, middle-distance runners, and volleyball. In general, RAST is a valid method for assessing the anaerobic performance of several age groups and sports[8].

Studies over the past two decades have provided important information about the use of RAST in disabled sports. Campos et al.[10] used the RAST to evaluate the anaerobic parameters of para-athletes of a Brazilian blind football team. However, Weber et al.[11] showed that the RAST underestimated the anaerobic power of wheelchair basketball players. Based on the RAST procedure, the Muscle Power Sprint Test (MPST) was developed to measure the short-term muscle power of children with cerebral palsy[12]. The anaerobic power and capacity of the Belgian wheelchair rugby squad were assessed using an adapted version of the MPST and RAST[12]. While research has been performed of blind football, wheelchair basketball, and wheelchair rugby, no studies have investigated whether the RAST can reliably evaluate the anaerobic performance of amputee football players. The RAST, owing to its intermittent characteristics, seems to be better suited for assessing amputee football players. Thus, our study aimed to test whether RAST is a useful tool for assessing the anaerobic performance of amputee football players. We hypothesized that the RAST would reliably provide stable test scores of the anaerobic performance of amputee football players.

2. METHODS

2.1 Participants

Six male amputee football players (age: 28±4 years; height: 1.68±0.09 cm; body mass: 76.7±10.2 kg; fat mass percentage: 15.6±9.9%; 01 defenders, 03 midfielders, and 02 forwards) with unilateral lower limb amputation (transfemoral, n = 4; transtibial, n = 2) participated in this study. All participants were involved in national and international competitions and affiliated with the Disability Sport Brazilian Association. We adopted the following inclusion criteria for the study: a) having at least 6 months of continuous training in amputee football (specific experience); b) over 18 years of age; and c) involvement in amputee football competitions. The participants had a mean 2.3±1.8 years of experience. None reported any current or ongoing neuromuscular diseases or musculoskeletal injuries, and none were taking any dietary or performance supplements that might be expected to affect their performance during the study. All athletes were in the preparatory period phase of periodization.

This study was approved by the local ethics committee (no. 3.654.572). Initially, the goals and procedures of the study were presented to the Board of the Disability Sport Brazilian Association. After the study received the Board's approval, information regarding the study was presented to the coach and athletes. Participation was voluntary and anonymous, and all athletes signed an informed consent form.

2.2 Design

All participants underwent anthropometric evaluations and two experimental sessions separated by 1 week (08:30—11:30 am). The participants were asked not to drink alcoholic and caffeinated beverages, not to practice intense physical activity in the 24 h prior to the test, and to urinate 30 min before the evaluation procedures. On the first day, the participant was characterized, followed by preparatory activity, performance of the WanT, and familiarization with the RAST test. On the second day, preparatory activity and the RAST were performed.

2.3 Wingate Anaerobic Test (WanT)

WanT is performed on a cycle ergometer (upper limbs) at maximal effort for 30 s [6]. The test is used in the laboratory to measure an individual's anaerobic capacity and anaerobic power output. Prior to the WanT, the participants performed dynamic stretching of the shoulder joint, pectoral, biceps, triceps, and forearm muscles. After stretching, the participants cycled (using the upper limbs) for 3–5 min. At the end of each minute, the participants performed maximal sprints. The participants started the WanT after a 5-min rest from the previous activities. Each participant performed the test without a load. The WanT was performed using an EB 4100 cycle ergometer for the upper limbs (Cefise, Brazil). The peak power output (PPO) and mean power output (MPO) measured in watts (W), relative PPO (rPPO; W.Kg-1), relative MPO (rMPO; W.Kg-1), and fatigue index (FI; %) were the outcome variables.

2.4 Running Anaerobic Sprint Test (RAST)

The RAST was developed to measure anaerobic power and capacity in the field [9]. The original test involved six sprints over a 35-m distance, with a 10-s recovery between sprints. In this study, we used the sprints protocol adapted from the RAST, in other words, six sprints with 10-s intervals over a 20-m-long horizontal line. Before the RAST, the participants performed a preparatory activity consisting of stretching exercises for the shoulder joint, pectoral muscles, and muscles of the biceps, triceps, and forearms and 5 min of low-intensity running and walking. Next, the participants performed the adapted RAST, consisting of six 20-m maximal runs interspersed with a 10-s passive recovery period. The time was recorded at each run using the Speed Test 6.0 photocell system (Cefise, Brazil). The power of each sprint was determined by measuring the time, distance, and body mass of each participant [Power = (Body mass*Distance^2)/ Time^3]. We used the same variables from the WanT in the RAST to compare the test results.

2.5 Statistical analysis

Data are presented as mean, standard deviation (SD), and 95% confidence interval (95% CI). The relative reliability was assessed using the regression model (method: stepwise; independent variable: WAnT indices), Pearson's correlation coefficient (r), and intraclass correlation coefficient (reliability - $ICC_{3,1}$) between tests. The following criteria were adopted to interpret the magnitude of the correlation: "trivial" ($r < 0.1$), "small" ($0.1 \leq r < 0.3$), "moderate" ($0.3 \leq r < 0.5$), "large" ($0.5 \leq r < 0.7$), "very large" ($0.7 \leq r < 0.9$), "nearly perfect" ($0.9 \leq r < 1$), and "perfect" ($r = 1$)[13]. An ICC < 0.40 was considered "low," 0.40–0.70 as "acceptable," 0.70–0.90 as "good," and >0.90 as "excellent"[14]. The analysis of agreement between the WanT and RAST indices was performed by employing the Bland-Altman method[15].

Absolute and relative reliabilities were analyzed by calculating the standard error of measurement (SEM) as follows: SEM = (SD diff)/√(1-ICC), where SD diff = the standard deviation of the differences between tests. The SEM results were classified as good (SEM ≤ 5.0%), moderate (SEM = 5.0 – 9.9%), or poor (SEM ≥ 10.0%)[16]. The smallest worthwhile change (SWC) was assumed by multiplying the SD_diff by 0.2 ($SWC_{0.2}$), indicating the typical small effect, or 0.6 ($SWC_{0.6}$), showing an alternative medium effect [17]. The ability of the tests to detect a change was rated as "good," "satisfactory," or "marginal" when the SEM was lower than, similar to, or higher than the SWC, respectively[17]. The minimal detectable change (MDC95) of the tests was determined as $MDC_{95} = 1.96*SEM*\sqrt{2}$. This measure represents the 95% CI of the difference in scores between paired observations[18]. This indicator is interpreted as the minimal change required for a given variable, and sufficient confidence for a practically relevant change is provided[17].

To determine the difference between the WanT vs RAST indices we used the mean, 90% confidence interval (90% CI) and paired t-test. Effect sizes for significant pairwise comparisons were calculated using Cohen's d [19] and interpreted as d (0.01) = "very small," d (0.2) = "small," d (0.5) = "medium," d (0.8) = "large," d (1.2) = "very large," and d (2.0) = "huge" [20].

3. RESULTS

Validity, Reliability analyses

Table 1 presents the results of the validity analysis. The Shapiro-Wilk test indicated normality in the distribution of standardized residual values (p = 0.175 to 0.927). Correlations between variables of the WanT and RAST showed a strong relationship between MPO and rMPO. The regression resulted in R^2 values of 0.609 and 0.596 for MPO and rMPO, respectively.

Table 1. Regression model to explain WAnT indices from the RAST test values.

	r (95%CI)	R^2 (%)	Anova	Coefficient
PPO (W)	0.019 - trivial (-0.81 to 0.82)	0.0004 (0,04%)	F1;4 = 0.001; p = 0.972	β = -0.027; -2.037 to 1.982
rPPO ($W. kg^{-1}$)	0.083 - trivial (-0.78 to 0.83)	0.007 (0,7%)	F1;4= 0.027; p = 0.876	β = -0.093; -1.652 to 1.466
MPO (W)	0.780 – very large (-0.09 to 0.97)	0.609 (60,9%)	F1;4= 6.235; p = 0.067	β = 0.677; -0.076 to 1.431
rMPO ($W. kg^{-1}$)	0.772 – very large (-0.11 to 0.97)	0.596 (59,6%)	F1;4= 5.890; p = 0.072	β = 0.649; -0.093 to 1.391
FI (%)	0.019 - trivial (-0.81 to 0.82)	0.0004 (0,04%)	F1;4= 0.001; p = 0.972	β = 0.006; -0.461 to 0.474

Legend: PPO = peak power output, rPPO = relative peak power output, MPO = mean power output, rMPO = relative mean power output, FI = fatigue index.

The absolute and relative reliabilities of the WanT and RAST obtained from the test are presented in Table 2. These data suggest "good" reliability of MPO and rMPO ($ICC_{3,1}$ = 0.872 and 0.864, respectively). The SEM for all variables exceeded $SWC_{0.2}$ (rating: marginal) but were ≥ $SWC_{0.6}$.

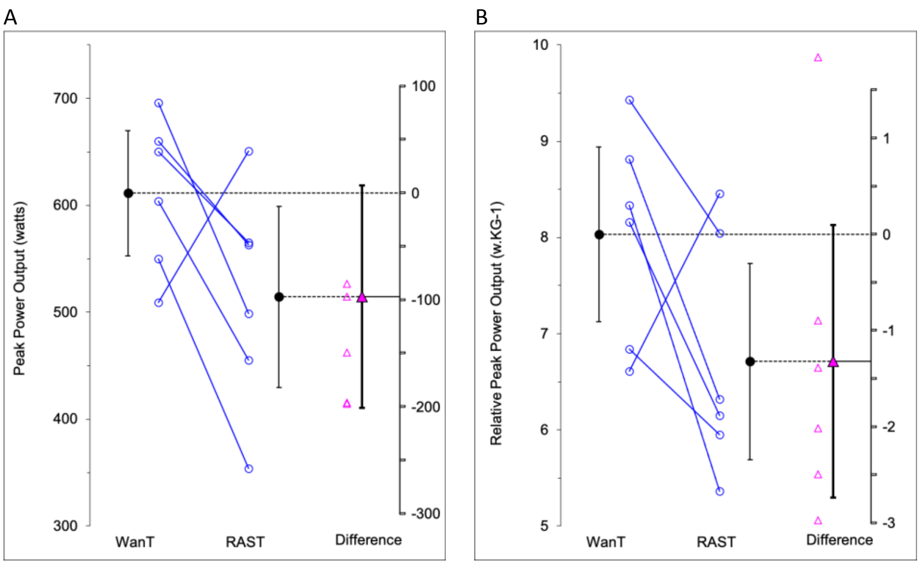
Table 2. Results of the absolute and relative reliability analysis.

	PPO (W)	rPPO ($W.kg^{-1}$)	MPO (W)	rMPO ($W.kg^{-1}$)	FI (%)	Time (s)
$ICC_{3,1}$ (95%CI)	0.02 - Poor (-0.76 to 0.74)	0.11 - Poor (-0.80 to 0.70)	0.88 - Good (0.36 to 0.98)	0.87 - Good (0.33 to 0.98)	0.02 - Poor (-0.75 to 0.76)	-
Bias	97.0	1.3	28.2	0.4	12.3	6.8
95% LoA	-150.6 to 344.6	-2.1 to 4.7	-30.9 to 87.2	-0.4 to 1.2	-22.6 to 47.2	0.5 to 13.0
SEM (%) (95%CI)	125.0 (1.3%) (-148.1 to 342.1)	1.6 (1.2%) (-1.9 to 4.5)	10.4 (0.4%) (7.7 to 48.6)	0.1 (0.4%) (0.1 to 0.7)	17.6 (1.4%) (-22.2 to 46.9)	3.2 (0.5%) (0.5 to 13.0)
MDC_{95}	346.6	4.5	28.9	0.4	48.9	8.8
$SWC_{0.2}$ (Rating)	25.3 (Marginal)	0.3 (Marginal)	6.0 (Marginal)	0.08 (Marginal)	3.6 (Marginal)	0.6 (Marginal)
$SWC_{0.6}$ (Rating)	75.8 (Marginal)	1.0 (Marginal)	18.1 (Good)	0.2 (Good)	10.7 (Marginal)	1.9 (Marginal)

Legend: PPO = peak power output, rPPO = relative peak power output, MPO = mean power output, rMPO = relative mean power output, FI = fatigue index, 95% ICC = intraclass correlation coefficient, LOA = Bland and Altman limits of agreement (LoA), SEM = standard error of measurement, SWC = smallest worthwhile change, MDC = minimal detectable change.

WanT vs RAST comparisons

The performance characteristics (individual and group) of the WanT vs RAST indices are shown in Figure 1.



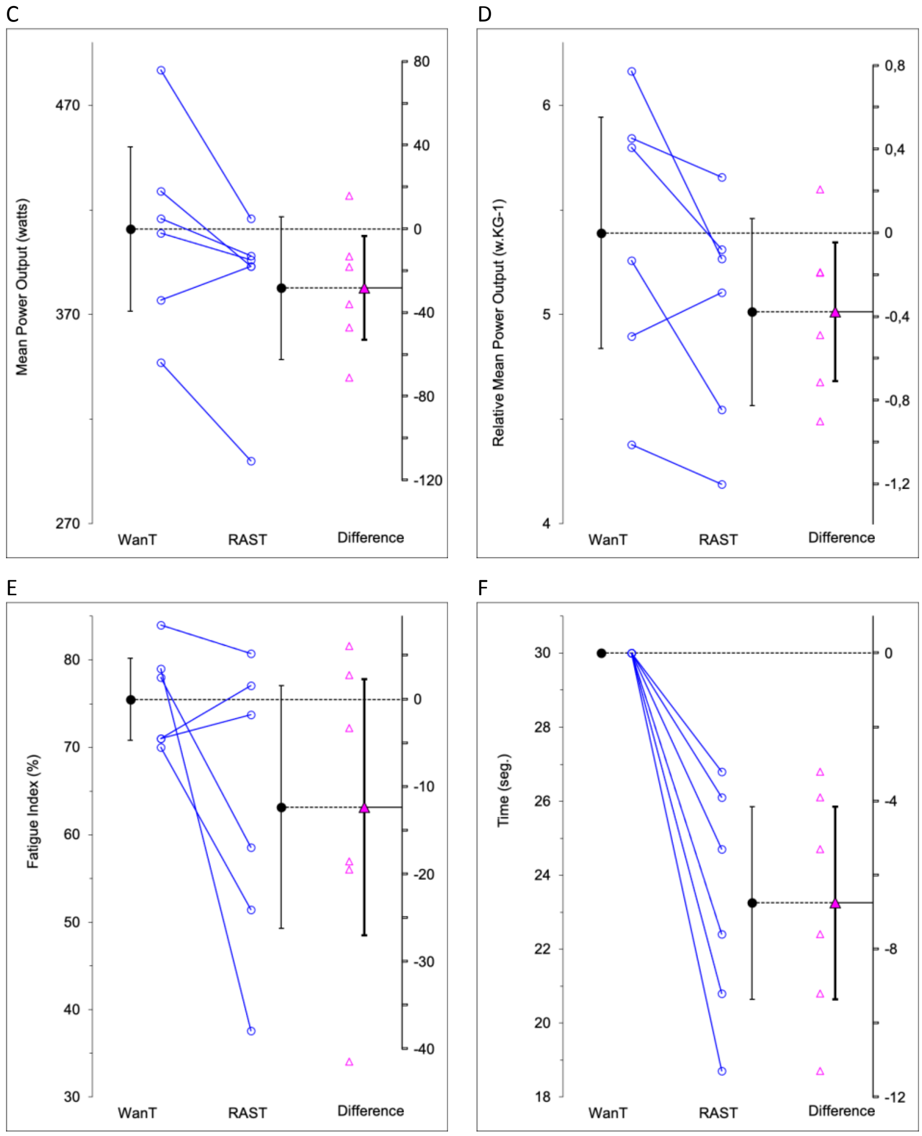


Figure 1: Individual and group differences in PPO (Panel A), rPPO (Panel B), MPO (Panel C), rMPO (Panel D), FI (Panel E) and Time (Panel F).

Note: Panel A: PPO (WanT: CV = 12%, CI = 555 to 668; RAST: CV = 20%, CI = 432 to 597; Mean Differences = 97.0; 16%; t-test = 1.88; p = 0.119; ES = 1.1 – Large; CI = 0.003 to 2.0), Panel B: rPPO (WanT: CV = 14%, CI = 7.3 to 8.7; RAST: CV = 19%, CI = 5.8 to 7.6; Mean Differences = 3.0; 17%; t-test = 1.88; p = 0.119; ES = 1.2 – Very large; CI = 0.06 to 2.1),Panel C: MPO (WanT: CV = 12%, CI = 379 to 443; RAST: CV = 11%, CI = 355 to 411; Mean Differences = 28.2; 7%; ; t-test = 2.29; p = 0.071; ES = 0.6 – Medium; CI = -0.4 to 1.5), Panel D: rMPO(WanT: CV = 12%, CI = 4.9 to 5.9; RAST: CV = 11%, CI = 4.6 to 5.4; Mean Differences = 0.2; 7%; ; t-test = 2.20; p = 0.079; ES = 0.6 – Medium; CI = -0.4 to 1.5), Panel E: FI (WanT: CV = 8%, CI = 72 to 79; RAST: CV = 27%, 50 to 77; Mean Differences = 12.3; 16%; ; t-test = 1.68; p = 0.153; ES = 1.1 – large; CI = -0.1 to 1.9) and Panel F: Time(WanT: CV = 0%; RAST: CV = 14%, CI = 21.1 to 25.1; Mean Differences = 6.8; 23%; ; t-test = 5.22; p = 0.003; ES = 10.4 – Huge; CI = 1.4 to 4.1).

4. DISCUSSION

Validity, Reliability analyses

Here we tested whether RAST can be used to evaluate anaerobic performance in amputee football players. Our main results indicated that the test was reliable for the MPO and rMPO indices. For the indices, the bias was small and the SEM good. The capacity for detecting all variables exceeded $SWC_{0.2}$ (rating: marginal) but were similar to or above $SWC_{0.6}$ (rating: good). Our study found a very strong correlation between the MPO and rMPO indices. Thus, MPO and rMPO of RAST were responsible for more than 59.6% of the variance in WanT.

The results showed that the criterion validity of RAST was very high for MPO and rMPO. The RAST underestimated the PPO, rPPO, and FI (effect size: large to very large) versus the WAnT. The R^2 values in the regression analysis for MPO and rMPO were 0.609 ($F_{1;4}$ = 6.235; p = 0.067) and 0.596 ($F_{1;4}$ = 5.890; p = 0.072), respectively, indicating “good” validity. The R^2 value indicates the proportion of variance in the dependent variable explained by the independent variable [21]. As the R^2 value increases, the confidence in the predictive value of the regression line increases [21]. Systematic bias was not detected because the p values in the analysis of variance were not significant [21]. This indicated that the researchers or coaches did not need to adapt the RAST protocol to remove the learning or fatigue effects of the test.

Reliability is fundamental to all aspects of physical test measurements [17]. In other words, a reliable instrument will perform accurately under several conditions [14, 17, 22]. Here the RAST indices (MPO and rMPO) presented small dispersion scores. This means that the results showed small variability among the test scores. In practice, these results indicate that amputee football players maintain similar MPO and rMPO values during repeated measurements. Furthermore, these repeated measurements did not vary among the amputee football players. This indicates that the MPO and rMPO indices have adequate relative and absolute reliability for samples with amputee football players.

Reliability was investigated using ICC values and the 95% limit of agreement method. In our study, the ICC for MPO and rMPO were rated as good. This value was in the same range as the relative reliability value indices reported in several sports [23-25] and disabled sports [11, 12, 26]. In addition, it is important to use MDC_{95} as a criterion to determine whether a real change has occurred in the tests [27]. In this study, the MDC_{95} for the MPO and rMPO has been 30.1 W and 0.42 W. kg^{-1}, respectively. When a change in the test score is below or above these values, it can indicate a true change [14]. We emphasize that MDC_{95} depends on the reliability coefficient used to calculate SEM [18]. With less reliable measurements, the SEM and MDC values increased. Instruments that do not show good reliability will have larger MDC values, indicating that even larger change scores are needed before measurement errors can be considered a single source [28].

Validity and reliability evaluations address the interpretation and application of measured values and reflect the meaning ascribed to a score [14]. Validity and reliability depend on the relevance of the variable and how well the variable represents the concept [21]. MPO and rMPO values are indicative of the anaerobic capacity. In amputee football, decisive actions during a match are related to anaerobic metabolism [2]. In other words, the physical performance of amputee football players is linked to a higher anaerobic capacity (MPO and rMPO).

WanT vs RAST comparisons

Anaerobic performance is essential for amputee football players. However, evaluating this variable is problematic with ecological validation. This is because of the challenges of conducting laboratory tests in para-athletes. Recent studies have investigated whether field tests can accurately determine the anaerobic performance of wheelchair athletes [11]. However, to the best of our knowledge, this is the first study to investigate the ecological reliability of a field anaerobic performance test in amputee football players. We compared the WanT and RAST scores. In this comparison, the CI of the differences in MPO and rMPO was small, indicating high precision [29]. The CI is useful in these comparisons because it indicates the extent of uncertainty and provides the best point estimate of the variable in question [29]. These findings suggest that the RAST reliably evaluates anaerobic capacity. The MPO and rMPO generated during RAST reflect the localized endurance of the exercising upper limbs, utilizing energy mainly from anaerobic pathways. The execution of successive sprints and other high-intensity actions during an amputee football match is initially maintained by high-energy phosphates [2]. The performance of several stimuli with short recovery periods was not sufficient to restore the phosphocreatine stock, increasing the participation of the glycolytic pathway to meet metabolic demands. This provides support for the conceptual premise that the evaluation of anaerobic capacity is more important than peak power for amputee football players.

Anaerobic performance (power and capacity) tests involve high-intensity efforts lasting from fractions of a second to a few minutes. Our results indicated differences in the CI of the means in the duration of the tests (WanT vs. RAST; Panel F; effect size = large). This result may be explained by the fact that the WanT is performed at a fixed time with the subjects sitting on a chair and ergometer. On the other hand, the RAST Test is performed by six runs with fixed distances and varied durations. Another possible explanation for this is that the shorter duration of the RAST may be responsible for the differences in the test recordings [30].

The WanT is the most widely used test worldwide for the evaluation of anaerobic performance and has recently been used in amputee football players [4, 5]. These studies have related WanT indices to limb impairment types and levels [4], body composition, and speed [5]. Despite the relevance of these variables to the sports performance of amputee football players, its applicability in amputee football is limited. The WanT test used in the arm crank protocol lacks specificity compared to moving with crutches. Pedaling is a nonspecific movement for amputee football players that compromises the test's reliability. In practice, the greatest interest in the evaluation of anaerobic performance lies in identifying variables that directly influence performance in the game. Amputee football involves fundamental movements, such as running/sprinting in a straight line and with changes in direction, jumping, and kicking. The running speed is present in most decisive moments of the game [1, 2] because of the need to arrive before an opponent to crucial areas of the field. Therefore, the RAST is more specific because it involves runs with the upper and/or lower limbs in a natural environment (football field) using their normal crutch configuration and considering similar efforts as movements in the game. This fact contributes to making the RAST results closer to the practice environment than the WanT results. Thus, it seems advantageous to use the RAST to evaluate amputee football players because it has better ecological validity. Another advantage of the RAST is that large groups of players can be tested in less time.

A natural progression of this work is to analyze the relationship between the RAST and match physical performance. This is a fruitful area for further research. Additionally, these study results can be used to develop targeted interventions aimed at improving anaerobic performance training in amputee football players. Another important practical implication is that the RAST is easy to administer, can be used to assess a large number of subjects simultaneously, requires little equipment (e.g., stopwatch and note sheets), and faithfully represents the running actions performed by amputee football players.

Based on the results obtained, the conclusions of this study strengthen the initial hypotheses about the use of the RAST in assessing anaerobic performance in amputee football players. The reliability demonstrated in the study confirms the consistency of these measures throughout the test, supporting the idea that the RAST is a reliable tool for this population. The associations between the RAST indices and the variance explained in the WanT reinforce the validity of these measures, supporting the ability of the RAST to reflect the specific anaerobic capacity of amputee football players. The close agreement between RAST and WanT indices confirms the RAST's high accuracy, supporting its utility as a robust tool for assessing anaerobic capacity in amputee football players. These findings suggest that the RAST can be generalized for the effective assessment of anaerobic performance in amputee football players.

5. LIMITATION

The study acknowledges certain limitations that warrant consideration for future research. A key gap lies in its failure to address the potential influence of variables like movement patterns, position roles, and amputation level on RAST performance. The limited sample size unfortunately prevented a nuanced investigation into these factors, leaving a blind spot in our understanding of how RAST's reliability and validity might vary across amputee soccer players with different movement patterns, playing styles, or amputation levels. This limitation underscores the need for further research with larger and more diverse samples. Only then can we gain a comprehensive picture of the nuanced factors that might influence RAST performance in this unique population, ensuring its effectiveness as a robust assessment tool for amputee football players.

6. CONCLUSION

Our findings indicate that the RAST is applicable for the effective evaluation of anaerobic performance in amputee football players.

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