

Fatigue index and anaerobic power obtained in different surfaces types

Índice de fadiga e potência anaeróbia obtida em diferentes tipos de solo

Walmir Romário dos Santos¹

<https://orcid.org/0000-0001-5558-3109>

Clodoaldo José Dechechi²

<https://orcid.org/0000-0002-5151-5130>

Isac Alexandre Ferreira da Silva¹

<https://orcid.org/0000-0001-5222-1444>

Matheus Machado Gomes¹

<https://orcid.org/0000-0002-2123-5699>

Gustavo Augusto Fernandes Correia³

<https://orcid.org/0000-0002-7914-6840>

Pedro Pinheiro Paes³

<https://orcid.org/0000-0002-6765-5672>

Wlaldemir Roberto dos Santos⁴

<https://orcid.org/0000-0001-5706-2243>

Abstract – Due to the high intensity of competitive sports, the anaerobic power is a very important physical capacity for most sports. However, the diverse surfaces were these sports may interfere in the performance of this capacity. In running-based sports, the Running Anaerobic Sprint Test – RAST is largely used to evaluate anaerobic power. Considering the specificity of each sport, it is suggested to apply this test on the surface that it is played. Thus, the aim of the present study is to analyze the performance of RAST on different surfaces. The sample was composed by 10 subjects, mean age 20.2 ± 0.9 years old, mean height 1.8 ± 0.1 meters, mean body weight 77.4 ± 15.9 kg, and practice time of 6.0 ± 2.0 years. RAST was conducted on three different surfaces (hard, grass and sand). The maximum and minimum power and the fatigue index were compared between the surfaces. The results indicate that maximum and minimum power were lower in sand when compared to grass and hard surfaces. However, the fatigue index did not change. So, we observed that the surface is an important factor in RAST performance.

Key words: Anaerobic threshold; Athletic performance; Exercise; Physical fitness; Running.

Resumo – Devido à alta intensidade do esporte competitivo, a potência anaeróbia é uma capacidade física de natureza decisiva para a maioria das modalidades esportivas. Entretanto, diferentes tipos de superfícies onde são jogadas estas modalidades podem interferir no desempenho dessa capacidade física. Em esportes cuja corrida é base para sua prática, o Running Anaerobic Sprint Test – RAST é largamente utilizado para a avaliação da potência anaeróbia e levando em consideração à especificidade de cada esporte, sugere-se que este teste seja aplicado na superfície onde ele é praticado. Neste sentido, o objetivo do presente estudo foi analisar o desempenho no RAST em diferentes tipos de solo. A amostra foi composta por 10 sujeitos com idade média de $20,2 \pm 0,9$ anos, estatura média de $1,8 \pm 0,1$ metros, massa corporal média de $77,4 \pm 15,9$ kg e histórico médio de treinamento de $6,0 \pm 2,0$ anos. O RAST foi realizado em três superfícies diferentes (cimento, grama e areia). A potência máxima e mínima e o índice de fadiga foram comparados entre os solos. Os resultados indicam que as potências máxima e mínima foram menores na areia comparadas a grama e ao cimento. No entanto, não houve diferença no índice de fadiga. Conclui-se que o tipo de solo é um fator que influencia no desempenho do RAST.

Palavras-chave: Aptidão física; Corrida; Desempenho atlético; Exercício; Limiar anaeróbio.

1 Universidade de São Paulo. Escola de Educação Física e Esporte de Ribeirão Preto. Ribeirão Preto, SP, Brasil.

2 Universidade de São Paulo. Faculdade de Medicina de Ribeirão Preto. Ribeirão Preto, SP, Brasil.

3 Universidade Federal de Pernambuco. Departamento de Educação Física. Recife, PE, Brasil.

4 Universidade Federal de Pernambuco. Centro de Biociências. Recife, PE, Brasil.

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INTRODUCTION

The need for performance improvement in sports has driven sports science to develop ways to improve athletes' performance¹. Physical capacity is the main component of sports performance, using aerobic or anaerobic systems on practice. However, the anaerobic system has proven to be extremely important in several disciplines, mainly on those that are intermittent². The importance of anaerobic system on mainly aerobic disciplines is due to the intensity overcome the volume in many situations on collective sports³. Thus, intermittent activities are directly linked to muscular glycogen stores⁴ and to ATP resynthesis from phosphocreatine⁵.

So, techniques to evaluate anaerobic power are extremely important to monitor the efficiency³. Tests like Wingate⁶, that uses short distances like 10 or 20 meters sprints and RAST - *Running Anaerobic Sprint Test*⁷ are used to evaluate anaerobic power in sports. Due to its characteristics, RAST is widely used in disciplines where technical expertise is needed when using intermittent running on its practice⁸⁻¹⁰, confirming the specificity principle¹¹. Besides that, RAST results allow obtaining the fatigue index from the athlete to monitor physical conditioning¹².

Although several studies have shown the influence of different types of soil on physical exercise intensity, helping on the training prescription to court sports played on hard floors (basketball, volleyball, futsal, and handball), on grass (soccer) and sand (beach soccer, beach volley, and beach hand)^{9,13-16}, few studies addressed the influence of the type of soil on performance and fatigue index on RAST. It is an efficient method to evaluate anaerobic power on athletes and physically active individuals, allowing better conditions to physical and sports training programs. The aim of this study was, then, evaluate anaerobic power and fatigue level on RAST in different types of soil (cement, sand, and grass).

METHODS

Subjects and Experimental Design

The sample was composed by ten individuals, all college students, all physically active males. The subjects did not participate in a specific sports discipline described in Table 1. The participation was voluntary, being informed about all risks and benefits. The inclusion criteria were signing the free consent form, medical approval for exercise practice, and to be engaged on any regular physical exercise program for at least three months. All procedures underwent all ethical norms accord to resolution 466/2012, regulating human research (UNICEP, CAAE: 58888516.4.0000.5380 and protocol number: 1705382). After participant selection, they were submitted to anthropometric data collection, anamnesis and oriented to RAST execution. The test was conducted on all three types of surfaces, within a 72-hour interval between them, following this specific order: cement, grass, and sand.

Anthropometric measures and sample characterization

The height and weight were measured using an electronic scale with a stadiometer (*Welmy*[®], Santa Bárbara d'Oeste, São Paulo, Brasil, accuracy of 0.1 cm, and 0.1 kg). Age and training history were collected in the previous anamnesis prior to the test.

Running anaerobic sprint test - RAST

Following the protocol suggested by Zagatto, Beck, and Gobato¹⁷, RAST is composed by 6 sprints of 35 meters, performed at maximum speed, and 10 second intervals between each sprint. To delimitate the 35 meters, a scale was used, and the distance was marked by cones. Three researchers participated in the data collection, two of them at the end cone to register sprint time. After the collection, the mean time from the researchers was calculated and considered to decrease the error between researchers. The recovery time was registered by a third researcher. Professional chronometers were used for time collection (*Guepardo Of0100*, Guarulhos, São Paulo, Brasil).

Test guidelines

RAST protocol was conducted in four phases: (1) 10-minute warmup with light to moderate running on the surface where the test was conducted (cement, grass, and sand); (2) pause to recovery for three minutes; (3) six-sprints test; (4) active recovery with 2-minute walking. This protocol in this study was adapted from Keir, Thériault, and Serresse¹⁸. The first test was conducted on cement, followed by grass and sand, with 72-hours intervals between tests, always applied at 7 pm.

The subjects were tested on the facilities of the University of São Paulo, campus de Ribeirão Preto. On cement (closed space, gymnasium) and grass (open space, soccer field), shoes for physical activities were used while on sand (open space, sand court), the subjects were tested barefoot. The weather conditions were very similar in all tests, with no rain occurring in any test.

Maximum and minimum strength and fatigue index

After RAST on all surface, it was verified the Fatigue Index (FI) for each subject on each surface. To obtain the FI, the maximum (MAXS) and minimum (MINS) strength and time (T) were used through the equation $FI\% = (MAXS \times MINS) / MAXS^2$. To obtain the strength to each sprint, the body mass (BM), distance (D), and time (T) were used through the equation $S = BM \times D^2 / T^3$.

Statistical Analysis

The Statistical Package for the Social Sciences (SPSS), version 17.0 was used. The data are described in mean and standard deviation. To the data normality analysis, the *Shapiro-Wilk* test was used, and the *Mauchly* test was used to evaluate its sphericity. Since the data are not spheric, the

Greenhouse-Geisser correction factor was used. To analyze the mean differences, repeated measures ANOVA were used, with Tukey *post hoc*. The significance level was set at 5%.

RESULTS

The sample characterization is in table 1.

Table 1. Anthropometric characteristics, age, and training history of the subjects.

Variable	Mean ± Standard Deviation
Age (years old)	20.2 ± 0.9
Height (cm)	178.0 ± 0.1
Total body mass (kg)	77.4 ± 15.9
Training history (years old)	6.0 ± 2.0

Table 2 presents the performance variables obtained on all surfaces. There were differences between surfaces for minimum and maximum strength ($p < 0.001$). Post hoc tests revealed that maximum and minimum strength were lower on the sand when compared to cement and grass, with no difference between cement and grass. Regarding Fatigue Index, there was no difference among the surfaces ($p > 0.05$).

Table 2. Mean ± standard deviation for maximum and minimum strength and fatigue index on three different surfaces.

	Cement	Grass	Sand
MAXS (W)	509.26 ± 114.96	504.99 ± 114.15	468.27* ± 104.80
MINS (W)	414.98 ± 91.55	410.77 ± 100.27	373.25* ± 87.72
FI	2.70 ± 0.88	2.66 ± 0.65	2.45 ± 0.80

Note. * significant difference ($p < 0.001$) compared to cement and grass; MAXS (W) – Maximum strength (Watts); MINS (W) – Minimum strength (Watts); FI – Fatigue index.

DISCUSSION

The present study aimed to analyze the anaerobic power and fatigue index using RAST on three different surfaces (cement, grass, and sand). The results showed lower minimum and maximum strength on the sand when compared to cement and grass, with no difference between the later surfaces, and with no difference regarding fatigue index in all surfaces.

Fatigue index has been used to describe the processes that calculate the reduction of anaerobic power performance, affecting the performance of athletes¹⁹. Thus, this study corroborates those from Araújo Junior et al.²⁰, which analyze fatigue index through RAST with 13 soccer player and 13 futsal players, calculating their fatigue indexes and did not find any differences between both surfaces.

Fatigue index using RAST under different surfaces and types of shoes was also investigated by Kalva-Filho et al.⁹ The results were similar to those on these studies, with no difference in track or grass. However, the

researchers did not study RAST results on the sand. It has been noted that RAST is widely used to evaluate fatigue index, however, only a few studies used several surfaces to evaluate its response.

On the other hand, the findings from Kalva-Filho et al.⁹ were different regarding maximum anaerobic power since it was demonstrated better maximum strength on track when compared to grass. Those differences may be related to several factors as physical conditioning, gender, weather conditions, shoes, among others.

Anaerobic power of RAST on grass and cement court was also investigated by Gonçalves et al.²¹ in 159 athletes from several sports, including volleyball, futsal, handball, basketball, and soccer using specific shoes for those disciplines. There was no difference for maximum strength on cement when compared to grass, in agreement with the results obtained by this study.

The difference in maximum strength on different surfaces may be explained by a higher energy cost on sand and grass, directly proportional to speed^{21,22}. Another factor may be the higher grip on hard surfaces when compared to grass and sand, thus, influencing performance increase on RAST²³⁻²⁶. Otherwise, smaller strength on sand may be due to higher energy cost and physical effort inherent to this surface. In sand sprints, feet may slide on one of the steps phases, losing part of the surface reaction strength that would propel the individual forward¹⁵.

This may be the first study to investigate RAST performance on cement, grass, and sand, pointing that the type of surface is a key factor that must be considered to RAST application. There are some limitations on this study as the sprint barefoot on sand, fatigue from previous tries, and the fact of some subject not being familiar to sprint in some surfaces.

CONCLUSION

The RAST performance on sand is lower when compared to cement, and grass while the fatigue index was not influenced by the type of surface where the test is conducted.

COMPLIANCE WITH ETHICAL STANDARDS

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Ethical approval

Ethical approval was obtained from the local Human Research Ethics Committee: Centro Universitário Central Paulista (number: 1705382), and the protocol was written in accordance with the standards set by the Declaration of Helsinki.

Conflict of interest statement

The authors have no conflict of interests to declare

Author Contributions

Conceived and designed the experiments: WRS, CJD, IAFS, PPP and WRS. Performed the experiments: WRS, IAFS and WRS. Analyzed data: WRS, IAFS, MMG, GAFC and WRS. Contributed with materials and analysis tools: WRS, WRS, CJD, IAFS and AFS. Wrote the paper: WRS, AFS, CJD, MMG, IAFS, GAFC and PPP.

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Corresponding author

Walmir Romário dos Santos

University of São Paulo, School of Physical Education and Sports of Ribeirão Preto.

Av. dos Bandeirantes, nº 3.900. Monte Alegre, Ribeirão Preto, São Paulo, Brazil.

ZIP Code: 14040-907.

Email: walmir@usp.br