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**Original Article**

# DETERMINING FACTORS OF PERFORMANCE IN MIDDLE/LONG DISTANCE EVENTS IN UNIVERSITY ATHLETICS

## FATORES DETERMINANTES DO DESEMPENHO EM PROVAS DE MEIO FUNDO/FUNDO NO ATLETISMO UNIVERSITÁRIO

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**RESUMO**
Para verificar as relações entre testes de campo e o desempenho nas provas de 800 metros, 1.500 metros e 5.000 metros no atletismo universitário, foram selecionados para realização dos testes motores 20 participantes do sexo masculino atletas universitários, no qual realizaram os seguintes testes: o teste de resistência de salto vertical (RSV); um teste incremental em esteira ergométrica para a avaliação do consumo máximo de oxigênio ($\dot{V}O_2max$); *Running Based Anaerobic Sprint Test* (RAST) além de três tomadas de tempo (*time trials*) de 800, 1500 e 5000 metros, de onde foi calculada a potência crítica. Foram encontradas correlações positivas ($p < 0,05$) entre índice de fadiga e 800 m, 1.500 m ($R^2 = 0,65$) e 5.000 m ($R^2 = 0,20$), e entre B35M e 1.500 m ($R^2 = 0,72$). Foram encontradas correlações negativas ($p < 0,05$) entre o $\dot{V}O_2max$ relativo e 800 m ($R^2 = 0,74$), 1.500 m ($R^2 = 0,80$) e 5.000 m ($R^2 = 0,86$), e entre potência crítica e a prova de 5.000 m ($R^2 = 0,97$). O RSV não se correlacionou com desempenho dos *time trials* ($p > 0,05$). Como conclusão, para esta amostra as variáveis investigadas que mais determinam o desempenho nas três provas são: o índice de fadiga (800m; 1500m; 5000m), $\dot{V}O_2max$ (800m; 1.500m; 5.000m) M35M (1.500m) e potência crítica (5.000m).
**Palavras-chave**: Desempenho esportivo; Corrida; Esporte universitário.

**ABSTRACT**
To verify the relationship between field tests and performance in the 800 meters, 1,500 meters, and 5,000 meters in university athletics, 20 male university athletes were selected to perform the motor tests, which they performed: the vertical jump endurance (VJE) test; a graded exercise test on a treadmill to access the maximal oxygen uptake ($\dot{V}O_2max$); the Running Based Anaerobic Sprint Test (RAST) in addition to the three Times Trials of 800, 1,500 and 5,000 meters, from which the critical power was calculated. It was found positive correlations ($p < 0.05$) between fatigue index and 800 m, 1,500 m ($R^2 = 0.65$), and 5,000 m ($R^2 = 0.20$), and between B35M and 1,500 m ($R^2 = 0.72$). It was found negative correlations ($p < 0.05$) between relative $\dot{V}O_2max$ and 800 m ($R^2 = 0.74$), 1,500 m ($R^2 = 0.80$), and 5,000 m ($R^2 = 0.86$), and between critical power and the 5,000 m event ($R^2 = 0.97$). VJE did not correlate with the time trials performance ($p > 0.05$). It was concluded that for this sample the variables that seem to explain the most with the three tests are: fatigue index (800m; 1,500m; 5,000m), $\dot{V}O_2max$ (800m; 1,500m; 5,000m) B35M (1,500m) and critical power (5,000m).
**Keywords**: Sports performance; Running; University sport.

## Introduction

Middle and long-distance running events have distances that are understood as official events ranging from 800 m and 1,500 m (middle distance) and longer distances like 5,000 m[1,2]. The growth of these events has been expressive in recent decades, leading to an exponential increase in the number of recreational practitioners, especially in universities, among university students[3], increasing the need for more in-depth investigations of this modality and this specific population. Given the demand of an increasingly active and demanding athletic and university population, various means to increase sports performance have been developed and studied, aiming to find models that address the various factors that encompass the training for long-distance runners from the physiological, neuromuscular, and coordinative viewpoint[4].

The improvement in sports performance can be considered the main objective of coaches from most sports modalities, but within a periodization process, many factors count on the process, influencing the athlete's training and their result in the competition.

It is understood that performance in middle and long-distance running is determined by components such as the Anaerobic Threshold (AnT), Maximum oxygen uptake ($\dot{V}O_2max$), and the intensity at which it is reached ($i\dot{V}O_2max$)[4,5]. The AnT consists of an exercise intensity above which there is a disproportionate increase in blood glucose, blood lactate (usually above 4 mmol), and ventilation, and is observed in parallel with a decrease in blood pH[6]. $\dot{V}O_2max$ is understood as the maximum capacity to capture, transport, and use oxygen during dynamic exercise involving large body muscle mass, and this indicator is considered an excellent means for analyzing aerobic power[7].

According to Duffield Dawson and Goodman[8], the 400 and 800 m events have different aerobic/anaerobic contributions, taking into account the distance of the event and the gender of the participants. For the 400 m event, the aerobic and anaerobic routes participate, being 41/59% and 45/55% for men and women respectively, while in the 800 m event, the metabolic contribution showed 60/40% and 70/30% for men and women, respectively[8]. When dealing with the 1,500 m and 3,000 m events, the metabolic participations were also determined. The aerobic/anaerobic contributions in the 1,500 m event were 77/23% and 86/14% for men and women, respectively, and in the case of the 3,000 m event, these proportions were 86/14% and 94/6% for men and women, respectively[9].

Given the greater anaerobic contribution in middle-distance events, it seems logical that anaerobic capacity has great importance. However, the quantification of this and other variables has not yet been shown in the literature, concerning the athletes' performance. Because of this, and intending to improve sports performance being the main objective of athletes and their respective coaches, this study sought to determine the relationship between the proposed motor and cardiorespiratory tests with performance, culminating in obtaining the predictive capacity of each of them concerning the different middle and long-distance events. This work was therefore guided by the following question: which test would be able to better predict the performance of these athletes in such events?

From this, the study aimed to verify the relationships between field tests and performance in time trials in 800, 1,500, and 5,000 m athletics events in university athletes. Our initial hypothesis was that there would be an increase in the importance of the aerobic variables with the increase in the distance of the events, (i.e., the greater the distance of the event, the more the aerobic variables would be active and the smaller the event distance, the more the anaerobic variables would be active).

## Methods

*Sample*

20 male university athletes (body mass: 73.7 ± 8.0 kg; height: 176.1 ± 5.2 cm; age: 22.9 ± 3.0 yrs; body mass index: 23.7 ± 1.9 $kg \cdot m^{-2}$), from nine different courses, practitioners of the modalities from 800, 1.500, and 5.000 m voluntarily to participate in this study. Participants met the following inclusion criteria: aged between 18-35 yrs; being enrolled in an undergraduate or graduate program at a public or private university; being a practitioner of one of the following modalities (800 m, 1,500 m, and 5,000 m); having at least one year's experience; maintaining a regular attendance of at least three weekly sessions, in the pre-competitive period, with volume average of 40 kilometers per week; participate in at least two competitions per year of at least municipal level or that encompass at least more than one university. The exclusion criteria were the impairment of the participants by any health problem or orthopedic injury that prevents the performance of the experimental protocol.

Participants were selected for convenience through the dissemination of the project through digital media. From this, a meeting was held with the participants to show the activities that would be carried out. Furthermore, the participants were informed by the evaluators regarding the proposed test protocol, and they were only initiated after the institution's ethics committee previously approved the data collection and application of the tests (CAAE: 35825720.4.0000.5659.). Participants completed the Physical Activity Readiness Questionnaire (PAR-Q), which sought to verify the need for medical evaluation.

*Procedures*

To carry out the time trial tests, the set of rules adopted by World Athletics (WA) for the 800 m, 1,500 m, and 5,000 m events were considered, in addition to the technical description of the track and appropriate clothing, the times obtained in seconds to make the calculations with the other tests. The tests were carried out on the athletics track consisting of 6 lanes in the curves and 8 lanes in the main straight. The other tests were carried out in the School of Physical Education and Sports of Ribeirão Preto (*Escola de Educação Física e Esporte de Ribeirão Preto* - EEFERP), in a controlled environment (23ºC). As the data collections were carried out during the COVID-19 pandemic, and because of that, a request was made to the School of Physical Education and Sports of the Ribeirão Preto Campus from where it was borrowed the athletics track used for the experimental protocol, strictly following all security protocols with restricted entry of people into the site. The request was approved and signed by the head of the Campus and by the head of the Physical Education, Sports and Recreation Center (*Centro de Educação Física, Esportes e Recreação* - CEFER).

The experimental protocol had two weeks of duration, and participants had to come in for 6 visits, being on the first week, the first day used for the 800 m time trial, the second for the intermittent vertical jumps, countermovement jump, and squat jump, and the third for the 1,500 m time trial. On the second week, the fourth day was used for the graded exercise test, the fifth for the Running Based Anaerobic Sprint Test (RAST), and the sixth for the 5,000 m time trial. The tests were performed with an interval of 48 hours (Figure 1).

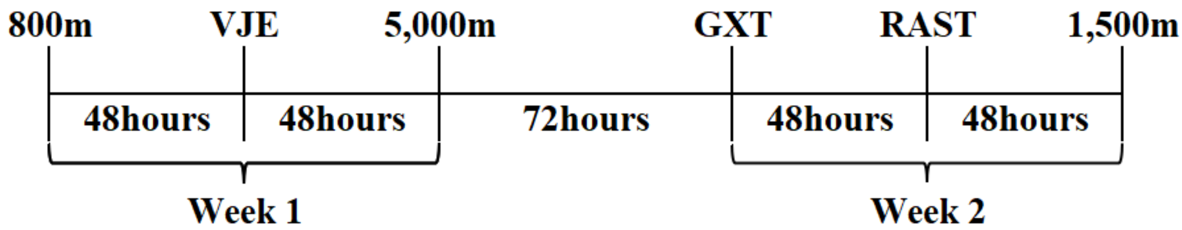


**Figure 1.** Programming of experimental procedures in the two weeks. VJE = vertical jump endurance; GXT = graded exercise test; RAST = Running Based Anaerobic Sprint Test.
**Source**: authors.

*Time trial tests*

In all track tests the athletes positioned themselves immediately before the specific starting line of the determined distance and after two sound commands "on your marks" and a whistle, the test started.

In the 800 m test, the splits were timed every 400 m. In the 1,500 m test, the splits obtained were the first 300 m and the last three 400 m splits. For the 5,000 m, the splits were the first 200 m and the last twelve splits of 400 m. In the three track tests, the participants were instructed to cover the target distances in the shortest time possible and lane 1. From the times obtained in the three time trials, the critical power values were obtained through the equation by the linear method, with the y-axis representing the velocity in m/s and the x-axis 1/time(s) of these events. The line is represented by the equation $y = a \times x + b$, where b is the critical power in $m \cdot s^{-1}$, subsequently multiplied by $km \cdot h^{-1}$[10].

From the distance covered in the time trials, the critical power[11] was calculated.

*Vertical Jump Endurance (VJE) Test*

The vertical jump endurance (VJE)[12] performance variables with intermittent effort were estimated using the Ergojump contact mat (Cefise, Sorocaba, Brazil) which informs the jump time (m·sec) and contact time (m·sec). A wooden stadiometer was used to measure height, and a Plena Lithium Digital electronic scale was used for body mass. The test following the protocol described by Bosco, Luhtanen and Komi[13] consisted of four sets of 15 seconds of vertical jumps with an interval of 10 seconds between each set. The athletes started from a semi-squat position, standing on the mat, feet parallel and hands on hips to neutralize the action of the upper limbs [12]. Participants were instructed to perform continuous vertical jumps in a work performed at maximum effort without pauses between jumps. To validate the test, the athletes were asked to: keep the trunk vertical without excessive advance, and the knees extended during the jump phase. From the results obtained, a calculation was performed to measure the Fatigue Index (IF) of the RSV, which according to Bosco, Luhtanen and Komi[13], is given by:

$$\%IF = \frac{p45-60}{p0-15} \times 100$$

With p being power in $W \cdot Kg^{-1}$.

*Graded exercise test*

The protocol used followed the model used by Fraga et al.[14]. The incline of the treadmill remained at 1 %. The initial speed of 8 $km \cdot h^{-1}$, with each stage lasting 3 minutes, and at the end of each stage, there was an increase in speed of 1 $km \cdot h^{-1}$ every 3 minutes until the subject's volitive exhaustion determined the end of the test, when the participant could not support the determined speed. For data collection, a motorized treadmill (INBRAMED SUPER ATL, Brazil), with dimensions of 2 m in length and 63 cm in width was used. From this test, both absolute in relative to weight $\dot{V}O_2max$ were found, and the peak treadmill velocity (VPeak) was determined by:

$$VPeak = CST + \frac{IST}{180} \times I$$ [15]

Being CST completed stage time in seconds; IST = incomplete stage time in seconds; I = intensity increment.

*Running Based Anaerobic Sprint Test – RAST*

Before performing the RAST test, the subjects' total body mass was measured using the Plena Lithium Digital electronic scale. RAST consisted of six maximal runs of 35 m, interspersed with a passive recovery period of 10 s. Time recording was performed for each effort (TIMEX, model 85103). The absolute power (Pabs) was determined in each run by measuring the individual's time (t), distance (D), and body mass (BM):

$$Pabs\ (W) = \frac{BM \times D2}{t3}$$

The average power in Watts was also measured, being the average of the powers in the five stimuli of 35 m. The RAST variables peak (PP), mean (PM), and minimum (Pmin) powers were determined, presented in both relative unit of body mass (REL) and in absolute values (ABS), in addition to the fatigue index (IF):

$$IF\ (\%) = \frac{(PP - Pmin) \times 100}{PP}$$

In addition, through the relationship between the distance and the effort time, the maximum velocity (VMAX) and the average speed (VMED) were determined.

*Statistical analysis*

Data are expressed as mean and standard deviation. Statistical analysis followed the protocol used by Paluno et al.[16], which performs the analysis using the multiple linear regression technique, using the stepwise method, following a 20:1 ratio in the ratio between the number of subjects and variables in the model. For validation, the performance calculations of the new equations were then performed by simple linear regression, taking into account a significance of 5 %. All statistical procedures were performed using IBM SPSS v.23 software (Inc. Chicago, IL). Data were analyzed using the stepwise method to verify the relationship between the explanatory variables of the process, i.e., the degree of association between these variables.

Data normality and homogeneity of variance were performed using the Shapiro-Wilk and Levene tests, respectively. A significance level of alpha = 0.05 was chosen to denote statistical significance; P values are reported as two-tailed. Accordingly, data here is presented as means, standard deviations (SDs), and confidence intervals (95% CI) for each performance variable.

Multiple regression was performed using the stepwise model to analyze the relationship between all parametric variables. In addition, Pearson's correlation was performed between variables to classify statistical significance. The value of the correlation coefficient was interpreted from insignificant to high positive/negative. All statistical procedures were performed using IBM SPSS v.23 software (Inc. Chicago, IL).

Associations were reported by their correlation coefficient (rho), significance level (p value), and amount of explained variance ($R^2$ value). Values of $r \leq 0.1$ indicated insignificant, r between 0.1 - 0.3 indicated small association, r between 0.3 - 0.5 moderate association, r between 0.5 - 0.7 high association, r between 0.7 - 0.9 very high association, and $r \geq 0.9$ indicated almost perfect association[17]. Determination coefficients ($R^2$ x 100) were used in 800 m, 1,500 m, and 5,000 m, and internal training load ratings to interpret the significance of the relationships[18].

## Results

Table 1 presents the performance obtained in the tests during the experimental protocol.

**Table 1.** Mean ± standard deviation of the variables obtained in the experimental protocol.

| Test | Results |
|---|---|
| **T800 (s)** | 162.3 ± 18.25 |
| **T1500 (s)** | 350 ± 41.17 |
| **T5000 (s)** | 1412.7 ± 195.71 |
| **P MAX (W)** | 486.3 ± 78.32 |
| **IF (%)** | 13.1 ± 3.94 |
| **B35M (s)** | 5.7 ± 0.24 |
| **RSV (%)** | 68.6 ± 17.43 |
| **$\dot{V}O_2max$ ($ml \cdot kg^{-1} \cdot min^{-1}$)** | 46.2 ± 4.91 |
| **$\dot{V}O_2max$ ($ml \cdot min^{-1}$)** | 3392.7 ± 399.1 |
| **Critical power ($km \cdot h^{-1}$)** | 12.2 ± 1.64 |

**Note:** T = Time Trial; P MAX = Maximum Power; IF = Fatigue Index; B35M = best RAST time in 35 m; RSV = Vertical Jump Resistance; $\dot{V}O_2max$ = maximum absolute oxygen consumption.
**Source**: Authors

Figure 2 represents the coefficient of determination of the variables that were significantly ($p < 0.05$) correlated to the athletes' performance in the three analyzed events. It was found positive correlations between fatigue index and 800 m ($R^2 = 0.69$; Figure 2A), 1,500 m ($R^2$ = 0.65; Figure 2C), and 5,000 m ($R^2$ = 0.20; Figure 2F), and between B35M and 1,500 m ($R^2$ = 0.72; Figure 2E). It was found negative correlations between relative V̇O2max and 800 m ($R^2$ = 0.74; Figure 2B), 1,500 m ($R^2$ = 0.80; Figure 2D), and 5,000 m ($R^2$ = 0.86; Figure 2G), and between critical power and the 5,000 m event ($R^2$ = 0.97; Figure 2H).

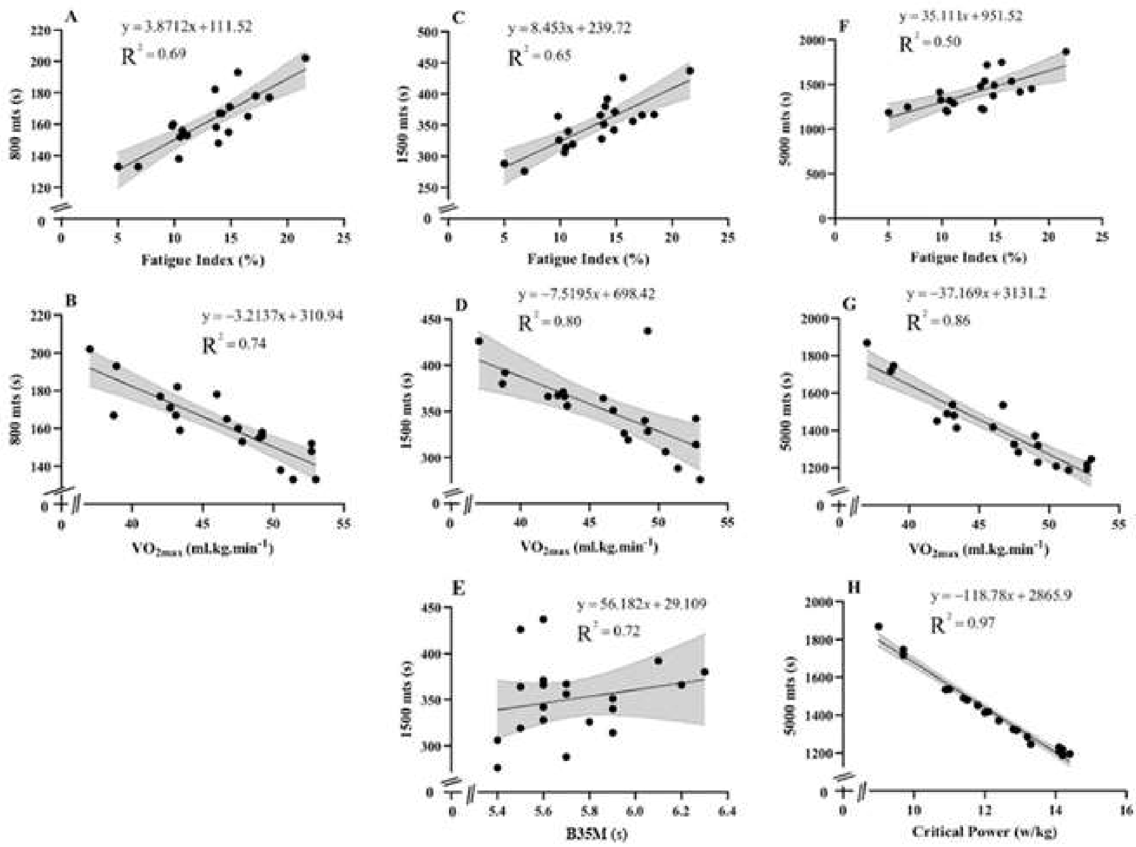


**Figure 2.** Predictions between performance measures and physiological variables obtained in the tests. $R^2$ = coefficient of determination. IF= Fatigue Index; B35M = best time in RAST in 35 m; V̇O2max = maximum oxygen uptake; SD = standard deviation; β = beta coefficient.
**Source**: authors

Table 2 presents the results obtained from the stepwise regression analysis of the variables that positively influence the performance of the 800m, 1,500m, and 5,000m from which the prediction equations were obtained.

**Table 2.** Results of the stepwise regression analysis of the variables that positively influence the performance of 800 m, 1,500 m, and 5,000 m.

| | Model | Non-standard coefficientes | | β | Sig | $R^2$ |
|---|---|---|---|---|---|---|
| | | B | SD errors | | | |
| **800m** | (Constant) | 229.028 | 25.532 | | 0.000 | |
| | IF | -2.058 | 0.437 | -0.553 | 0.000 | 0.69 |
| | V̇O2max | 2.168 | 0.543 | 0.468 | 0.001 | 0.74 |
| **1,500m** | (Constant) | 390.766 | 103.056 | | 0.002 | |
| | IF | 4.255 | 1.092 | 0.407 | 0.000 | 0.65 |
| | B35M | 22.920 | 13.169 | 0.142 | 0.047 | 0.72 |
| | V̇O2max | -4.912 | 0.911 | -0.585 | 0.000 | 0.80 |
| **5,000m** | (Constant) | 2,786.839 | 109.055 | | 0.000 | |
| | IF | 3.659 | 2.366 | 0.074 | 0.000 | 0.50 |
| | V̇O2max | -3.471 | 3.774 | -0.087 | 0.000 | 0.86 |
| | Critical Power | -103.123 | 11.486 | -0.858 | 0.000 | 0.97 |

**Note**: IF= Fatigue Index; B35M = best time in RAST in 35 m; V̇O2max = maximum oxygen uptake; SD = standard deviation; β = beta coefficient.
**Source**: Authors

From the statistical data, three equations were obtained, one for each distance, which could predict the performance in each event mentioned, based on the results of the tests that showed greater affinity with the described distance. Thus, it was established as follows:

Prediction of 800 m = 229.028 – 2.058 × ($\dot{V}O_2max$) + 2.168 (IF)

Prediction of 1,500 m = 390.766 + 4.255 × (IF) + 22.920 × (B35M) – 4.912 × ($\dot{V}O_2max$)

Prediction of 5,000 m = 2,786.839 + 3.659 × (IF) – 3.471 × ($\dot{V}O_2max$) – 103.123 × (Critical power)

## Discussion

The present study had as its objective to investigate the determinant variables of performance in middle and long-distance events in university athletics, being the Maximum Power; Fatigue Index; best time in RAST at 35 m; Vertical jump resistance; maximum relative oxygen consumption; maximum consumption of absolute oxygen, and Critical Power. The final hypothesis that the greater the event distance, the more the aerobic variables would gain strength, and the shorter the distance, the more the anaerobic variables would appear, was mainly confirmed concerning $\dot{V}O_2max$, critical power, and the Fatigue Index. Speculatively, the best time in 35 m seems to be explained by the heterogeneity of the sample, being college athletics practitioners and not middle and long-distance event athletes.

Denadai, Ortiz and Mello[19] observed in 14 well-trained runners that the performance prediction of endurance athletes from the $\dot{V}O_2max$, $i\dot{V}O_2max$, exhaustion time of $i\dot{V}O_2max$ (Tlim), running economy (EC), and anaerobic threshold is dependent on the distance of the race. It was found that the anaerobic threshold was able to predict performance at a distance of 5.000 m ($R^2 = 0.50$), but at 1,500 m it was noticed that performance can be determined mainly by the aerobic power indices, $i\dot{V}O_2max$, as in Lacour et al.[20], and Tlim, which are influenced by anaerobic capacity. As in the study of Duffield, Dawson and Goodma[9], Denadai, Ortiz and Mello[19] also verified that the Tlim associated with $i\dot{V}O_2max$ explained 88 % of the performance variation in the 1,500 m. For 800 m, performance can be determined by the aerobic power indices $i\dot{V}O_2max$ and Tlim, which are influenced by the anaerobic capacity, associated with the variable related to the power of lower limbs, which goes against what was said by Scott et al.[21] in which this performance in the 800 m cannot be predicted only by the aerobic capacity variables. In Lacour et al.[20] however, i$\dot{V}O_2max$ showed no significant correlation with 800 m ($r = 0.32$; $n = 13$), indicating that at distances greater than 800 m, performance strongly depends on the athlete's ability to sustain a high speed in aerobic conditions. Paavolainen et al.[22] found a relationship of $\dot{V}O_2max$ with performance in the 5,000 m in 17 well-trained athletes and verified that in addition to aerobic power and running economy, neuromuscular characteristics and muscular power were also related to performance in the 5,000 m race. Costill et al.[23] stated that in addition to $\dot{V}O_2max$, long-distance running success depends on running economy and the ability to use a large fraction of $\dot{V}O_2max$. Brandon and Boileau[24], discovered in the 800 m, 1,500 m, and 10 km events that there was a relationship between performance in them and $\dot{V}O_2max$, being more important for the 10 km event. Finally, Padilla et al.[25] verified in a group that contained male and female athletes, a relationship between the performances of 1,500 and 3,000 m and $\dot{V}O_2max$, and the relationship between $\dot{V}O_2max$ and race energy cost. In the study by Mølmen et al.[26], it was found that aerobic capacity is a major predictor of $\dot{V}O_2max$ and maximal power.

The results of the studies mentioned above corroborate the results found in the present study, in which the absolute $\dot{V}O_2max$ obtained a very strong relationship with the 800 m and 5,000 m events and a perfect relationship with the 1,500 m. This can be explained by the heterogeneity of the group since when runners with similar $\dot{V}O_2max$ are analyzed, it is believed that the homogeneity of the group can provide more accurate information regarding the ability to predict performance by other physiological indices[27].

In the study of Arins et al.[28] with 11 trained runners in the events of 800 m and 1,500 m, it was found that the indices related to aerobic power ($\dot{V}O_2max$ and Tlim) were the main determinants of performance for distances of 800 m and 1,500 m races, as well as in other studies[19,29].

In the study by Hespanhol et al.[12], it was stated that there was a reliable measure of the 4 x 15 intermittent jump test with 10 seconds of rest in the estimation of the explosive strength endurance through the variables mean power and fatigue index, as well as Storniolo et al.[30], who stated the same reliability but in a 60-second protocol without rest. Despite this finding, in the vertical jump resistance test, no significant correlation was found with performance in the events of the present study. Thus, in this work, the suggested association did not prove to be valid, probably because the sample is composed of a university population. However, it is noteworthy that in athletes the phenomenon can present itself in another way. Important results were found from the RAST test that corroborate the results of the present study. Oliveira et al.[31] stated that RAST can be used to determine relative and absolute maximum power values, as well as absolute mean power values. Complementarily, RAST proved to be more effective in determining the effort demands of aerobic capacity. Thus, the absolute parameters of RAST are valid, as demonstrated by Zagatto, Beck and Gobatto[32] in which the same comparison was made between the tests, finding significant correlations in the absolute parameters, peak ($r = 0.53$), and mean ($r = 0.46$) power, but in this study, the results for the relative parameters were not reported. In continuation, in Zagatto, Beck and Gobatto[32] RAST had significant correlations with the Wingate test (peak power $r = 0.46$; mean power $r = 0.53$; fatigue index $r = 0.63$) and performance scores of 35, 50, 100, 200, and 400 m ($p<0.05$). Furthermore, the parameters determined through RAST have shown significant correlations with the maximum performances of 100, 200, and 400 m races[33]. RAST can be used to measure anaerobic power in running and predict short-distance performance. In Andrade et al.[34] there is an indication that the aerobic metabolism influences the performance of the RAST. In this study, the main finding was the confirmation of the hypothesis that the maximum aerobic fitness ($\dot{V}O_2max$) can influence the parameters from the RAST. Kalva-Filho et al.[35] found in soccer players that the mean and relative absolute power for body weight presented significant correlations with i$\dot{V}O_2max$ ($r=0.79$ and $r=0.85$, respectively). Fatigue index and relative peak power were also significantly correlated with i$\dot{V}O_2max$ (r=-0.57 and r=0.73, respectively, i.e., the aerobic variable correlated to performance was i$\dot{V}O_2max$).

Adamczyk[36] stated that the RAST test can be used for regular monitoring of the level of anaerobic capacity of athletic athletes. However, in the present study, a variable found in the RAST test did not present a significant correlation with the performance in the evaluated events, it being the maximum power (P MAX). The best time in 35 m (B35M) presented an unexpected correlation with the 1,500 m event. Speculatively, the lack of experience of participants with all three events probably explains this result in the best time in 35 m and again this is probably due to the composition of the sample; the phenomenon could be different in athletics athletes. Another hypothesis would be that with a lower maximum oxygen consumption, the anaerobic contribution could gain importance.

Critical power was correlated to the performance in the 5,000 m event. The critical power model was applied to the treadmill, by Hughson et al.[37] and Housh et al.[38]. The running data fit the model well, and fatigue threshold (or critical speed, similar to critical power) was correlated with $\dot{V}O_2max$[37]. As in the present study, Kolbe et al.[39] found that among a group of runners of varying abilities, critical power was as good a predictor of running as $\dot{V}O_2max$. Critical power was a slightly better predictor of 10 km performance than $\dot{V}O_2max$ (r = -0.85 vs r = -0.81). The authors further cite that these values would not be useful for predicting performance or for monitoring small changes in performance as a result of training or other interventions. Jenkins and Quigley[40], found a strong relationship in 18 untrained men between the critical power found in the ergometer cycle and aerobic measures such as the resistance time at 270 W, $\dot{V}O_2max$, and the average power maintained for 40 min, concluding that critical power appears to provide a useful practical means of monitoring aerobic endurance capacity and individual response to training.

Practically, the three equations for performance prediction for middle and long-distance athletes are an option for coaches in their control routine and training prescription, especially at the beginning of work, in teams in which athletes do not have extensive experience in the events above, as well as sophisticated materials for measuring their motor skills. Further studies are warranted to understand the assessments that predict performance in long-distance running (> 5 km).

This study strengthens the idea that a cluster of specific assessments may predict performance in middle and long-distance running. This study has the limitation of the number of participants because it's hard to schedule tests in the well-trained athlete's agenda, without compromising their periodization.

## Conclusion

For university runners in middle and long-distance athletics events, the variables that most explained the distances running were the FI (800 m, 1,500 m, 5,000 m); $\dot{V}O_2max$ (800 m, 1,500 m, 5,000 m), B35M (1,500 m); and critical power (5,000 m). Athletes and coaches should utilize assessments such as FI, $\dot{V}O_2max$, B35M, and critical power to better middle and long-distance running.

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