Research article

Influence of time of day on performance in a battery of physical fitness tests in young university student

Influência do período do dia no desempenho em uma bateria de testes de aptidão física em jovens universitários

Influencia de la hora del día en el rendimiento en una batería de pruebas de aptitud física en jóvenes universitarios

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ABSTRACT

This work aims to investigate whether the time of day influences the performance of individuals in a PFT battery. The sample consisted of ten individuals of both genders (24.10±0.96 years), who performed the FAT in three periods of the day: morning, afternoon and night, on three non-consecutive days over the course of a week. The FAT consisted of five tests (handgrip test, fixed bar test, abdominal flexion test, horizontal impulsion test and Shuttle-run) for men and four tests for women, who did not perform the strength test on the bar. fixed. On the first day of the battery of tests, they underwent an anthropometric and body composition assessment with bioimpedance. On each evaluation day, the participants had their body temperature measured before starting the tests and answered the subjective perception of exertion (RPE) after each test. For the statistical analysis, one-way anova with Bonferroni post-hoc was used to compare performance differences over the three periods of the day. No significant differences (P>0.05) were found in the performance between the tests performed, nor in the PSE in the comparisons between the three periods of the day. Body temperature was significantly (P<0.01) lower in the morning (36.28±0.08 °C) when compared to the afternoon (36.54±0.69 °C) and night (36.70 ±0.10 °C). Thus, it is possible to conclude that the time of day does not influence the performance of young adults in a PFT battery.

Key words: Athletic performance; Circadian rhythm; Physical fitness tests.

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RESUMO

Esse trabalho tem como objetivo investigar se o período do dia influencia no desempenho dos indivíduos numa bateria de TAF. A amostra foi composta por dez indivíduos de ambos os sexos (24,10 ± 0,96 anos), que realizaram o TAF nos três períodos do dia: manhã, tarde e noite, em três dias não consecutivos no decorrer de uma semana. O TAF foi composto por cinco testes (teste de preensão manual, teste na barra fixa, teste de flexão abdominal, teste de impulsão horizontal e Shuttle-run) para homens e quatro testes para as mulheres, que não realizaram o teste de força na barra fixa. No primeiro dia da bateria de testes, eles foram submetidos a avaliação antropométrica e de composição corporal com bioimpedância. Em cada dia de avaliação, os participantes tiveram a temperatura corporal aferida antes de iniciar os testes e responderam à percepção subjetiva de esforço (PSE) após cada teste. Para a análise estatística foi utilizado a ANOVA one-way com post-hoc de bonferroni para comparar as diferenças de performance ao longo dos três períodos do dia. Não foram encontradas diferenças significativas (P>0,05) no desempenho entre os testes realizados, nem na PSE nas comparações entre os três períodos do dia. A temperatura corporal foi significativamente (P<0,01) menor no período da manhã (36,28 ± 0,08 °C) quando comparada ao período da tarde (36,54 ± 0,69 °C) e da noite (36,70 ± 0,10 °C). Assim, é possível concluir que o período do dia não influência o desempenho de adultos jovens em uma bateria de TAF.

Palavras chave: Desempenho atlético; Ritmo circadiano; Testes de aptidão física.

RESUMEN

Este trabajo tiene como objetivo investigar si la hora del día influye en el rendimiento de los individuos en una batería de pruebas de aptitud física (BAF). La muestra estuvo conformada por diez individuos de ambos sexos (24,10±0,96 años), quienes realizaron el BAF en tres momentos del día: mañana, tarde y noche, en tres días no consecutivos en el transcurso de una semana. La BAF constaba de cinco pruebas (handgrip test, test de barra fija, test de flexión abdominal, test de impulsión horizontal y Shuttle-run) para hombres y cuatro pruebas para mujeres, que no realizaron la prueba de fuerza en barra fija. El primer día de la batería de pruebas se les realizó una valoración antropométrica y de composición corporal con bioimpedancia. En cada día de evaluación, a los participantes se les tomó la temperatura corporal antes de comenzar las pruebas y respondieron la percepción subjetiva de esfuerzo (PSE) después de cada prueba. Para el análisis estadístico, se utilizó Anova unidireccional con Bonferroni post-hoc para comparar las diferencias de rendimiento en los tres períodos del día. No se encontraron diferencias significativas (P>0,05) en el rendimiento entre las pruebas realizadas, ni en el PSE en las comparaciones entre los tres períodos del día. La temperatura corporal fue significativamente (P<0,01) más baja en la mañana (36,28 ± 0,08 °C) en comparación con la tarde (36,54 ± 0,69 °C) y la noche (36,70 ± 0,10 °C). Por lo tanto, es posible concluir que la hora del día no influye en el rendimiento de los adultos jóvenes en una BAF.

Palabras clave: Desempeño atlético; Ritmo circadiano; Pruebas de aptitud física.

INTRODUCTION

Physical fitness is a much-discussed topic today, and its health benefits have a strong influence on the quality of life of human beings, demonstrating that both physical inactivity and low physical fitness are harmful to health (Araújo & Araújo, 2000). Conceptually, physical fitness is divided into two approaches: performance-related physical fitness and health-related physical fitness (Nahas, 2001).

The health-related components encompass a larger number of people and value the physiological variables that facilitate the performance of activities of daily living, such as muscular strength and endurance, flexibility and components of body composition. In addition to the health-related components, the performance-related physical fitness components include all those necessary to achieve maximum sports or work performance, such as agility, balance, motor coordination, power and speed (Nahas, 2001; Shephard & Balady, 1999).

In the field of Physical Education, the development of physical fitness components is the central focus of a training program (Böhme, 1993). For both health maintenance and athletic performance improvement, there are specific tests capable of individually measuring the level of each of these components (Roschel et al., 2011). In job functions in which these components are highly required, it is common to assess these variables through physical fitness test batteries (PFT), which are even used as a stage in public examinations, and may have an elimination and/or classificatory nature (Lima et al., 2008).

In order for candidates to perform better, specific training for the tests is necessary. In addition, it should be taken into account that the human body is influenced by several physical and environmental factors that can compromise its performance, such as the circadian cycle (Hey et al., 2020). The circadian cycle refers to a set of biological processes that revolve around a twenty-four-hour day, during which a variety of physiological processes such as body temperature, neurotransmitters, hormones and heart rate are regulated (Mendonça, 2019) and, according to the literature, is directly related to the performance of individuals, as well as their sleep and alert cycle (Fuller et al., 2006; Ayala et al., 2021).

A study by Hey et al. (2020) demonstrated that the time of day does not influence the muscular endurance of trained men. On the other hand, another study demonstrated that increases in strength, power and endurance are often observed in the afternoon and evening (Ayala et al., 2021). Thus, even though it is known that the circadian cycle acts on different physiological components that can influence physical performance, there is still no consensus in the literature to state whether there is a best time of day to achieve maximum performance (Grgic et al., 2019; Minati et al., 2006).

When performing a PFT, it is not always possible for the person being evaluated to choose the time of day to perform the test. Considering possible differences in performance in relation to the time of day, this could influence the result of the person being evaluated. Thus, the present study aimed to investigate whether the time of day influences the performance of individuals in a PFT battery.

METHODS

Study Design

The study lasted seven days. After the sample was recruited, a draw was held to determine the order in which the PFT would be performed (evening, morning, afternoon). On the first day, the participants

underwent anthropometric and body composition assessments and answered a questionnaire to determine their level of physical activity. They were then instructed and began the procedures for performing the PFT. On the second and third days of the assessment, only the PFT was performed, always with the tests in the same order (handgrip, abdominal test, horizontal jump test, shuttle run and, for men, the pull-up test).

Sample

The sample consisted of ten individuals of both sexes who were recruited through advertisements on social media at the university. As inclusion criteria for participation in the study, participants had to: a) be between 18 and 35 years old; b) not have any physical injuries that could be aggravated during the application of the tests; c) the women could not be pregnant.

The project was submitted for analysis and approval by the Standing Committee for Ethics in Research involving Human Beings of UEM (COPEP/UEM). Before the beginning of the study, the individuals were duly informed about the research procedures and those who agreed to participate signed the Free and Informed Consent Form (FICF).

Physical activity level

To assess the level of physical activity, the International Physical Activity Questionnaire - IPAQ short version, validated for the Brazilian population (Matsudo et al., 2012), was used. The questionnaire consists of eight questions about the time and intensity of physical activity in the last week during leisure time, in addition to the time spent in sedentary behavior. Individuals who reported a minimum of 150 minutes per week of moderate-intensity physical activity or 75 minutes per week of vigorous activity were considered physically active, as recommended by the Physical Activity Guide for the Brazilian Population (Ritti-Dias et al., 2021).

Anthropometry and Body Composition

Anthropometric and body composition assessments were performed to characterize the sample. Participants were assessed individually in a private location by an experienced evaluator. The anthropometric assessment consisted of height (H) and body mass (BM). Height was assessed using a stadiometer fixed to the wall, with the participant barefoot and adopting the Frankfurt position. Body mass was measured using a digital scale, with the participant barefoot and wearing light clothing. Based on these data, the body mass index (BMI) was calculated using the formula BMI=BM/H (Nahas, 2001). Body composition was assessed using bioimpedance (BiaAnalyser). Participants were instructed to fast from food and water for at least four hours, not to engage in strenuous physical exercise in the 24 hours prior to the assessment, to wear light clothing, to remove metal objects, and to empty their bladders prior to the assessment. They were evaluated in the supine position, with electrodes attached to the feet and hands, on the right side of the body. Resistance and reactance values were measured, and absolute and relative values of body fat and fat-free mass were calculated.

Physical Fitness Test Battery

Muscle strength

The handgrip test with a dynamometer (Saehan SH, 1001) was used to assess muscle strength. The subject was instructed to stand upright, where the grip bar was adjusted so that the second joint of the fingers fit perfectly under the handle, aligning the equipment with the forearm at thigh level, away from the body. The subject squeezed as hard as possible without holding his breath, always keeping the grip away from the body. The test was performed three times on each hand, alternately, and the highest value achieved was considered for the analyses (American Society Hand Therapy, 1983).

Abdominal Flexion

The abdominal flexion test indirectly assesses abdominal muscle strength through the performance of flexing and extending the hip (Schoenell et al., 2013). In this test, the individual had to perform the greatest number of abdominal flexions possible during the period of one minute, starting in the supine position, with knees flexed, arms crossed at chest height, so that the right hand held the left shoulder and the left hand the right shoulder, with support on the instep of the feet, perform abdominal flexions extending the hips so that the forearms touched the thighs and shoulder blades on the ground, so that the repetition was counted. The maximum number of repetitions that the individual managed to perform in a single one-minute attempt were counted.

Horizontal thrust

This test was applied to assess the explosive strength of the lower limbs. In the horizontal impulse test, the subject had to reach the maximum distance in a horizontal jump, where the starting point is stationary and with the feet parallel. The greatest distance reached between the closest point of the subject's body in relation to the starting line of the jump was considered (Guedes & Guedes, 2006).

Agility

The Shuttle Run test was used to assess agility. It was performed on a flat site where two lines of one meter each were marked, with a distance of 9.14 m between them, two wooden sticks separated from each other by a distance of 30 centimeters and were placed ten centimeters from the outside of the line opposite the starting line. At the command “in position”, the subject positioned one foot as close to the starting line as possible. At the sound signal, the participant ran at maximum speed to the other line with the objective of picking up one stick at a time, passing both feet of the line and returning to the starting line, leaving the stick on the ground after having passed both feet of the starting line, without stopping the run. The same sequence described above was repeated. For the second stick, the time was measured from the moment of the sound signal until the moment the participant placed the second stick on the ground after the starting line (Johnson & Nelson, 1979).

Muscular endurance

The pull-up test was used to assess upper limb muscular strength and endurance. The test was performed with the hands in a supine position in relation to the bar. The participant had to perform the pull-up on the pull-up bar until the chin passed the bar, without any momentum or swinging of the trunk during the movement, so that the first repetition would be counted. The maximum number of repetitions that the participant could perform in a single attempt without letting go of the bar was counted (Johnson & Nelson, 1979).

Body Temperature

The body temperature of the subjects was measured on each day of the assessment series, before performing the PFT, using a digital thermometer (Bioland E127).

Subjective Perceived Exertion

To assess the subjective perception of effort (RPE), the Borg Scale (Borg, 1982) was used, which was applied after the end of each test battery, where the person being evaluated responded to the level of effort that was necessary to perform the PFT, following a scale of 6 to 20, in which 6 means very easy and 20 very exhausting.

Statistical analysis

The SPSS 26 program was used for statistical analysis of the data. Descriptive statistics were used to characterize the sample. The Shapiro-Wilk test was used to analyze the distribution of the data and ANOVA one-way with Bonferroni post-hoc to compare the data in the different periods of the day. P<0.05 was considered significant. etc).

RESULTS

Table 1 presents the characterization data of the study participants. The sample consisted of six men and four women, all university students.

Table 1

Characterization data of study participants (n=10).

	Mean ± standard deviation	[Minimum – Maximum]
Age (years)	24,10 + 0,96	[19,00 – 30,00]
Weight (kg)	76,03 + 4,70	[51,30 – 101,30]
BMI (kg/m²)	26,18 + 1,42	[18,39 – 32,33]
FFBM (%)	78,19 + 2,35	[70,20 – 95,90]
BM (%)	21,82 + 2,35	[4,10 – 29,80]

Note: BMI – Body mass index; FFBM – Fat free mass; BM – Body fat.

Regarding the level of physical activity, the analyses indicated that all study participants (100%) were physically active, performing at least 150 minutes of moderate-intensity physical activity per week and/or 75 minutes of vigorous-intensity physical activity per week. Figure 1 presents the results of the comparisons of each of the tests that made up the PFT. The analyses indicated that there was no significant difference (P>0.05) between the periods of the day in the performance of the study participants. It is worth noting that the pull-up test was performed only by male participants, who represented 60% of the sample, since strength fitness tests with a number of repetitions on pull-ups are more commonly used for males.

Figure 1

Comparison of participants' performance in the three periods of the day in the physical performance battery tests (n=10).

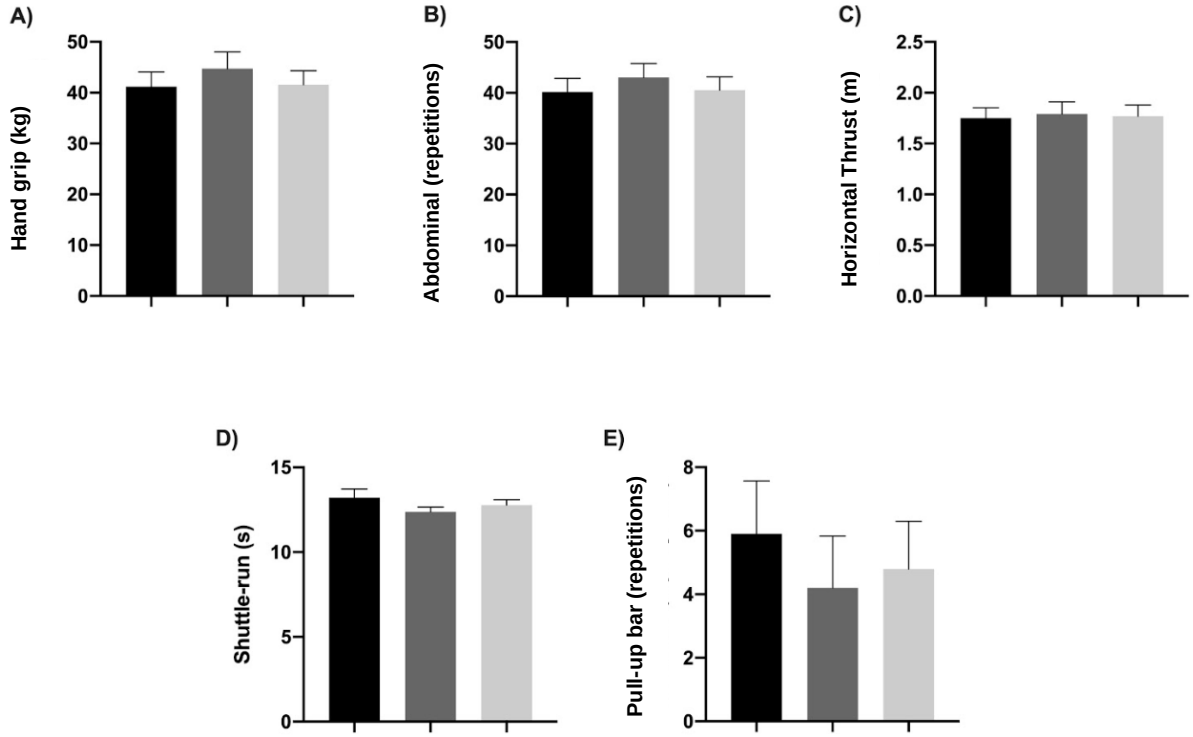

Table 2 shows the comparison of body temperature and RPE in different periods of the day. The analyses indicated that body temperature was significantly lower (P<0.01) in the morning when compared with the afternoon and evening periods. The results for RPE did not show significant differences between the three periods evaluated, suggesting a similar effort in the proposed test, regardless of the period of the day.

Table 2

Comparison of body temperature and RPE at different times of the day (n=10).

	Morning	*Afternoon*	*Evening*	*P*
Body temperature (°C)	36,28 + 0,08	36,54 + 0,69*	36,70 + 0,10*	**< 0,01**
Abdominal RPE	15,00 + 0,45	15,20 + 0,33	15,00 + 0,45	0,98
Horizontal Thrust RPE	11,80 + 0,35	12,20 + 0,63	12,40 + 0,45	0,54
Shuttle-run RPE	12,40 + 0,79	13,40 + 0,69	12,80 + 0,61	0,57
Pull-up bar RPE	10,80 + 2,39	7,40 + 2,51	9,00 + 2,46	0,54

Note: RPE – Perceived exertion; * Difference for morning, One-way ANOVA with Bonferroni post-hoc.

DISCUSSION

The results of this study indicate that there was no difference in the time of day in PFT performance, which is in line with the initial hypothesis that the time of day would influence performance. Our result corroborates that found by Hey et al. (2020), who showed that there was no difference in muscular

endurance performance in relation to the different times of the day in men practicing weight training. Chtourou et al. (2018) also found no differences in performance in the times of day in judo athletes. These studies, together with our findings, contradict the literature that indicates an increase in maximum force production in the afternoon and evening (Pedroso et al., 2013), and reinforce the lack of consensus regarding the time of day in performance in anaerobic tests (Ayala et al., 2021).

The possible explanations for a significant difference in performance at some time of the day, especially in the afternoon, come from understanding the influence of the circadian cycle on hormone concentrations. Therefore, a higher concentration of testosterone and cortisol in the late afternoon could explain the superior performance during this period (Ayala et al., 2021). However, a limitation of our study was that we did not perform any type of biochemical evaluation, and it is not possible to confirm the influence of these parameters on the results found.

The only variable that presented a significant difference between the periods was body temperature, which was significantly lower in the morning compared to the afternoon and evening. This result is in line with other findings that indicate a significant variation in body temperature throughout the day (Ayala et al., 2021; Deschenes et al., 1998). It is already known that the circadian rhythmicity of temperature assumes some basic characteristics in its measurement, which reaches a minimum during sleep around 4 am and begins to increase before waking (Minati et al., 2006). To analyze the intensity of the effort performed by each participant in the applied tests, the RPE was used, which also showed no significant difference between the periods, indicating that the intensity of the tests was similar in the three periods of the day. Chapman et al. (2019) performed performance tests, evaluating such behavior through the subjective effort scale and identified a relationship between the scale and the drop in performance. The literature indicates that the RPE is a reliable tool for assessing performance related to strength and fatigue (Moura et al., 2003). The similar scores in our study demonstrate that a standardized level of effort was maintained in the tests, confirming that there was no influence of the time of day on the participants' performance.

It is worth noting that we did not perform any cardiorespiratory fitness tests, an assessment that is commonly used in PFT for public examinations. This is a limitation of our study, as is the size of our sample, which was small and involved people of both sexes, which may have compromised the power of our analyses. Another important point is that our results cannot be extrapolated to other populations, since our sample consisted only of physically active young adult university students.

As a practical application, this study presents results that demonstrate that for the assessment of agility, endurance and muscular strength there is similarity in performance regardless of the time of day. Thus, it is possible to state that for the assessment of these physical fitness parameters, the PFT can be applied in the morning, afternoon and evening without, apparently, any harm to those evaluated.

CONCLUSION

It is concluded that the time of day does not influence the performance of young adult university students in a battery of physical fitness tests. In other words, regardless of whether the tests are performed in the morning, afternoon or evening, there are no significant differences in relation to the performance of adults of similar age and physical condition.

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