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EVALUATION OF THE RELATIONSHIP BETWEEN PHYSICAL ACTIVITY LEVEL AND EXECUTIVE FUNCTIONS IN UNIVERSITY STUDENTS

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ABSTRACT

Purpose: This study aimed to evaluate the relationship between physical activity level and executive functions in university students.
Methods: Ninety-three (18-25 years of age) (Female:64; Male:29) university students studying at Bezmialem Vakif University, Faculty of Health Sciences, Department of Physiotherapy and Rehabilitation were included in the study. The participants' physical activity levels were assessed using the International Physical Activity Questionnaire-Short Form (IPAQ-SF), and their executive functions were evaluated using the Stroop Test-TBAG form.
Results: In this study, 32.3% of participants were found to be very active, 30.1% were inactive, and 37.6% were minimally active. No statistically significant relationship was found between university students' total IPAQ-SF scores and the Stroop Test-TBAG form scores.
Discussion: In this study, no relationship was obtained between physical activity level and executive functions. Further research is needed using objective methods to understand the possible interaction between physical activity and executive functions in university students. Investigating the effect of physical activity on executive functions can contribute to raising awareness of physical activity, healthy aging, and success in academic life in university students.
Key Words: executive function, physical activity, student

ÖZET

Amaç: Bu çalışmanın amacı, üniversite öğrencilerinde fiziksel aktivite düzeyi ile yürütücü fonksiyonlar arasındaki ilişkiyi değerlendirmektir.
Yöntem: Çalışmaya Bezmialem Vakıf Üniversitesi, Sağlık Bilimleri Fakültesi, Fizyoterapi ve Rehabilitasyon Bölümü'nde eğitim gören 18-25 yaş aralığında, 93 öğrenci (64 kız, 29 erkek) dahil edildi. Katılımcıların fiziksel aktivite düzeyleri Uluslararası Fiziksel Aktivite Ölçeği-Kısa Formu (IPAQ-KF) ve yürütücü fonksiyonları Stroop Testi-TBAG formu ile değerlendirildi.
Bulgular: Çalışmaya katılan olguların %32.3'ü fiziksel olarak yeterli derecede aktif, %30.1'i inaktif ve %37.6'sı minimal düzeyde aktif olarak bulundu. Olguların IPAQ-KF total skorları ile Stroop Testi-TBAG formu skorları arasında istatistiksel olarak anlamlı bir ilişki bulunmadı ($p>0.05$).
Tartışma: Bu çalışmada, fiziksel aktivite düzeyi ile yürütücü işlevler arasında bir ilişki elde edilemedi. Üniversite öğrencilerinde fiziksel aktivite ile yürütücü işlevler arasındaki olası etkileşimi anlamak için objektif yöntemlerin kullanıldığı daha fazla çalışmaya ihtiyaç vardır. Fiziksel aktivitenin yürütücü işlevler üzerindeki etkisinin araştırılması, üniversite öğrencilerinde fiziksel aktivite farkındalığının artırılmasına, sağlıklı yaşlanmaya ve akademik yaşamda başarıya katkıda bulunabilir.
Anahtar Kelimeler: yürütücü fonksiyon, fiziksel aktivite, öğrenci

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INTRODUCTION

According to the 'Physical Activity and Sedentary Behavior Guidelines' published by the World Health Organization (WHO) in 2020, physical activity (PA) is characterized as any bodily movement demanding energy expenditure beyond the basal level, accomplished through the contraction of skeletal muscles (1). As per the 'Global Recommendations on Physical Activity for Health' published by the WHO in 2010, it is noted that approximately one in four adults (27.5%) and over three-quarters of adolescents (81%) fail to meet the guidelines for aerobic exercise (1, 2). The 21st century has been the cradle of modernization, automation, and numerous technological advancements. However, the sedentary lifestyle that has emerged as a result is now recognized as a significant risk factor for mortality in contemporary times (3).

Physical inactivity contributes to the emergence of chronic diseases such as coronary heart disease, osteoporosis, diabetes, cancer, hypertension, and obesity, turning them into significant public health issues, besides being the fourth leading risk factor for mortality worldwide. Additionally, it is also associated with the development of mental disorders like depression and anxiety in the community (4).

PA improves physiological, psychological, and metabolic parameters, reducing the risk of chronic diseases and premature mortality. In addition to its impact on physical health conditions, PA contributes positively to mental performance, executive functions (higher level of cognitive functioning like working memory, planning, attention, etc.), and motor coordination in specific psychiatric disorders like depression and anxiety (5). A study conducted in the United States and Canada involving 55,000 individuals concluded that those with higher levels of PA tend to have better mental health (6). PA has been observed to be effective in different neurodevelopmental problems in children, such as attention deficit hyperactivity disorder (ADHD). In adults, it has been found to contribute to a 14-24% reduction in the risk of dementia and a 33-38% reduction in the risk of cognitive decline. Research indicates that individuals with higher levels of PA tend to have better brain structure and function than those with lower levels (7). Indeed, studies have shown that exercise interventions can enhance cognitive levels, executive functions, memory, and visual-spatial skills in cognitively normal older adults. Additionally, these interventions have demonstrated the ability to increase brain volume and functional connectivity (8).

The relationship between PA and executive functions is especially emphasized in the literature, with reports stating that increased PA can lead to positive cognitive development, particularly in children and older people (9). However, few studies investigate the relationship between PA level and executive functions in young people, one of our country's major populations. Considering the importance of cognitive functions in educational life, it is possible to investigate the factors that may improve these functions in university students. In this context, this planned study aims to contribute to the literature by examining the relationship between PA level and cognitive functions in university students to enhance the success of young university students in their educational life and promote healthy aging by raising awareness about PA.

METHODS

The research was conducted in the Division of Physiotherapy and Rehabilitation of Bezmialem Vakif University in October-November 2023. The study was approved by the Bezmialem Vakif University Non-Interventional Clinical Research Ethics Committee (Approval number: 2023/276, approval date: 06.09.2023). Written informed consent was obtained from the individuals participating in the research by adhering to the ethical principles of the Declaration of Helsinki.

Participants

G-Power 3.1 (Universitat Dusseldorf, Germany) was used to estimate the sample size (10). In this study, our hypothesis was to identify a significant correlation between PA and executive functions in students, as suggested by a previous study. The sample size was determined to be at least 75 subjects to detect this relationship with a correlation coefficient of 0.28, confidence level of 95% and 80% power (11).

Ninety-three participants, 64 females and 29 males, aged between 18 and 25 years, studying at Bezmialem Vakif University Department of Physiotherapy and Rehabilitation in class 3 and 4, were included in the study. The inclusion criteria were to speak and understand Turkish, while the exclusion criteria were to have any diagnosis of chronic and severe systemic disease or vestibular, neurologic, musculoskeletal, vision, speech, and hearing problems.

Assessments

The participants' data, such as gender, height, and weight, were recorded in demographic data forms. The subjects' PA levels were evaluated with the International Physical Activity Questionnaire-Short Form (IPAQ-SF), and the Stroop Test-TBAG form was applied to measure the executive functions of subjects.

International Physical Activity Questionnaire- Short Form (IPAQ-SF)

The International Physical Activity Questionnaire (IPAQ) is a survey developed to determine the PA levels of individuals aged 15-65 (12). The short form was created with the support of the WHO and the Centers for Disease Control and Prevention (CDC), and its validity and reliability have been studied. The questionnaire consists of seven questions, providing information about the time individuals spend in light, moderate, and vigorous activities and their sitting time. For the assessment of all activities, the criterion is that each activity should be performed for at least 10 minutes at a time. The score is calculated as "metabolic equivalent (MET)-minutes (min)/week" by multiplying minutes, days, and MET values (multiples of resting oxygen consumption). For calculating walking scores, 3.3 MET is used for walking, 4 MET for moderate-intensity activity, and 8 MET for vigorous activity. Accordingly, weekly MET-min scores of individuals are obtained. To the scores, PA levels are categorized as “inactive (<600 MET-minute/week)”, “minimally active (600-3000 MET-minute/week)”, and “very active (>3000 MET-minute/week)” (13).

Stroop Test TBAG Form (STP-TBAG)

The neuropsychological test primarily assesses complex attention and is available in various versions. This study utilized the Stroop Test TBAG (STP-TBAG), developed by the Scientific and Technological Research Council of Turkey (TBAG). This form combines elements from the original Stroop test and the Victoria form, which have undergone standardization, reliability, and validity studies tailored to our national culture. The STP-TBAG Form consists of five subtests administered in a specific sequence using four cards: reading the color names printed in black (STP-TBAG-1), reading color names printed in different colors (STP-TBAG-2), naming the colors of colored circles (STP-TBAG-3), naming the colors of colored neutral words (STP-TBAG-4), and naming the colors of colored words where the color and meaning are incongruent for some words (e.g., the word 'red' printed in blue) (STP-TBAG-5). Test scores were determined by recording the time to complete each section based on normative data (14, 15).

Statistical Analysis

Statistical analysis was performed using SPSS 22.0 statistical program (SPSS Inc., USA). Descriptive statistical methods (Percentage, Frequency, Standard deviation, Mean) were used for data assessment. The Kolmogorov–Smirnov test was used to evaluate whether the data had a normal distribution. For correlation analysis, Pearson correlation analysis was used because of all variables showing a normal distribution. A value of $p<0.05$ was considered statistically significant.

RESULTS

Ninety-three participants with the mean age 20.66±1.33 years were included in this study. Sixty-for participants (68.8%) were girls, and 29 participants (31.2%) were boys. Demographic characteristics of the subjects are presented in Table 1.

Participants’ IPAQ-SF score was calculated as 2390.45 MET-min/week. According to scores, 30.1% were inactive, 37.6% were minimally active and 32.3% were very active (Table 2). There was no statistically significant correlation

between IPAQ-SF score and Stroop-TBAG form test scores (Table 3).

Table 1. Demographic characteristics of subjects

Variables	X±SD	Min-Max
Age (years)	20.66±1.33	18-25
Weight (kg)	62.10±11.19	46.8-87.6
Height (cm)	164.35±6.49	150-178
Body mass index (kg/m²)	23.47±4.25	17.6-31.4

x:mean; SD: standard deviation

DISCUSSION

The current study investigated the relationship between PA level and executive function in university students. Study findings showed that the PA levels of participants were minimally active. In addition, no relationship was found between participants' total PA level and their executive performance.

In our study, only 32.3% of participants were very active, 30.1% were inactive, and 37.6% were minimally active. Yuksel et al. (2021) found that 34% of university students had sufficient PA levels, and 66% had inadequate PA levels (16). In the study by Demirer et al. (2020), they found that 22.6% of the 702 university students participating in the study were sufficiently active, 57% were minimally active, and 20.4% were inactive according to IPAQ scores (17). In another study conducted by Savcı et al., where the PA levels of 1097 university students were evaluated using IPAQ, 18% were found to be sufficiently active, 68% minimally active, and15% inactive (18). Similarly, in another study carried out in our country, it was reported that the total MET score of the students was 2569.7±3833.3 according to the IPAQ-SF score (19). The participants' IPAQ-SF score in our study was 2390.45 MET-min/week. The above studies conducted in our country, including our research in this field, determined that university students' PA levels are insufficient. Various factors can have an adverse impact on engagement in PA. The primary obstacles to PA in university students were associated with the following dimensions: psychological, emotional, and cognitive factors (such as lack of time and motivation), environmental factors (such as a lack of accessible places, cost, accessibility to exercise facilities), and socioeconomic and demographic factors (such as a lack of financial resources). According to the researchers, the most prevalent barrier to PA perceived by university students is the "lack of time" (20). Conversely, in a recent systematic review incorporating studies from different countries, it has been reported that university students have sufficient levels of PA (21). This variation may be due to various factors, related to cultural differences, educational systems in different countries, and differences in PA assessment tools in the studies. In a study published in 2015, the prevalence of physical inactivity among university students was reviewed across 23 countries with varying income levels. The authors reported a notable prevalence of inactive students. They highlighted that student from upper-middle-income and high-income countries demonstrated higher PA levels than those from low-income countries. Additionally, they noted significant disparities in the prevalence of physical inactivity among countries. Consistent with this study, other research has also noted a correlation between a country's economic development and higher levels of PA (22). It is posited that university students from higher-income countries may engage in increased PA levels due to factors such as better access to sports facilities, greater availability of health promotion information, and heightened motivation to participate in PA and sports.

Table 2. Interpretation of total physical activity MET according with IPAQ-SF

		IPAQ-SF Total (n=93)		Gender Girls (n=64)	Gender Boys (n=29)
		MET-min/ week (x±SD)	n (%)	n (%) MET-min/ week (x±SD)	
Physical Activity Level	Inactive	552.13±253.83	28 (30.1%)	24 (37.5%)	4 (13.79%)
	Minimally active	1641.40±570.18	35 (37.6%)	25 (39.06%)	10 (34.48%)
	Very active	4942.63±2941.46	30 (32.3%)	15 (23.43%)	15 (51.72%)
Total		2390.45±2488.90		1859.62±1891.69	3565.87±3202.31

IPAQ-SF: International Physical Activity Questionnaire- Short Form; x:mean; SD: standard deviation.

Table 3. Correlation analysis between IPAQ-SF scores and STROOP test subscores

		STP1 (sec)	STP2 (sec)	STP3 (sec)	STP4 (sec)	STP5 (sec)
IPAQ-SF	**r***	-0.190	0.034	0.042	0.133	0.147
	p*	0.861	0.749	0.697	0.213	0.170

IPAQ-SF: International Physical Activity Questionnaire- Short Form; STP1: Completion time of first subtest of STP-TBAG form; STP2: Completion time of second subtest of STP-TBAG form; STP3: Completion time of third subtest of STP-TBAG form; STP4: Completion time of fourth subtest of STP-TBAG form; STP5: Completion time of fifth subtest of STP-TBAG form, sec: second; * Pearson correlation analysis, $p<0.05$

Generally, low levels of PA are notably common among female students. Also, it has been observed that male students tend to exhibit higher levels of PA compared to their female counterparts (2, 23). In our study, in line with the literature, only 23.43% of female participants were classified as very active, while 51.72% of male participants were categorized as very active. Male university students are more active due to anatomical, psychological, and social factors affecting PA (16, 24).

Executive functions, characterized by their complexity and multifaceted nature, encompass cognitive processes that govern goal-oriented actions, overseeing and managing the mechanisms required for processing information. The executive functions comprise planning, selective attention, sustained attention, adaptability in handling new situations and inhibiting pre-potent responses. Also, they can be categorized into three primary dimensions: working memory, inhibition, and cognitive flexibility (25, 26). As executive functions play an essential role in learning processes, methods capable of improving executive functioning are particularly interesting to researchers (27). In this context, many studies have investigated the correlation between PA and cognitive functioning, including executive functions, over the past few decades. Recently, hypotheses have been proposed suggesting executive functioning could benefit from alterations in neurobiological processes induced by PA. A considerable body of evidence, comprising observational studies, randomized controlled trials, and meta-analyses, consistently demonstrates that PA has a notable positive influence on executive function. The current body of literature investigating the association between PA and executive functions predominantly concentrates on elderly populations, individuals displaying signs of cognitive decline, or children (9, 28). While public health guidelines advocate for regular PA across all age groups, especially for the prevention of lifestyle-related diseases, the impact of habitual PA on cognition in healthy young individuals has been relatively underexplored (9). Salas-Gomez et al. found that the total amount of PA according to IPAQ-SF correlated positively with the Stroop test in university students. Additionally, the researchers speculated that the specificity of the impact of PA on executive control could be attributed to the ongoing development of brain regions, particularly the dorsolateral prefrontal cortex, which is closely associated with this function, in individuals within this age population (29). Conversely, a study conducted among university students, which examined the correlation between PA (as reported by the International Physical Activity Questionnaire, long version) and executive function (assessed using the flanker task), reported no discernible association between the two variables (30). Similarly, in a recent study that used IPAQ-SF and STROOP tests, a linear correlation could not be determined between the PA levels of university students and their executive functions (31). In our study, we used the Stroop Test to evaluate executive functions and IPAQ-SF to determine the PA level of participants similarly. As a result, no relationship was found between participants' total PA level and their executive performance. Despite a target population, there are methodological differences, including the number of participants (different numbers of female and male students) and test methods (some studies used the IPAQ long version and the flanker task) in the studies, which may have led to these conflicting findings. Moreover, the higher number of women in the gender distribution and the mostly inactive participants in our study may have affected the relationship between PA level and executive function.

Limitation

One limitation of this study could be the assessment of executive functions using only one test. Another limitation was the lack of objective data on PA in the study. The questionnaire method (IPAQ-SF) utilized to assess PA levels relies on subjective data. Furthermore, it's important to note that the IPAQ-SF is an indirect tool for quantifying the amount of PA and this factor could have potentially influenced the correlation results. Indeed, the IPAQ questionnaire has significant limitations since it focuses solely on PA conducted in the past week. This could present challenges for students, as factors like the academic calendar may affect the level of PA undertaken in any given week. Also including students of similar age groups from only a single school into the study was another significant limitation.

CONCLUSION

During the COVID-19 pandemic, the perceived stress level and care burden increased among mothers of individuals with CF. The higher the perception of the social support of the caregiver, the lower the stress and care burden level. Therefore, evaluating the care burden and social support perception of caregivers in routine control of individuals with CF and making improvement plans may help them cope with unexpected situations that may negatively affect their lives. Although the burden of care and coronaphobia were similar in both groups, the perceived stress level of mothers with a healthy child was higher. In the face of sudden and unexpected events, it is crucial to examine not only the caregivers of chronically ill children but also the caregivers of healthy children in terms of perceived stress and care burden.

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