https://doi.org/10.7251/SSH2502217S
UDC: 796-057.87:796.92
Original scientific paper
Originalni naučni rad

Relationship Between Physical Activity and Academic Success of Students

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Abstract: *This study aimed to examine the relationship between physical activity and the academic success of students. The total sample consisted of 116 undergraduate female students of the Faculty of Sport and Psychology, divided into three groups based on the physical activity level determined by use of the Godin Questionnaire for Physical Activity in Leisure Time. The academic success was calculated as the average grade values during studies. A one-way ANOVA revealed that there was a statistically significant difference in mean grade values between groups F = 12.089, p = 0.000. Post Hoc LSD test for multiple comparisons found that the mean grade values of the first group were significantly different from the second group. Insufficiently Active students had significantly lower grades compared to Moderately Active students (p = 0.041, 95% C.I. = -1.079, -0.02). There were statistically significant differences in mean grade values between Insufficiently Active and Active students. Active students had higher grade values (p = 0.000, 95% C.I. = -1.609, -0.665) compared to Insufficiently Active, and the mean grade value of Moderately Active students was significantly lower compared to Active ones (p = 0.010, C.I.= -1.046, -0.147). The obtained results indicating that a greater number of sessions of physical activity generates better academic success, and testifies to the assumption that physical activity integrated into the weekly life regime of a typical respondent/academic may have the character of contributing to positive neuroplastic changes and better academic success as a possible marker of the neurophysiological potential of the student population.*

Keywords: *physical exercise, physical and mental health, academic*

Introduction

Relevant studies refer to the benefits of physical exercise. They are affirmed as respectable factors in preserving the physical and mental health of man, in all periods of his ontogenesis. Factors of physiological etiology that contribute to physical health, but also factors that are important in maintaining mental health, are most often affirmed. When it comes to academic schooling, it in many ways represents the transition to adulthood. There is also a change in the context of social circumstances, physical environment, and academic workload in the form of new obligations for many academics, which is also a path of anxiety and stress (Misra & Castillo, 2004; Gasiuniene & Mieziene, 2021). Stress, as well as physical inactivity, are important factors that are linked to health (physical and mental well-being) and thus to cognitive functions that are important for achieving academic success. In the student population, a greater number of factors are identified that are correlated with stress.

Physical exercise processes and learning processes are different in their manifestations, but they are based on the same neurophysiological basis. In this sense, the following benefits of physical exercise could significantly affect the learning process: Neurobiological: Increase in oxygen flow and blood flow to the brain: Physical activity improves cerebral perfusion, especially in the hippocampus - the part of the brain that is crucial for memory and learning. In particular, there is an increase in blood flow to the prefrontal cortex and hippocampus during and after aerobic activity (Hillman et al., 2008). Exercise (especially aerobic) stimulates the production of BDNF (brain-derived neurotrophic factor), which improves the formation and maintenance of neural connections. Physical activity increases the levels of dopamine, serotonin and noradrenaline, which directly affect attention, motivation, and mood. Also, regular exercise reduces chronic stress through reduced secretion of cortisol, a hormone that negatively affects memory and learning when it is chronically elevated (Tomporowski et al., 2008). Cognitive, in accordance with which physical activity can improve: Attention and concentration, working memory, speed of information processing as well as executive functions of planning, inhibition, flexibility. The contribution of physical activities to learning success in areas such as mathematics and language has been proven (Sibley & Etnier, 2003; Tomporowski et al., 2008). Emotional. Physical activity alleviates the negative consequences of the distress reaction, raises the level of self-efficacy, and

alleviates the symptoms of depression as factors of negative impact on cognitive functions. Therefore, the mechanisms of increased Neutrophil brain factor (BDNF), improved oxygenation of the brain, activation of frontal and hippocampal regions, and hormonal and emotional regulation, represent overlapping points of the process of physical and cognitive activity. Heller-Wight et al. (2023) point to the influence of exercise in the functional connection of the hippocampus with changes identified in the frontal and temporal brain regions, which are key to cognitive development and the very function of BDNF, which plays a key role in mediating the effects of exercise, affecting synaptic plasticity, i.e. the brain's ability to adapt and learn. The type of physical activity, the intensity and duration of exercise affect the level of BDNF and, consequently, cognitive outcomes (Rahmi et al, 2022), which are the basis of academic success. It is important to note that the saturation (regional cerebral oxygenation) identified by NIRS (near-Infrared Spectroscopy) technology during physical exercise and learning points to the similarity of metabolic activities of brain cells. Thus, physical activity, especially of the aerobic type, activates cardiorespiratory activity and cerebral flow, thereby increasing oxygen supply, while cognitive activity and stimulated metabolic demands activate an increase in local oxygenation (Giles et al., 2014). It has been identified that certain physical activities such as yoga, tai chi, various forms of aerobic exercise, affect reducing stress and improving mental well-being (Guerriero et al., 2025). In relation to the complexity of the relationships between the various factors that influence p increasing the level of stress, scientific facts indicate that physical activity and exercise have a positive effect on improving psychological well-being (Cairney et al, 2014), reducing the experience of stress associated with social support, motivation and self-confidence in academics (Gasiuniene & Mieziene, 2021). Participation in exercise, physical activity has a significant impact on the development of cognitive functions, i.e. processes of attention, memory, and executive function (Chieffi et al, 2017). Exercise is known to slow down the decline of cognitive functions (Chapman et al., 2013) and emotional regulation functions (Kvam et al., 2016). Studies indicate that physical activity improves blood flow to brain structures, specifically the hippocampus, the brain region (in addition to the olfactory bulb) that ensures neuronal plasticity (Dwojaczny & Bejtka, 2023), i.e. generates new neurons throughout life (Kempermann, Song & Gage, 2015). In accordance with the above, research reports on the synergistic effects of stimuli of different origins on some human capacities (motor, emotional, cognitive...) in terms of the formation and strengthening of neural networks (Hilman et al, 2009). They also report that interventions that integrate both motor and cognitive and emotional stimuli have a significantly greater impact on the development of the frontal cortex (Diamond & Lee, 2011). Such an integral concept of managing the development of potential is called multimodal stimulation (Howard Gardner - Theory of multiple intelligences, 1983). Eric Jensen - Brain-based Learning promotes multimodal learning through the connection of movement, emotions, attention, and sensory stimulation and suggests that the brain functions best when it is stimulated through multiple channels simultaneously, movement-touch-sound-visual elements (Jensen E. Brain-Based Learning the Way Students Really Learn. Third Edition. 2020). Hypothetically, it is possible that precisely the possible quantification of success, achieved through proprioceptive ways (sensorimotor and audiovisual senses), in physical exercise activities contributes to better motivation in cognitive activities and quick recovery from fatigue (oxidative stress) as an underlying consequence of such activities. The findings of relevant studies contribute to this assessment (Daw 2008). Generally, quick feedback on the effects of exercise can contribute to the feeling of competence. This research aims to quantify the effects of different levels of weekly exercise achieved through specifically designed physical exercise protocols in the area of cognitive implications that manifest as success in the process of academic education.

Material and Method

Sample of respondents

All respondents, 116 of them, were undergraduate female students at the Faculty of Sport and Psychology, TIMS based in Novi Sad, Serbia. Respondents were divided in three groups according to the physical activity level. First group consists of 36 insufficiently active female students, means (±SD) age, body height, body weight were 22.38 ± 8.37 years, 168 ± 8.14 cm, and 58.01 ± 7.60 kg. Second group consist of 39 moderately active female students, means (±SD) of age, body height, body weight were 20.90 ± 2.59 years, , 166 ± 5.77 cm and 58.98 ± 8.34 kg and third group consist of 41 active female students, means (±SD) of age, body height, body weight were 21.16 ± 5.45 years, , 167.05 ± 6.09 cm and 60.50 ± 7.72 kg respectively.

Sample of measures

The measuring instrument used was the Godin Questionnaire for Physical Activity in Leisure Time (GSLTPAK), which measures the level of physical activity in leisure time. Participants assessed the frequency of strenuous, moderate, and mild activities in which they engaged during week. (GSLTPAK) is Godin's questionnaire that determines the level of physical activities in free time, where the participants estimate the frequency of light, moderate, and intensive activities they engaged in during the week. To calculate the total amount of physical activity, each activity category was multiplied by the following values: Strenuous physical activity: number of days multiplied by 9, Moderate physical activity: number of days multiplied by 5, Mild physical activity: number of days multiplied by 3. The resulting values were then summed to obtain the weekly leisure time physical activity score (Godin, 2011). This questionnaire is practical for assessing the level of physical activity and provides information about different intensities of activity.

The academic success was calculated as the average grade values during studies, which were taken from the official software Faculty platform ssluzba.TIMS.exe.

Statistical analysis

For all the variables, the basic parameters of descriptive statistics were calculated (Mean and Standard deviation). In order to calculate the statistically significant difference for each variable between the groups, the one-way ANOVA method and POST HOC (LSD) test were used. Data analysis involved utilizing the Statistical Package for Social Sciences (SPSS) version 26.0 by SPSS Inc. in Chicago, IL, USA. Testing the effect size *f* and level of power of one-way ANOVA has been conducted by means of G*Power version 3.1.9.7. software (Faul et al., 2007) and the effect size has been defined by standards proposed by Cohen 0.1 small, 0.25 medium, and 0.4 large (Cohen, 1988).

Results

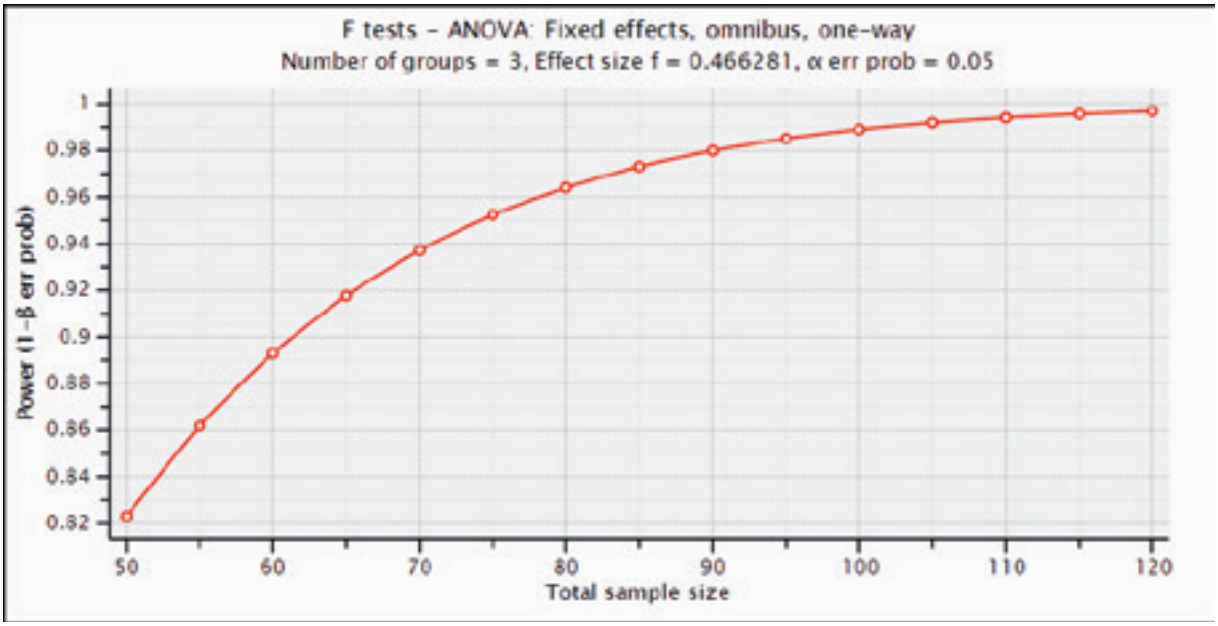
A one-way ANOVA was performed to compare the academic success of three different groups of female students. A one-way ANOVA revealed that there was a statistically significant difference in mean grade values between groups F = 12.089, p = 0.000 (Table 1). Post Hoc LSD test for multiple comparisons found that the mean grade values of the first group were significantly different from the second group i.e. Insufficiently Active students had significantly lower grades compared to Moderately Active students (p = 0.041, 95% C.I. = -1.079, -0.02). There were statistically signifficant differences in mean grade values between Insufficiently Active and Active student also. Active students had higher grade values (p = 0.000, 95% C.I. = -1.609, -0.665) comparing to Insuficiently Active and the mean grade value of Moderately Active students was significantly lower comparing to Active ones (p = 0.010, C.I.= -1.046, -0.147) (Table 1).

Table 1. *Comparison of academic succes for different groups of female students*

Group	n	M	SD	vs.	
Insufficiently Active	36	7.206	0.997	2*,3**	
Moderately Active	39	7.747	0.980	3*	
Active	41	8.343	1.038		
Total	116	7.934	1.108		
		Analysis of Variance			
Source	Sumo f Squares	Df	Mean Square	F	p
Between groups	24.897	2	12.448	12.089	0.000
Whitin groups	116.363	113	1.030		
Total	141.259	115			

*Abbreviations: n = Number of respondents, M = Arithmtetic mean, SD = Standard deviation, vs. = LSD post-hoc test *The difference is significant at the ≤0.05 level, **The difference is significant at the ≤0.01 level, F = the ratio of the mean square for the between groups divided by the mean square within groups, p = ANOVA level of significance.*

An a post hoc, achived power analysis was conducted using G*Power version 3.1.9.7. (Faul et al., 2007) for effect size estimation. Computed from means and group sizes, power analysis showed large effect size values of *f* = 0.466 with high statistical power of 1-β = 0.99 respectively (Graph 1).



Graph 1. *Practical significance of a research outcome based on Effect size and power values*

Discussion

Academic success is considered in this research as a dependent variable, that is, as a marker of neuroplasticity, as a condition for the quality of academic education. It is hypothetically affected by various stimuli, and in this research, the focus was on the isolated contribution of the respondents' physical activities to academic success. In this sense, physical activity is methodologically interpreted as an experimental factor that began to act before the beginning of the research, and its effects are valued in an ex-post-facto context. The sensitivity of the assessment is ensured by the differentiation of the weekly cadence of the subjects' physical activities. The finding that a greater number of sessions of physical activity generates better academic success, and testifies to the assumption that physical activity integrated into the weekly life regime of a typical respondent/academic may have the character of contributing to positive neuroplastic changes and better academic success as a possible marker of the neurophysiological potential of the student population. The research results showed that there is a statistically significant difference in terms of academic success between female students who practiced different levels of physical activity ($F = 12.089$, $p = 0.000$). At the same time, the results of the Post Hoc LSD test showed that female students who were insufficiently active had a significantly lower average grade compared to those who were moderately active ($p=0.041$) or active ($p<0.0001$). In addition, the results showed that there is a statistically significant difference between active and moderately active female students, and that the former had better average grades ($p=0.010$). A similar problem was investigated by the author Miletić (2017), who determined to what extent various physical exercises affect the academic success of students. The method involved the collection of relevant literature in the period from 2000 to 2015. The obtained conclusion is in accordance with the results of this research, which confirms that students who lead a healthy lifestyle have a higher degree of academic success. Research conducted by Mota et al. (2015) states that existing literature and research on this topic prove a positive relationship between physical activity and academic performance when the total time of physical activity per week is greater than 120 minutes. The same research mentions that reducing students' weekly physical activity will not benefit their academic performance. Redondo-Flórez, Ramos-Campo, and Clemente-Suárez (2022) highlight the importance of implementing different exercise programs that can improve health factors, especially those related to physical activity and sleep habits, with the aim of improving academic achievement. Machek and Janota (2019) state that. Unlike anaerobic activity, aerobic activity has positive effects on the academic success of female students. They complement this with the fact that other studies show that aerobic activities support the development of female students' executive functions, as well as their organizational skills and general well-being. Together, these effects can contribute to better learning ability. However, this study did not find statistically significant evidence of a positive relationship between physical activity and academic achievement among college students. Research in which aerobic capacity is also tested as a consequence of physical activities

(Kukić, Janković, & Koropanovski, 2023) aimed to examine the association of physical capacity with academic success represented by grade point average (GPA) and study efficiency represented by graduation time in women who were candidates for studies at the Criminalistics and Police University. At the same time, they also analyzed the aerobic abilities of female students, which are actually the result of physical activities. Based on the obtained results, the authors concluded that female students with better-developed physical abilities had greater chances for a more favorable academic outcome. Consequently, it could be said that female police university students who have a better developed culture of physical exercise have a higher chance of a more favorable academic outcome. Wunsch, Fiedler, Bachert and Woll (2021) tried to answer the question of the three-way relationship between physical activities, stress and academic performance using meta-analysis. The results of the analysis showed a positive relationship between physical activity and academic achievement, while between physical activity and stress they seem negative, while the relationship between stress and academic achievement is uncertain. A group of authors (Zhai, Ye, Gu, Huang, Wang, Chen, & Fan, 2020) in their research on the relationship between physical fitness and academic success in Chinese students concluded that poor academic performance was associated with low overall physical fitness. The probability of poor academic performance was significantly lower in students with high physical fitness than in those with low physical fitness.

Conclusion

This research quantified the effects of different levels of weekly exercise achieved through specifically designed physical exercise protocols in the area of cognitive implications manifested on academic success. Although the focus did not integrate the issue of "optimal cadence of weekly sessions of physical activities", as well as the issue of valorization and optimization of the content of sessions of physical activities, based on the set methodological framework, the obtained results testify to the positive interaction of markers of physical activities and markers of cognitive success of academics.

Acknowledgment

The paper is part of a four-year research project titled "The Importance of Physical Activity for Mental Health and Academic Achievement of Students." The main contractor for the project is the Faculty of Sport and Psychology in Novi Sad, TIMS, Serbia. The Provincial Secretariat for Higher Education and Scientific Research of Vojvodina financially supports the project.

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Primljen: 10. avgust 2025. / Received: August 10, 2025
Prihvaćen: 12. oktobar 2025. / Accepted: October 12, 2025