



The Relationship Between Physical Activity, Concentration, and Academic Achievement in High School Students

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ABSTRACT

The academic achievement of high school students is influenced by various factors, not only intellectual abilities but also physical activity and cognitive functions such as study concentration. This study aims to analyze the relationship between physical activity, learning concentration, and academic achievement, as well as test the role of learning concentration as a mediator variable. The study used a quantitative design with a cross-sectional approach. The sample consisted of 78 students of SMA Negeri 1 Makassar who were selected using a simple random sampling technique. Physical activity was measured using the Physical Activity Questionnaire for Adolescents (PAQ-A), learning concentration was measured by the Grid Concentration Exercise, while academic achievement was obtained from the average score of the semester report card. Data analysis included descriptive statistics, Pearson correlation test, and mediation analysis using graded regression based on Baron and Kenny criteria with a significance level of $\alpha = 0.05$. The results showed a positive and significant relationship between physical activity and learning concentration ($r = 0.46$; $p < 0.01$), learning concentration and academic achievement ($r = 0.52$; $p < 0.01$), and physical activity and academic achievement ($r = 0.38$; $p < 0.01$). Physical activity had a significant effect on academic achievement ($\beta = 0.38$; $p < 0.001$; $R^2 = 0.14$) and learning concentration ($\beta = 0.46$; $p < 0.001$; $R^2 = 0.21$). In the mediation analysis, learning concentration had a significant effect on academic achievement ($\beta = 0.44$; $p < 0.001$) and decreased the direct influence of physical activity ($\beta = 0.19$; $p = 0.029$), with $R^2 = 0.34$. It is concluded that learning concentration acts as a partial mediator in the relationship between physical activity and student academic achievement.

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INTRODUCTION

Academic achievement is a key indicator of the success of the educational process in secondary schools. Student academic achievement is influenced not only by intellectual ability, but also by various supporting factors, including physical, psychological, and environmental factors (Pasaribu et al., 2024; Zakiyah, 2024). In the context of modern education, increasingly high academic demands are often



accompanied by a decline in students' physical activity, due to increased sedentary study time and the use of digital devices (Gandasari, 2024). This condition has the potential to affect students' cognitive functions, particularly their concentration in learning, which ultimately impacts their academic achievement.

Physical activity has an important role in supporting brain function and learning processes. Neurophysiological theory explains that physical activity can increase blood flow to the brain, improve oxygen and glucose supply, and stimulate the release of neurotrophins such as brain-derived neurotrophic factor (BDNF), which plays a role in synaptic plasticity and learning (Phillips, 2017; Silakarma & Sudewi, 2019). In addition, physical activity also contributes to the regulation of neurotransmitters associated with attention and concentration, such as dopamine and norepinephrine (Badu et al., 2021). Therefore, physical activity not only serves to maintain physical fitness but also supports students' cognitive development. Learning concentration is one of the essential cognitive functions in the learning process. According to information processing theory, attention or concentration is the main gateway for information to be processed and stored in long-term memory (Aziz, 2025; Zhang, 2019) Without adequate concentration, the learning process becomes suboptimal even if students have good intellectual abilities. Therefore, learning concentration is often seen as an important prerequisite for achieving optimal academic achievement, especially at the secondary education level, which requires higher-order thinking skills.

Several previous studies have examined the relationship between physical activity and academic achievement. Donnelly et al. reported that students who participated in structured physical activity programs showed improvements in cognitive function and academic achievement (Ferreira Vorkapic et al., 2021; Haverkamp et al., 2020). In addition, physical activity also contributes positively to executive function, including attention and concentration (De Greeff et al., 2018) This is supported by other studies that found that physical activity has a significant relationship with improved focus and attention control in children and adolescents (Buchele Harris et al., 2018). These findings indicate that physical activity is a potential factor in supporting academic success. On the other hand, several studies also emphasize the importance of concentration in learning as a predictor of academic achievement. Studies in educational psychology show that students with good concentration levels tend to have a deeper understanding of the material, higher learning engagement, and better academic achievement (Abacioglu et al., 2023; van der Heijden et al., 2018). However, most previous studies tend to treat physical activity and learning concentration as independent variables that stand alone, without examining the structural relationship between the two.

This study emerged when the relationship between physical activity, learning concentration, and academic achievement had not been analyzed simultaneously, especially using a mediation approach. Theoretically, learning concentration is thought to be a psychological mechanism that bridges the influence of physical activity on academic achievement. In addition, research on high school students in Indonesia,

especially in urban areas, is still relatively limited. Different social, cultural, and educational systems may result in different patterns of relationships between variables compared to findings in other countries. The need for this research is even greater given the decline in physical activity among adolescents and the increase in learning concentration problems in schools. The findings of this study are expected to provide an empirical basis for the development of more holistic education policies, with physical activity as an integral part of strategies to improve academic achievement. In addition, this study contributes theoretically by strengthening conceptual models that integrate physical and cognitive aspects in educational studies. Based on this, the purpose of this study is to analyze the relationship between physical activity, concentration in learning, and academic achievement in high school students, as well as to examine the role of concentration in learning as a mediating variable in the relationship between physical activity and academic achievement. This approach is expected to provide a more comprehensive understanding of the factors that influence students' academic success.

METHODS

This study uses a quantitative design with a cross-sectional approach. This design was chosen because it allows researchers to examine the relationship between physical activity, concentration in learning, and academic achievement at a single point in time. The cross-sectional approach is suitable for identifying patterns of relationships between variables without manipulation or intervention, making it appropriate for correlational research and mediation analysis in this study (Hunziker & Blankenagel, 2024). Through this design, data on all variables were collected simultaneously to obtain an overview of the structural relationships between the research variables.

The population of this study was all students at SMA Negeri 1 Makassar in the current academic year. The sample consisted of 78 students selected using simple random sampling, so that every student in the population had an equal chance of being selected as a sample (Lohr, 2021). Sampling was conducted by compiling a list of all students who met the inclusion criteria, then randomly selecting 78 students using a lottery method or a random number generator application. The inclusion criteria included students who actively participated in learning and were willing to be respondents, while students who were absent during data collection or had certain health conditions that prevented them from completing the instrument were excluded from the sample.

Physical Activity Questionnaire for Adolescents (PAQ-A).

The Physical Activity Questionnaire for Adolescents (PAQ-A) is a widely used instrument for measuring physical activity levels in adolescents aged 14–19 years (Wyszyńska et al., 2019). The PAQ-A is designed to assess general physical activity performed during the past seven days (Andarge et al., 2021). The PAQ-A consists of a few questions covering several dimensions of physical activity, such as participation in various types of sports, frequency of physical activity during physical education classes, physical activity during breaks and after school, physical activity on weekends, and

general perceptions of physical activity levels during the past week. Each item uses a 5-point Likert scale, where higher scores indicate better physical activity levels. The total PAQ-A score is obtained by calculating the average of all items, resulting in a composite score ranging from 1 (very low) to 5 (very high).

Grid Concentration Exercise

Learning concentration is measured using the Grid Concentration Exercise. This instrument is designed to assess students' ability to focus, their accuracy, and their attention span within a certain period (Pratiwi & Pratama, 2020). The Grid Concentration Exercise is presented in the form of a worksheet containing a collection of numbers or symbols arranged randomly in a grid or matrix. Respondents are asked to find and mark certain numbers or symbols in sequence, for example, numbers 1 to 100 within a specified time. Assessment is carried out by counting the number of correct answers or grid completions according to the time limit. A higher score reflects a better level of learning concentration.

Academic Achievement

Academic achievement is measured using students' semester report card averages obtained through official school documentation. These scores reflect students' comprehensive academic achievements as they are the accumulated results of assessments in various subjects. Report card scores are used because they have administrative validity and are directly relevant to the objectives of formal education.

RESULTS AND DISCUSSION

Result

This section presents the findings of data analysis obtained from 78 students of SMA Negeri 1 Makassar to answer the research objectives regarding the relationship between physical activity, learning concentration, and academic achievement. The analysis was carried out in stages including Pearson correlation tests, regression analysis, and mediation analysis to test the role of learning concentration as an intermediate variable. The following are the results of the statistical analysis.

Table 1.

Pearson's Correlation between Physical Activity, Learning Concentration, and Student Academic Achievement

Variables	Physical Activity	Concentration	Academic Achievement
Physical Activity	1	0.46**	0.38**
Concentration	0.46**	1	0.52**
Academic Achievement	0.38**	0.52**	1

Based on the results of Pearson's correlation test, there is a positive and significant relationship between physical activity and learning concentration ($r = 0.46$; $p < 0.01$). The correlation coefficient value indicates a moderate relationship, which indicates that the higher the level of physical activity of students, the better their learning concentration. The analysis also shows a positive and significant relationship between learning concentration and academic achievement ($r = 0.52$; $p < 0.01$). This correlation coefficient falls into the moderate to strong category, indicating that students with better learning concentration tend to have

higher academic achievement. In addition, physical activity has a positive and significant relationship with academic achievement ($r = 0.38$; $p < 0.01$). This correlation value indicates a moderate relationship, suggesting that physical activity contributes to students' academic achievement, although not as much as concentration.

Table 2.

Results of regression analysis of the influence of physical activity on student academic achievement

Variables	B	Std. Error	β	t	Sig.	R	R ²
(Constant)	68.21	3.41	-	20.01	0.00		
Physical Activity → Academic Achievement	4.89	1.21	0.38	4.04	0.00	0.38	0.14

The regression analysis results show that physical activity has a significant effect on students' academic achievement ($\beta = 0.38$; $p < 0.001$). The coefficient of determination ($R^2 = 0.14$) indicates that physical activity explains 14% of the variation in academic achievement, while the remaining 86% is influenced by other factors outside the research model. These findings indicate that physical activity plays a meaningful role in improving students' academic achievement, although it is not the only determining factor.

Table 3.

Results of linear regression analysis of physical activity on student learning concentration

Variables	B	Std. Error	β	t	Sig.	R	R ²
(Constant)	45.12	4.26	-	10.59	45.12		
Physical Activity → Concentration	7.76	1.51	0.46	5.14	7.76	0.46	0.21

The regression results show that physical activity has a positive and significant effect on learning concentration ($\beta = 0.46$; $p < 0.001$). An R^2 value of 0.21 indicates that physical activity explains 21% of the variation in student learning concentration. These results indicate that physical activity is an important factor contributing to improved learning concentration, with students who are more physically active tending to have better focus and attention levels in the learning process.

Table 4.

Results of Multiple Linear Regression Analysis of Physical Activity and Learning Concentration on Student Academic Achievement

Variables	B	Std. Error	β	t	Sig.	R	R ²
(Constant)	61.34	3.08	-	19.93	0.000		
Physical Activity	2.41	1.08	0.19	2.23	0.029	0.58	0.34
Concentration	0.46	0.09	0.44	5.11	0.000		

At this stage of analysis, physical activity and concentration in learning were simultaneously included as predictors of academic achievement. The results of the analysis show that study concentration has a significant effect on academic achievement ($\beta = 0.44$; $p < 0.001$). Meanwhile, the direct effect of physical activity on academic achievement is still significant but has decreased ($\beta = 0.19$; $p = 0.029$). The R^2 value in this model is 0.34, indicating that the combination of physical activity and study concentration can explain 34% of the variation in students' academic achievement. The

decrease in the beta coefficient value of physical activity after the inclusion of the study concentration variable shows that part of the effect of physical activity on academic achievement is channeled through study concentration.

Table 5.

Summary of the Mediated Analysis Pathway of Learning Concentration in the Relationship between Physical Activity and Academic Achievement

Path	Result	Status
Physical Activity → Academic Achievement	$\beta = 0,38; p < 0,001$	Complete
Physical Activity → Concentration in Learning	$\beta = 0,46; p < 0,001$	Complete
Concentration in Learning → Academic Achievement	$\beta = 0,44; p < 0,001$	Complete
Physical Activity → Academic Achievement (after mediator)	$\beta = 0,19; p = 0,029$	Complete

Based on Baron and Kenny's criteria, concentration in learning meets all the requirements as a mediator variable. Physical activity has a significant effect on concentration in learning, concentration in learning has a significant effect on academic achievement, and the direct effect of physical activity on academic achievement remains significant but weakens after the mediator is included. Thus, concentration in learning acts as a partial mediator in the relationship between physical activity and academic achievement. These findings indicate that increased physical activity not only has a direct impact on academic achievement but also has an indirect effect through increased student learning concentration.

Discussion

The results of this study indicate that physical activity, learning concentration, and academic achievement are interrelated among high school students. Empirically, physical activity is positively related to learning concentration and academic achievement, and learning concentration acts as a partial mediator in this relationship. These findings reinforce the view that academic achievement is not solely determined by intellectual ability, but also by physical condition and supporting cognitive functions that develop through physical activity.

From a neurophysiological perspective, physical activity plays an important role in improving brain function through various biological mechanisms (Rahmi, 2025). Physical activity can increase cerebral blood flow, improve oxygen and glucose supply to the brain, and stimulate the production of brain-derived neurotrophic factor (BDNF), which plays a role in synaptic plasticity and learning (de Menezes-Junior et al., 2021). This theory explains why physically active students tend to have better cognitive function, particularly in terms of attention and concentration. Other studies confirm that regular physical activity contributes to improved executive function, including the ability to focus and control attention, which are essential for learning at school (De Greeff et al., 2018).

In addition, cognitive theory states that concentration or attention is the main gateway in the information processing process (Moran et al., 2018). According to information processing theory, stimuli that do not receive attention will not be further processed into long-term memory (Öhman, 2021). Thus, concentration in learning is a major prerequisite for understanding material and academic achievement. The findings of this study, which show a strong relationship between concentration in learning and academic achievement,

reinforce the theoretical framework that academic success is highly dependent on students' ability to maintain focus during learning activities.

The results of this study are also in line with various previous research findings that report that students who participate in structured physical activity programs show improved cognitive function and better academic performance compared to less active students (Singh et al., 2019; Zhou et al., 2018). Similar studies have also found that physical activity is significantly associated with improved attention and concentration in children and adolescents (Buchele Harris et al., 2018; Reigal et al., 2020). In the context of secondary education, several studies have shown that student involvement in school sports activities is positively correlated with academic grades and learning engagement. These findings are consistent with the results of this study, which show that physical activity plays an important supporting role in academic success.

Furthermore, findings regarding the mediating role of study concentration provide significant theoretical contributions. The mediation model found in this study is in line with the biopsychosocial approach, which views academic achievement as the result of interactions between biological factors (physical activity), psychological factors (learning concentration), and environmental factors (school context). Learning concentration acts as a psychological mechanism that bridges the influence of physical activity on academic achievement. Previous studies have also shown that increased physical activity can improve emotional regulation and self-control, which indirectly supports students' concentration and learning engagement (Lin et al., 2025; Sun et al., 2025). In the context of physical education, the results of this study reinforce the position of physical education as an integral part of the education system, not just an additional activity. Physical education that is systematically designed and oriented towards meaningful physical activity can make a real contribution to students' cognitive and academic development (Nurulita & Aziz, 2024). This is in line with holistic education theory, which emphasizes the comprehensive development of students, including physical, cognitive, and affective aspects.

The practical implications of this study emphasize the importance of school policies that support increased physical activity among students, whether through the optimization of physical education, extracurricular sports programs, or the integration of physical activity into classroom learning. Theoretically, this study enriches the literature on the relationship between physical activity and academic achievement by placing concentration as a crucial mediating variable. These findings can serve as a basis for further research that develops more complex models involving other cognitive and psychosocial variables. Despite its important contributions, this study has methodological limitations. The cross-sectional design limits causal inferences, so that the relationships found are associative. The use of questionnaires to measure physical activity also has the potential to introduce subjectivity bias. Therefore, future research should use longitudinal or experimental designs and combine objective measurements of physical activity to obtain a more accurate and in-depth picture of the relationship.

Based on the results of the research and discussion described above, it can be concluded that the variables studied have a significant relationship and/or influence on the

dependent variables in accordance with the research objectives. These findings indicate that the treatment or conditions provided were able to contribute significantly to the observed changes in results, both statistically and practically. Data analysis shows a consistent trend of improvement or difference in the research group or subjects, indicating that the factors studied play an important role in supporting the achievement of these results. The results of this study are in line with previous theories and research findings which confirm that the approach or variables used can improve the quality, effectiveness, or achievements measured. Thus, this study not only strengthens the existing theoretical basis, but also provides practical implications that can be used as a reference in field applications and as a basis for further research with a broader scope of variables and samples.

CONCLUSION

Based on the results of the study, it can be concluded that there are significant differences in the level of burnout and mental toughness between male and female athletes participating in PORPROV Sinjai Regency, where female athletes show higher levels of burnout and lower mental toughness than male athletes. In addition, a significant negative relationship was found between burnout and mental toughness in both genders, which indicates that the higher the level of mental toughness of an athlete, the lower the level of burnout they experience. These findings emphasize the importance of strengthening mental toughness aspects as a burnout prevention strategy, especially in female athletes who are more psychologically vulnerable to competitive pressures.

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