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The effects of physical activity on cognitive function, self-concept, and academic achievement among college students

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ABSTRACT

Background. Physical activity among sports science students is often assumed to support various aspects of personal development, although intensive academic and practical workloads may produce different effects on cognitive, psychological, and academic outcomes. **Objective.** This study examined the effects of physical activity on cognitive function, self-concept, and academic performance. **Method.** A quantitative correlational design was employed involving 97 undergraduate Sports Science students at Surabaya State University (69 males and 28 females). Data were collected using the International Physical Activity Questionnaire (IPAQ), cognitive function and self-concept instruments, and cumulative grade point average (CGPA). Simple linear regression was used to analyze the effect of physical activity on each dependent variable. **Results.** Physical activity significantly affected cognitive function ($p = 0.006$; $F = 7.878$; $R^2 = 0.077$; $B = 0.160$), but had no significant effect on self-concept ($p = 0.394$; $F = 0.732$) or academic achievement ($p = 0.551$; $F = 0.599$; $R^2 = 0.004$). **Conclusion.** Physical activity supports cognitive function but does not predict self-concept or academic achievement, highlighting the importance of promoting regular physical activity to enhance students' cognitive performance.

Key words: Physical activity; cognitive function; self-concept; academic achievement.

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INTRODUCTION

Physical activity is widely recognized as a key determinant of physical health; however, increasing evidence suggests that its influence extends to cognitive, psychological, and academic outcomes (Cools et al., 2011; Lola et al., 2022; Penov et al., 2020). However, as scientific knowledge has advanced, it has become clear that physical activity does not affect only physical components but also has a positive impact on mental well-being and psychological health (Ali et al., 2026; Balore et al., 2026; Abdulloh, 2026). Physical activity is an action characterized by body movement and the expenditure of energy. When analyzing physical activity, researchers consider how often, for how long, at what intensity, and what types of activities are performed over a specific period (Anggunadi & Sutarina, 2017). According to Bull et al. (2020), body movements generated by skeletal muscles that expend energy are also considered physical activity.

Sustained physical participation has been shown to have broad positive effects on physical development, biological maturation, and behavioral changes (Fatoni et al., 2021), and is believed to stimulate cognitive function (Badu et al.,

2021). Regular exercise plays a vital role in supporting health, growth, and overall well-being (Pratiwi et al., 2025). Unlike college students in general, students majoring in Sports Science have a unique characteristic: their daily physical activity levels are relatively much higher because sports are an integral part of their required curriculum. Furthermore, they have been equipped with in-depth theoretical and practical understanding of physical activity, so their psychological and cognitive responses to daily training loads may potentially exhibit different patterns.

Research shows that physical activity is not merely a means of maintaining fitness, but rather an integrated strategy for optimizing cognitive function, strengthening self-concept, and improving students' academic performance in a competitive academic environment (Cakrawati et al., 2023). From a neurophysiological perspective, regular physical activity increases blood circulation in the brain, promotes the formation of neural connections, and enhances the production of Brain-Derived Neurotrophic Factor (BDNF) (Clemente-Suárez et al., 2025; Phillips, 2017; Zhou et al., 2022). BDNF is a protein that plays a crucial role in supporting the growth and maintenance of nerve cells, thereby contributing to improved cognitive function and learning ability (Di Liegro et al., 2019; Romero Garavito et al., 2024). All these factors are essential for synaptic plasticity and memory formation (Runesi et al., 2024).

Physical activity plays a crucial role in the self-concept domain (Bayu, 2022), particularly Physical Self-Concept (PSC), which refers to an individual's perceptions and beliefs regarding their physical abilities. Physically active individuals often exhibit higher self-confidence and a more optimistic view of themselves, which can help reduce feelings of discomfort (Zhang et al., 2022). With improved cognitive function and a strengthened self-concept, these two factors synergistically become powerful drivers for enhancing students' academic achievement. Learning is a process that creates sustainable behavioral change, which occurs through repeated practice or more intensive application in an effort to achieve goals (Mduwile et al., 2026). It is common knowledge that physical activity stimulates brain neuroplasticity by releasing BDNF. This contributes to the formation and strengthening of synapses, which in turn enhances memory (Erickson et al., 2019). Physical activity helps regulate emotions by managing stress, which often hinders the learning process. This is implemented in a structured manner to ensure that national educational goals are achieved (Rahman et al., 2023).

Previous research has found a positive correlation between physical activity and cognitive ability ($r = 0.58$, $p < 0.001$) (Runesi et al., 2024). This optimal cognitive performance is highly relevant for adolescents who are required to process complex information and make quick decisions, both in academic and practical contexts (Clemente-Suárez et al., 2025; Zhou et al., 2022). Another

study demonstrated a positive relationship between Moderate to Vigorous Physical Activity (MVPA)-that is, physical activity of moderate to high intensity such as running, cycling, or competitive sports-and PSC, which refers to an individual's perception and assessment of their physical abilities and condition. This relationship is indicated by a correlation coefficient of 0.410 with a p-value of 0.003, suggesting that increased physical activity is followed by an improvement in an individual's physical self-concept (Schneider et al., 2008; Kim & Ahn, 2021). This improvement in PSC serves as a driver of intrinsic motivation for adolescents to continue participating.

Although previous studies have consistently demonstrated the benefits of physical activity for physical and psychological health, evidence regarding its simultaneous influence on cognitive function, self-concept, and academic achievement among sports science students remains limited and inconsistent. Most existing studies have focused on only one or two of these outcomes or have involved general student populations rather than sports science students. Therefore, further investigation is needed to provide a more comprehensive understanding of these relationships within sports science education.

Sember et al. (2020) explain that students' physical activity is closely related to improved concentration and short-term memory. Another study highlights a significant positive correlation between adequate levels of Health-Enhancing Physical Activity (HEPA) and better academic achievement among college students. Agoes and Atzmardina (2024) found that students who engage in HEPA are twice as likely to achieve a high Cumulative Grade Point Average (CGPA) compared to those who do not. This indicates that physical activity contributes to learning outcomes, with cognitive function acting as a mediator.

However, findings regarding the impact of physical activity are not entirely consistent across the literature. A study by Agoes and Atzmardina (2024) showed that physical activity levels did not have a significant correlation with the academic performance of medical students ($p = 0.402$); high levels of physical activity do not always correlate linearly with a high GPA. In line with these findings, Kurniawan et al. (2019) also reported no significant relationship between *physical self-concept* and physical activity in an adolescent population, further strengthening the empirical evidence regarding the inconsistency of the relationship between these variables in the literature. This inconsistency in results indicates an ongoing empirical debate regarding the extent to which physical activity directly influences self-concept and academic performance, thereby underscoring the urgency of further research on the characteristics of populations with specific practical training workloads, such as students in the field of Sports Science.

This study shows clear differences compared to the three previous studies. The first study Burhaein (2017) found that age-appropriate physical activity had

a positive impact on the physical growth and emotional development of elementary school students; however, that study was limited to the elementary school age group and did not examine cognitive function or self-concept at the college level. The second study Suwandaru and Hidayat, (2021) focused on the relationship between physical activity and academic achievement among students at SMK Negeri 1 Surabaya, finding no significant relationship (sig. = 0.730 > 0.05); however, its focus was limited to the vocational high school level without exploring cognitive function and self-concept variables. On the other hand, the third study Runesi et al. (2024) discussed a significant positive relationship between physical activity and cognitive function (r = 0.45), as well as between cognitive function and academic achievement (r = 0.52) in a population of high school students; however, it did not include the self-concept variable and did not examine a specific population with physically demanding academic requirements.

Unlike previous studies by Burhaein (2017) and Suwandaru and Hidayat, (2021), this study specifically integrates the variables of physical activity, self-concept, cognitive function, and academic achievement into a comprehensive relationship within the population of 2024 undergraduate students in the Sports Science program at Surabaya State University. Unlike the general student population, who engage in physical activity voluntarily for recreation, this population undergoes physical activity as a structured academic requirement that has the potential to induce physical fatigue. The novelty of this study lies in the relationship among these four variables as empirical evidence regarding the characteristics of a population that faces physical activity as a mandatory academic practicum requirement.

This study is expected to provide numerous practical benefits for faculty members and the institution. First, regarding curriculum planning, the study's findings can inform the development of a program structure with a more appropriate and realistic allocation of physical practicum hours for students. Faculty members can recognize the importance of a balanced proportion of physical workload to ensure that students' cognitive capacity remains intact in line with predetermined learning outcomes. This study emphasizes how important it is for institutions to monitor and align the value of field practicums with CGPA performance in the classroom to enable early detection of declines in academic performance resulting from the accumulation of practicum course loads.

Unlike previous studies that have examined cognitive function, self-concept, or academic achievement separately, this study simultaneously investigates the effects of physical activity on all three outcomes among sports science students. This integrated approach provides a more comprehensive understanding of the educational implications of physical activity within higher education. Therefore,

this study aims to examine the effects of physical activity on cognitive function, self-concept, and academic achievement among undergraduate sports science students.

METHOD

Participant

The population in this study consisted of all active undergraduate students in the Sports Science Program at Surabaya State University in the class of 2024, totaling 200 students. Given the high intensity and density of the field practicum schedule for this population, the sampling technique used was convenience sampling. The sample consisted of 97 students—69 males and 28 females—selected based on accessibility and the students' voluntary willingness to participate during data collection.

Table 1. Frequency of respondents by gender

Gender	Quantity
Male	69
Female	28
Total	97

Research Design

This study employed a quantitative method with a correlational design. Quantitative methods focus on the use of numerical data and statistical analysis, which are systematically described (Maksum, 2018). The research stages included the distribution and completion of questionnaires; all data were collected directly in accordance with established procedures and carried out at a time mutually agreed upon with the study program to avoid disrupting students' learning activities. To ensure compliance with research ethics, before the questionnaire administration began, the researcher coordinated with the study program, and all participants were given a verbal explanation of the study's objectives. Student participation was entirely voluntary and free from coercion, and the researcher provided an absolute guarantee of data confidentiality.

Data collection was conducted using a questionnaire; data to measure physical activity were collected using the International Physical Activity Questionnaire (IPAQ). Lee et al. (2011) explain that the IPAQ has been widely adopted by experts as a global standard instrument in physical activity research. Cognitive function and self-concept were measured using an instrument adapted from a study by (Fufu et al., 2026). This instrument was selected because it has been used to measure the psychological dimensions of cognitive function in both school students and college students within the academic context of sports. Academic achievement was measured using the Cumulative Grade Point Average (CGPA). The CGPA is a record of students' learning outcomes following the

learning process, which reflects their level of academic achievement. The analysis results were interpreted systematically by relating the data findings to the research problems and objectives that had been formulated, so that the interpretation of the results could be presented clearly, logically, and in accordance with the theoretical framework.

Data Analysis

The data were analyzed using SPSS with correlation tests and simple linear regression analysis to determine the extent of the influence of physical activity as an independent variable on cognitive function, self-concept, and academic achievement as dependent variables. All items in the physical activity, cognitive function, and self-concept variables were deemed valid because the item correlation values were greater than the r-table value (0.199; N = 97). In addition, all three instruments were deemed reliable, with Cronbach's Alpha values of 0.633 for physical activity, 0.837 for cognitive function, and 0.742 for self-concept, all of which exceeded the minimum reliability threshold for the study.

FINDINGS AND DISCUSSIONS

Findings

Table 2. Kolmogorov-smirnov normality test

Sig. (p)	Statistic	df	Sig. (p)
Physical Activity and Cognitive Function	0.105	97	0.2
Physical Activity and Self-Concept	0.055	97	0.2
Physical Activity and Academic Achievement	0.065	97	0.011

Before conducting a simple linear regression analysis, a Kolmogorov-Smirnov normality test was performed (N = 97). The results of the analysis showed that the Cognitive Function (sig = 0.20) and Self-Concept (sig = 0.20) variables had a normal data distribution (> 0.05). Meanwhile, the Academic Achievement (GPA) variable showed a p-value of 0.011, which is less than (<) 0.05, indicating that the data for this variable are not normally distributed statistically. Nevertheless, given that the sample size in this study is sufficiently large (N = 97), the Central Limit Theorem applies. This theorem states that with a large sample size, the sampling distribution will approach a normal distribution, so that parametric statistical analyses such as simple linear regression remain valid and can be conducted without compromising the validity of the results of the relationship test (Field, 2009).

Table 3. Simple linear regression analysis of physical activity and cognitive function

Variable	R	R Square	F	Sig. (p)	Unstandardized Coefficients (B)
Physical Activity and Cognitive Function	.277	.077	.878	.006	.160

Table 3 shows that there is a significant relationship between physical activity and cognitive function. This is evidenced by a p-value of 0.006, which is less than (<) 0.05. In addition, the R^2 value of 0.077 indicates that physical activity accounts for 7.7% of the variance in cognitive function. The remaining 92.3% is attributed to other factors. As seen in the Coefficients table, the regression coefficient (B) for physical activity is positive (+0.160), meaning that the more intense the physical activity, the better their intellectual abilities.

Table 4. Simple linear regression analysis of physical activity with self-concept and academic achievement

Variable	R	R Square	F	Sig. (p)	Unstandardized Coefficients (B)
Physical Activity and Self-Concept	.087	.008	.732	.394	.060
Physical Activity and Academic Achievement	.061	.004	.599	.551	-.015

Meanwhile, Table 4 shows that there is no significant relationship between physical activity and self-concept. This can be seen from the high significance value (Sig. = 0.394), which is greater than (>) 0.05. The very small coefficient of determination, 0.008 (0.8%), indicates that physical activity contributes almost nothing to explaining the variation in self-concept. Although the regression coefficient is positive (B = +0.06), the insignificance of this result suggests that an increase or decrease in physical activity does not significantly predict changes in self-concept.

It also indicates that there is no significant relationship between physical activity and academic achievement. This can be seen from the high significance value (Sig. = 0.551), which is greater than (>) 0.05. Furthermore, the very small coefficient of determination—0.004 (0.4%)—suggests that physical activity contributes almost nothing to academic achievement. Although the regression coefficient is negative (B = -0.015), the insignificance of this result indicates that this effect cannot be used to accurately predict academic achievement.

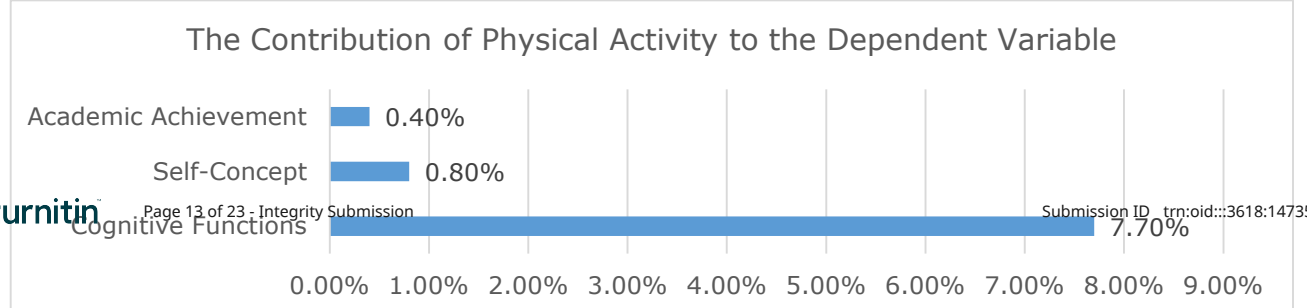

Figure 1. Percentage contribution of physical activity to cognitive function, self-concept, and academic achievement

Figure 1 presents a visual comparison of the percentage contribution of the coefficient of determination (R2) of physical activity to the three dependent variables under study. Based on the bar chart, physical activity has a dominant and significant effect on cognitive function, with a contribution of 7.7%, while its contributions to self-concept and academic achievement are very low, at only 0.8% and 0.4%, respectively. This visualization underscores that the impact of physical activity on 2024 Sports Science students is significantly greater on cognitive function compared to self-concept and academic achievement.

Discussion

The study results show that physical activity has a significant effect on improving students' cognitive function. These findings indicate that students with high levels of physical activity demonstrate better cognitive abilities. This positive relationship is consistent with the neurophysiological theoretical framework, which explains that physical activity optimizes blood flow to vital areas of the brain (Mahindru et al. 2023). Optimal blood circulation distributes oxygen and essential nutrients that stimulate the release of neurotrophic factors, such as BDNF, which are responsible for synaptic plasticity, the strengthening of neural connections, and support for efficient thinking processes, mental acuity, and working memory capacity (Badu et al., 2021). Physical activity requires mental effort related to memory and thought processes.

This phenomenon confirms that every structured physical movement automatically involves rapid problem-solving and decision-making processes, thereby training the brain to remain responsive (Di Liegro et al., 2019; Phillips, 2017; Romero Garavito et al., 2024). Although it has a significant influence, the results of the regression analysis show that the contribution of physical activity to students' cognitive function is relatively low, at only 7.7%. This finding suggests that physical activity is not the sole determinant of intellectual ability in a college setting (Apriandi et al., 2023; Gunawan et al., 2023); rather, there are other factors accounting for 92.3% that are far more dominant in influencing students' cognitive function, including adequate rest duration or sleep quality, management of academic stress levels, and students' daily nutritional intake.

The regression test results indicate that physical activity influences students' cognitive function. The improvement in cognitive function resulting

from physical activity is supported by previous literature, which consistently demonstrates that regular participation helps sharpen executive function, memory, and concentration (Shine, 2019). Improved cognitive abilities and brain health have a significant impact on an individual's quality of life (Noor & Merijanti, 2020). These benefits are particularly relevant in an academic context, where students are required to process complex information and maintain focus over extended periods (Syafruddin et al., 2023). Therefore, physical activity serves not only as a pillar of physical health but also as a crucial enabler of optimal cognitive readiness and ability to tackle learning challenges. Academic success ultimately depends heavily on how well students can maintain a dynamic balance between consistent physical activity and increasingly competitive intellectual demands.

The findings of this study are also consistent with research developments in the Southeast Asian region. A study (Hamidi & Haslee, 2024) reported that students at Universiti Teknologi MARA (UiTM) in Malaysia who had higher levels of physical activity engagement demonstrated better cognitive function compared to students with low levels of physical activity engagement. These results are supported by a study (Chia et al., 2025) in Malaysia, which found that individuals with moderate to high levels of physical activity had better cognitive function scores compared to those with low levels of physical activity. Although that study was conducted on an older adult population, the results indicate that physical activity is consistently associated with better cognitive ability across various age groups.

The consistency of these results reinforces the research findings that physical activity serves as a key factor supporting the optimization of students' cognitive function. Interestingly, however, although physical activity is theoretically correlated with self-perception, the results of this study indicate that physical activity does not have a significant effect on students' self-concept. The regression test results for this variable show a very small coefficient of determination, indicating that physical activity contributes almost nothing to explaining the variation in students' self-concept. This finding suggests that among populations that are already intrinsically physically active—such as students in the field of Sports Science, their physical self-concept may already be at a high and stable level (Runesi et al., 2024). As sports science students, they are in an academic environment characterized by a very high degree of homogeneity in physical activity levels, since sports are part of their mandatory daily curriculum.

This high level of homogeneity in physical activity among students results in very little variation in the data for the independent variables. Consequently, the range of physical activity scores—which tend to be uniformly high—weakens the statistical power of regression analysis to detect the contribution of variance

to self-concept. Furthermore, other internal factors—such as proficiency levels in specific sports, athletic achievements, and social recognition from peers—play a more dominant role in shaping self-image than mere volume of physical activity. The shared educational background in sports science also tends to create a homogeneous standard of self-perception among students, meaning that training intensity is no longer the primary differentiator in how they view their own capabilities. This indicates that the identity as an active individual has been deeply internalized as part of their self-identity, so that fluctuations in the frequency of physical activity do not directly undermine the stability of a long-established self-concept.

This demonstrates that once physical activity levels have reached a certain threshold, other internal and psychosocial factors take over the primary role in shaping self-image. Therefore, variations in their self-concept are no longer predominantly explained by minor changes in physical activity levels but rather by other psychological and social factors, such as profound personal experiences or perceptions of competence derived from social interactions and the environment (Bayu, 2022). These findings differ from those of a study Gorospe and Ferrer (2022) conducted in the Philippines,

27 which showed that college students with higher levels of physical activity tended to have a more positive physical self-concept. This discrepancy in results may be influenced by differences in respondent characteristics. The study by Gorospe and Ferrer (2022) involved students from various academic programs with a wider range of physical activity levels, whereas the respondents in this study were Sports Science students who generally already had relatively high levels of experience with sports and physical activity. These conditions suggest that the students' physical self-concepts are already established and relatively homogeneous, meaning that variations in physical activity are no longer a strong enough factor to explain differences in self-concept.

3 41 Furthermore, this study concluded that physical activity has no significant effect on academic achievement as measured by the Grade Point Average (GPA). The results of the regression analysis for GPA showed a very small coefficient of determination, explicitly indicating that physical activity is not a strong predictor of students' academic achievement. Although the improvement in cognitive function triggered by physical activity should support the learning process, academic achievement has been shown to be multifactorial (Balore et al., 2026). The cognitive enhancement derived from physical activity is merely one supporting component; there are many factors that influence academic achievement (Suwandaru & Hidayat, 2021). Overall academic performance is more directly influenced by intrinsic motivation, the effectiveness of the learning strategies used, and the learning environment.

The results of this study are also consistent with previous research (Supriyanto et al., 2021), which found no significant relationship between physical activity and academic achievement, further reinforcing these findings. Non-physical factors have been shown to play a more dominant role in determining academic performance (Agoes, 2024). These findings align with the view that academic achievement serves as an indicator for students, educators, and educational institutions to achieve their long-term goals (Redondo-Flórez et al., 2022). The GPA is a cumulative measure that reflects the consistency of learning performance over the long term, making it less sensitive to short-term fluctuations in physical activity. The quality of learning, personal discipline (Agoes & Atzmardina et al., 2024), and the ability to adapt to a challenging curriculum Tadese et al. (2022) are stronger predictors of academic success than physical activity levels alone. There is strong evidence that the accuracy and objectivity of the faculty grading system mean that the resulting GPA does not fully reflect students' academic achievement.

Overall, although physical activity is not a direct predictor of self-concept or GPA in this specific population, its significant benefits for cognitive abilities remain undeniable. These findings convey an important message that physical activity should be viewed as a vital foundation supporting students' mental readiness and cognitive function. Efforts to enhance self-concept and achieve optimal academic performance must be integrated into broader strategies, including psychosocial interventions, the development of effective learning skills, and effective stress management. However, although physical activity has been proven to be a strong driver of cognitive function, efforts to improve self-concept and achieve optimal academic success require a more comprehensive approach—integrated with the design of learning strategies and the enhancement of the quality of academic interactions—to ensure the holistic development of students.

Limitations

This study has several limitations: it involved only students in the Sports Science Program at Surabaya State University from the class of 2024; therefore, the results cannot yet be generalized to a broader population and do not explain causal relationships or account for other variables such as learning motivation, sleep quality, stress levels, self-efficacy, and social support. Nevertheless, this study suggests that physical activity has been shown to contribute to improved cognitive function in students, thereby providing a basis for universities to develop physical activity programs that are not only focused on fitness but also support cognitive abilities. Furthermore, the findings of this study are expected to serve as a foundation for future research involving more diverse samples and integrating psychological, social, and lifestyle variables to gain a more

comprehensive understanding of the factors influencing cognitive function, self-concept, and academic achievement, thereby enabling research in this field to continue to advance in the future.

CONCLUSION

The research findings indicate that physical activity has a significant and meaningful impact on improving the cognitive function of Sports Science students. This is demonstrated by the results of regression tests, which show that increased levels of physical activity have a positive effect on cognitive function. This improvement in cognitive function serves as a crucial asset for students in processing academic information. The research findings also indicate that physical activity does not have a significant effect on students' self-concept or academic achievement. The fact that physical activity is not a strong predictor of self-concept and GPA suggests that, within this specific population of Sports Science students, these two variables are more strongly influenced by other factors. In the context of self-concept, because the respondents already had a homogeneous and high background in physical activity, their physical self-concept tended to be well-established, so fluctuations in activity no longer significantly affected it (Kurniawan et al., 2019). As for academic achievement, non-physical factors such as learning strategies, motivation, and self-efficacy Zulfikar et al. (2024) have been shown to be more dominant. Overall, these findings confirm that the primary benefit of physical activity in an academic population lies in the cognitive domain.

Based on these results, it is recommended that faculty members continuously educate students about the direct relationship between physical activity and cognitive sharpness, rather than focusing solely on physical fitness. Additionally, institutions should maintain and enhance structured physical activity programs. Given the significant benefits to cognitive function, programs should be designed not only for physical fitness but also for cognitive stimulation (cognitive-motor training). Furthermore, researchers are advised to expand their studies by considering other aspects, such as stress levels and quality of life, to gain a deeper understanding. Additionally, the study's findings can serve as a foundation for designing curricula that emphasize both physical and mental health.

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AUTHOR CONTRIBUTION STATEMENT

ANK, as the corresponding author, was fully responsible for the mapping, conceptualization, implementation of the research, and sample search. NI assisted in guiding the data analysis, design determination, and final assessment before submission.

AI DISCLOSURE STATEMENT

The authors declare that this research was prepared, researched, written, and edited without the aid of artificial intelligence (AI) techniques.

CONFLICT OF INTEREST

No Conflicts of Interes

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