



A data-driven analysis of the mediating role of physical fitness in the relationship between motivation and physical educational learning outcomes

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Abstract

Background: Learning outcomes in physical education are influenced by both psychological and physiological factors. However, the mechanism through which motivation contributes to learning outcomes, particularly through physical fitness as an intervening variable, remains underexplored in educational research.

Aims: This study aims to analyze the direct and indirect effects of motivation and physical fitness on physical education learning outcomes among junior high school students.

Method: A quantitative, data-driven approach with a causal-associative design was employed. The sample consisted of 32 students selected using purposive sampling. Data were collected through a Likert-scale motivation questionnaire, the Indonesian Student Fitness Test (TKSI Phase D), and students' academic performance records. Data analysis included descriptive statistics, normality testing, and mediation analysis using multiple regression.

Results: The results indicate that motivation significantly affects physical fitness ($\beta = 0.547, p < 0.001$) and has a direct effect on learning outcomes ($\beta = 0.295, p < 0.05$). Physical fitness also significantly influences learning outcomes ($\beta = 0.331, p < 0.05$). Furthermore, physical fitness partially mediates the relationship between motivation and learning outcomes, with an indirect effect of 27.6%.

Conclusion: Motivation and physical fitness significantly influence physical education learning outcomes, both directly and indirectly. Physical fitness functions as an important mediating variable, highlighting the need for integrated strategies that enhance both student motivation and physical condition to improve academic performance.

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INTRODUCTION

Education plays a fundamental role in shaping the progress of a nation, as it represents a structured and systematic effort carried out by various stakeholders, including families, communities, and governments. Through education, individuals develop knowledge, skills, and values that are essential for personal and societal advancement. The success of educational processes is not solely determined by intellectual abilities but is also influenced by physical, psychological, and social factors (Córdova Olivera et al., 2023; Estrada et al., 2021). In the context of modern education, there is growing recognition that learning outcomes are the result of complex interactions among these dimensions. In particular, psychological factors such as motivation and physiological factors

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such as physical fitness have been identified as important contributors to student achievement (Fierro-Suero et al., 2023; Frikha et al., 2024; Herbert, 2022; Ma et al., 2025). Motivation encourages students to actively engage in learning activities, while physical fitness enhances their readiness and capacity to participate effectively (Hidayat et al., 2023; Mokmin & Jamiat, 2021; Rosenkranz et al., 2023). These two factors are especially relevant in physical education, where learning involves both cognitive understanding and physical performance (Dominguez et al., 2023; Martín-Rodríguez et al., 2024; Norris et al., 2020; Rudd et al., 2020). Despite their importance, the relationship between motivation and physical fitness is often not fully explored in an integrated manner. Understanding how these variables interact can provide deeper insights into the mechanisms underlying learning outcomes. Therefore, it is essential to examine the interrelationship between motivation, physical fitness, and learning outcomes within a comprehensive analytical framework.

In practice, the implementation of physical education in schools still faces several challenges that may hinder optimal learning outcomes. One of the major issues is the persistence of traditional teaching approaches that are predominantly teacher-centered (Alam, 2023). In such approaches, students tend to follow instructions passively rather than actively engaging in learning activities. This limits opportunities for students to develop autonomy, creativity, and intrinsic motivation (Ghosh et al., 2020; Gulzar et al., 2022; Shin & Bolkan, 2021). As a result, the learning process becomes less meaningful and less effective in fostering long-term development. Furthermore, the quality of physical education instruction has been a subject of concern across different educational levels (Bates et al., 2020; Block et al., 2021; O'Brien et al., 2020). The limited use of student-centered approaches reduces the potential for integrating physical, cognitive, and emotional aspects of learning (Bhardwaj et al., 2025; Kerimbayev et al., 2023; Martin-Alguacil et al., 2024). This condition may also negatively affect students' motivation to participate in physical activities. When students are not motivated, their level of physical engagement decreases, which in turn impacts their physical fitness. Consequently, low levels of physical fitness may reduce students' ability to perform well in physical education tasks. Therefore, improving both teaching strategies and student engagement is essential to enhance learning outcomes in physical education.

Motivation plays a crucial role in influencing both physical fitness and learning outcomes, as it serves as a driving force that encourages individuals to act and persist in various activities. It can originate from internal factors, such as personal interest and enjoyment, as well as external influences, such as rewards and social support (Murayama, 2022). Students with high levels of motivation are more likely to participate actively in physical activities and maintain consistent learning behaviors (Cents-Boonstra et al., 2021; Leo et al., 2022). This active participation contributes to improved physical fitness, which is an important component of overall student development (Herbert, 2022; Norris et al., 2020). In addition, physical fitness supports cognitive functions such as concentration, endurance, and problem-solving ability. These cognitive benefits can positively influence academic performance and learning outcomes. Therefore, motivation not only enhances students' willingness to learn but also indirectly contributes to their physical condition. However, the interaction between motivation and physical fitness is often treated as separate influences rather than interconnected factors. This limits a deeper understanding of how motivation can influence learning outcomes through physiological pathways. As a result, there is a need to examine physical fitness as a potential mediating variable that explains this relationship.

A growing body of literature has established that both motivation and physical activity play important roles in improving students' academic achievement and learning outcomes in physical education contexts, with studies on gamification, cooperative learning, and self-determination theory consistently showing significant effects on students' motivation and engagement (Fernandez-Rio et al., 2020; Kalajas-Tilga et al., 2020; T. Liu & Lipowski, 2021). In parallel, systematic reviews and meta-analyses have confirmed that physical activity and physical fitness are positively associated with

cognitive performance and academic achievement, indicating the importance of physiological factors in supporting learning processes (Barbosa et al., 2020; Norris et al., 2020; Sember et al., 2020; Sluijs et al., 2021). Moreover, recent studies have increasingly adopted mediation analysis to understand the underlying mechanisms linking educational variables, particularly by examining mediators such as psychological needs satisfaction, student engagement, and behavioral factors in explaining academic outcomes (Ballen & Salehi, 2021; Edwards & Konold, 2020; Leo et al., 2022). However, despite these advancements, limited research has specifically examined the mediating role of physical fitness in the relationship between motivation and physical education learning outcomes, as most studies tend to treat motivation and physical fitness as independent predictors rather than integrating them into a unified mediation model. In addition, although mediation approaches have been widely applied in general education and health research, their application in physical education contexts using data-driven quantitative frameworks remains underexplored, particularly among secondary school students. Therefore, this gap highlights the need for a comprehensive investigation that simultaneously examines the direct and indirect effects of motivation on learning outcomes through physical fitness, in order to better understand the mechanism linking psychological and physiological factors in physical education.

Based on the issues identified, this study aims to examine the direct and indirect effects of motivation on physical education learning outcomes, with physical fitness functioning as a mediating variable. This research seeks to explore how psychological and physiological factors interact within a unified analytical model. By adopting a quantitative and data-driven approach, this study aims to provide a clearer understanding of the mechanisms underlying student learning outcomes in physical education. The analysis focuses on identifying both the direct influence of motivation and the indirect influence through physical fitness. In addition, this study aims to address the limitations of previous research that has primarily examined these variables independently. The findings are expected to contribute to the development of more effective educational strategies that integrate both motivational and physical aspects of learning. Furthermore, this study aims to provide practical insights for educators in designing student-centered learning approaches. It also seeks to support policymakers in improving the quality of physical education programs. By examining the mediating role of physical fitness, this research offers a more comprehensive perspective on student achievement. Ultimately, this study aims to enhance learning outcomes through a more holistic and integrated approach in physical education.

LITERATURE REVIEW

Motivation is widely recognized as a key psychological factor influencing students' learning behaviors and academic performance across various educational contexts. In physical education, motivation plays a central role in determining students' willingness to participate in physical activities and engage in learning processes (Chen et al., 2020; Fierro-Suero et al., 2023; Kalajas-Tilga et al., 2020; Leo et al., 2022; Su & Liu, 2025). It functions as an internal and external driving force that directs students' efforts toward achieving specific learning goals. Motivation is commonly categorized into intrinsic and extrinsic types, each of which contributes differently to learning outcomes (Ryan & Deci, 2020; Van den Broeck et al., 2021). Intrinsic motivation is associated with personal interest, enjoyment, and satisfaction derived from the learning process itself. In contrast, extrinsic motivation is driven by external rewards, recognition, or social pressures. Students who possess high levels of intrinsic motivation are more likely to demonstrate sustained engagement and persistence in physical education activities (de Bruijn et al., 2023; Guo et al., 2023; Vasconcellos et al., 2020). This sustained engagement can enhance both their physical performance and cognitive understanding of the subject matter. Moreover, motivated students tend to exhibit positive attitudes

toward learning, which further supports their academic success. Therefore, motivation is considered a fundamental determinant of learning outcomes in physical education.

Physical fitness represents a crucial physiological factor that supports students' ability to perform physical tasks and sustain active participation in learning activities. It encompasses various components, including muscular strength, endurance, flexibility, agility, and coordination. These components collectively contribute to an individual's overall physical condition and readiness to engage in physical activities. In educational settings, physical fitness is particularly important in physical education, where students are required to perform both theoretical and practical tasks (Norris et al., 2020; Vasconcellos et al., 2020; Zhamardiy et al., 2020). Higher levels of physical fitness are associated with improved physical performance, which can enhance students' confidence and participation (Fossati et al., 2021; García-Hermoso et al., 2020; Guimarães et al., 2023; Ouyang et al., 2020). In addition, physical fitness has been linked to cognitive functions such as attention, memory, and problem-solving ability. These cognitive benefits suggest that physical fitness contributes not only to physical health but also to academic achievement. Students who are physically fit tend to demonstrate better concentration and learning efficiency. This improved cognitive functioning can lead to higher learning outcomes in physical education. Therefore, physical fitness is an essential factor that supports both physical and academic aspects of student development.

Learning outcomes in physical education are influenced by a combination of cognitive, affective, and psychomotor domains. These outcomes reflect the extent to which students acquire knowledge, develop skills, and demonstrate appropriate attitudes during the learning process. In physical education, learning outcomes are often measured through both theoretical assessments and practical performance evaluations (Moura et al., 2021; Norris et al., 2020; Swann et al., 2021). The integration of physical activity into learning creates a unique environment where multiple dimensions of learning interact simultaneously (Liu, 2023; Rudd et al., 2020). Students are expected not only to understand theoretical concepts but also to apply them in physical practice. This dual requirement highlights the importance of both psychological readiness and physical capability. Motivation influences students' willingness to engage in learning, while physical fitness determines their ability to perform physical tasks effectively (Liu et al., 2023; White et al., 2021). When these two factors are optimized, students are more likely to achieve higher learning outcomes. Conversely, low motivation and poor physical fitness can hinder student performance. Therefore, understanding the factors that influence learning outcomes is critical for improving the effectiveness of physical education programs.

Recent developments in educational research have emphasized the importance of examining indirect relationships among variables through mediation analysis. Mediation analysis allows researchers to explore how one variable influences another through an intermediary variable (Angriman et al., 2024; Nguyen et al., 2021). This approach provides a deeper understanding of the mechanisms underlying observed relationships. In the context of physical education, mediation analysis can be used to investigate how motivation affects learning outcomes through physical fitness. This perspective moves beyond simple direct-effect models and highlights the complexity of interactions among psychological and physiological factors. Several studies have demonstrated that mediating variables such as engagement, self-efficacy, and behavioral factors play important roles in shaping learning outcomes. However, the mediating role of physical fitness has received relatively limited attention in the literature. This gap suggests that the relationship between motivation and learning outcomes may not be fully understood without considering physical fitness as an intermediary factor. By incorporating mediation analysis, researchers can develop more comprehensive models of student learning. Therefore, the use of mediation analysis is essential for advancing knowledge in physical education research.

A data-driven approach is increasingly important in educational research, as it enables the systematic analysis of relationships among variables using quantitative methods. This approach involves the use of statistical techniques such as regression analysis, path analysis, and structural modeling to examine direct and indirect effects. In physical education research, data-driven methods provide robust evidence for understanding how psychological and physiological factors influence learning outcomes. These methods allow researchers to quantify the strength and significance of relationships among variables. In addition, data-driven analysis supports the development of evidence-based educational strategies that can improve student performance. By integrating motivation, physical fitness, and learning outcomes into a single analytical framework, researchers can identify key factors that contribute to educational success. This integrated approach is particularly relevant in physical education, where multiple dimensions of learning interact dynamically. Furthermore, data-driven findings can inform teachers and policymakers in designing effective interventions. The use of quantitative analysis also enhances the reliability and validity of research findings. Therefore, adopting a data-driven approach is essential for generating meaningful insights in physical education research.

METHOD

Research Design

This study employed a quantitative approach using a causal-associative research design to examine the relationships among motivation, physical fitness, and physical education learning outcomes. The purpose of this design was to identify both direct and indirect effects between variables within a unified analytical framework. In this study, motivation (X1) was treated as the independent variable, physical fitness (X2) as the mediating variable, and learning outcomes (Y) as the dependent variable. The research model assumed that motivation influences learning outcomes both directly and indirectly through physical fitness. A descriptive quantitative approach was also applied to provide an overview of the distribution and characteristics of each variable. The study adopted a cross-sectional design, where data were collected at a single point in time without manipulation of variables. This design allowed for the examination of relationships among variables under natural conditions. The conceptual framework of this study illustrates the direct and indirect relationships among variables, as shown in Figure 1. The use of mediation analysis enabled a deeper understanding of the mechanism linking motivation, physical fitness, and learning outcomes. Therefore, this design was considered appropriate to address the research objectives.

Participant

The population in this study consisted of all grade IX students of SMP N 1 Ogan Komerang Ulu, totaling 270 students distributed across nine classes. From this population, a sample of 32 students was selected using purposive sampling techniques. The selection was based on specific considerations, including students' participation in physical education classes and the availability of complete data required for analysis. Although random sampling is commonly used in quantitative research, purposive sampling was considered more suitable for this study to ensure that the selected participants met the research criteria. All participants were within a relatively homogeneous age group and educational level, which helped minimize variability due to demographic differences. The sample size was deemed adequate for regression-based mediation analysis. Prior to data collection, participants were informed about the purpose of the study and their voluntary participation was ensured. Ethical considerations were maintained by guaranteeing the confidentiality and anonymity of participants' data. No personal identifiers were recorded during the data collection process.

Therefore, the selected sample was considered appropriate to represent the population within the scope of this study.

Instrument

Data were collected using three primary instruments corresponding to the research variables. Motivation (X1) was measured using a structured questionnaire based on a Likert scale, designed to capture both intrinsic and extrinsic motivational dimensions. Physical fitness (X2) was measured using the Indonesian Student Fitness Test (TKSI Phase D), which evaluates several components, including explosive power, abdominal muscle strength, endurance, agility, and coordination. Learning outcomes (Y) were obtained from students' academic records in physical education, which reflect cognitive, affective, and psychomotor performance. The operational definitions of the variables and their corresponding indicators are presented in Table 1.

Table 1. Indicator Variable

Research Variables	Operational Definition	Indicator	Instrument
Motivation (X1)	Motivation is a condition that drives an individual to do something.	1. Intrinsic Motivation 2. Extrinsic Motivation	Questionnaire with Linkert Scale
Physical Fitness (X2)	Physical fitness is very important for a person's life in carrying out daily activities or work.	1. Explosive power 2. Abdominal muscle strength 3. Durability 4. Agility 5. Coordination	TKSI Phase D
Learning Outcomes (Y)	Learning outcomes are abilities acquired by individuals after going through a learning process, which can produce positive changes in behavior and knowledge.	1. Cognitive, 2. Effective, 3. Psychomotor	Physical Education Learning Outcomes for Semester 2 of the 24/25 academic year

Table 2.example of a Likert scale that will be used in this study.

No.	Answer	Code	Weight
1	Strongly Disagree	STS	1
2	Don't agree	TS	2
3	Quite Agree	CS	3
4	Agree	S	4
5	Strongly agree	SS	5

Table 3.TKSI Phase D Value Category Norm

No	Value Range	Category
1	22 - 25	Very well
2	18 - 21	Good
3	14 - 17	Currently
4	10 - 13	Not enough
5	≤ 9	Less than once

Data collection was conducted systematically in several stages. First, the motivation questionnaire was administered directly to the participants under supervision to ensure accurate responses. Second, physical fitness tests were carried out following standardized TKSI procedures to ensure consistency and reliability. Third, students' learning outcomes were collected from official academic records with permission from the school authorities. All collected data were recorded and organized for further analysis.

Data Analysis

Data analysis was conducted through three main stages: descriptive analysis, classical assumption testing, and inferential statistical analysis. Descriptive statistics were used to summarize the characteristics of the data, including mean, standard deviation, minimum, and maximum values. To ensure the validity of the instrument, item analysis was performed using Pearson product-moment correlation. Reliability and validity testing were conducted using statistical software to confirm the consistency of the measurement instruments. Prior to hypothesis testing, classical assumption tests were performed, including the normality test using the Kolmogorov-Smirnov method. The results of this test were used to determine whether the data were normally distributed. Furthermore, multiple linear regression analysis was employed to examine the direct effects of motivation and physical fitness on learning outcomes. Path analysis was also conducted to evaluate indirect effects and to test the mediating role of physical fitness. The level of significance was set at 0.05. All statistical analyses were performed using SPSS software to ensure accuracy and reliability. The results of the analysis were interpreted to determine the strength and direction of relationships among variables. Therefore, this analytical approach provided a comprehensive evaluation of both direct and indirect relationships in the research model.

RESULTS AND DISCUSSION

Results

The results of this study show a significant influence between motivation and physical fitness on learning outcomes in class IX students of SMP Negeri 1 Ogan Komering Ulu, South Sumatra. To find out whether the test conducted has a significant difference or not, a comparison is needed, so it is necessary to use the r table at the desired level, namely at a significance level of 0.05 with a 2-sided test. If the value is positive and the calculated $r \geq r$ table, then the item can be declared valid, conversely if the calculated $r < r$ table, then the item is declared invalid (Sugiyono, 2013: 114).

Motivation

Based on the results of the motivation questionnaire of class IX students of SMPN 01 Ogan Komering Ulu, from 32 students, the average (mean) was 173.9, standard deviation = 36.7, maximum value = 240 and minimum = 103. Next, the frequency distribution of motivation data.

Table 4. Frequency distribution of motivation of class IX students of SMPN 01 OKU

NO	Interval Class	Frequency	Percentage (%)
1	103 - 125	4	13%
2	126 - 148	3	9%
3	149 - 171	11	34%
4	172 - 194	5	16%
5	195 - 217	5	16%
6	218 - 240	4	13%
Amount		32	100%

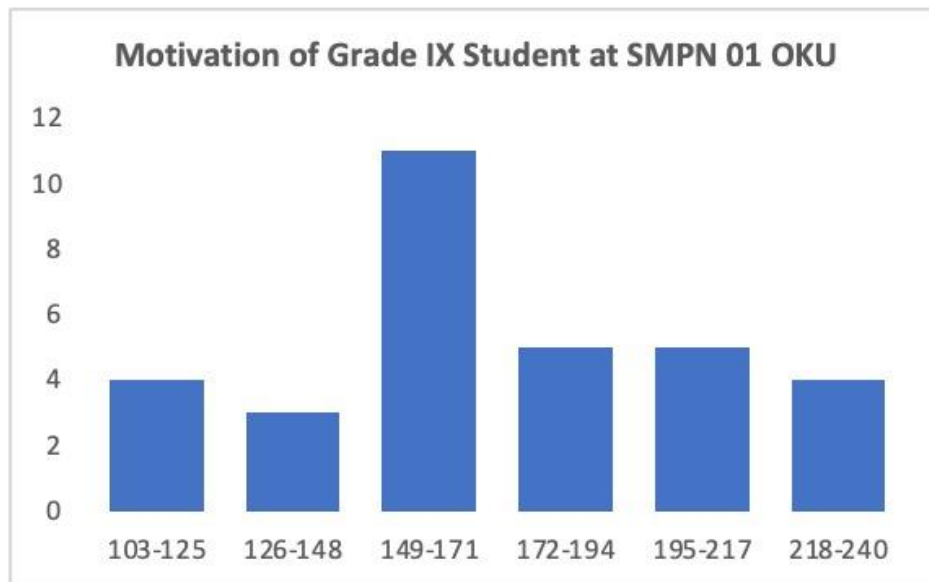


Figure 1. Motivational chart of class IX students of SMP Negeri 01 OKU

Based on the results above, it can be concluded that of the 32 students of class IX of SMP Negeri 01 OKU, 4 people or 13% are included in the interval class 103-125, 3 people or 9% are included in the interval class 126-148, 11 people or 34% are included in the interval class 149-171, 5 people or 16% are included in the interval class 172-194, 5 people or 16% are included in the interval class 195-217, 4 people or 13% are included in the interval class 218-240. Frequency distribution of motivation of class IX students of SMP Negeri 01 Ogan Komerang Ulu.

Physical fitness

Based on the results of the physical fitness test of students at SMP Negeri 01 Ogan Komerang Ulu, from 32 students, the average (mean) was 16.4, standard deviation = 1.9, maximum value = 20, minimum value = 13.

Table 5. Frequency distribution of physical fitness of class IX students of SMP Negeri 01 OKU

NO	Interval Class	Frequency	Percentage (%)
1	13 - 14	6	19%
2	15 - 16	10	31%
3	17 - 18	12	38%
4	19 - 20	4	13%
5	21 - 22	0	0%
6	23 - 24	0	0%
Amount		32	100%

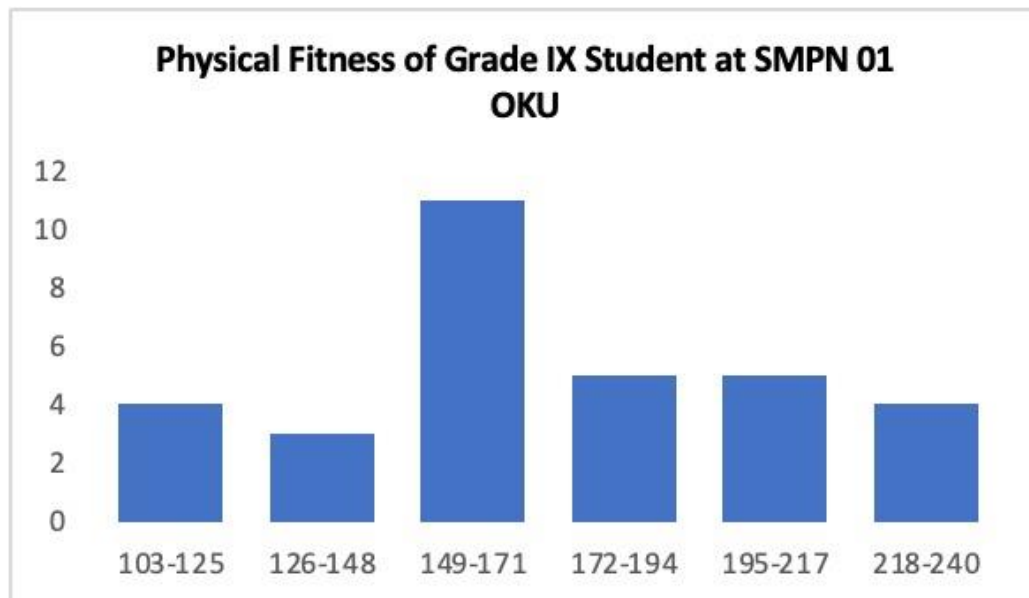


Figure 2. Physical fitness graph of class IX students of SMP Negeri 01 OKU

Based on the research results, it can be concluded that of the 32 students of class IX of SMP Negeri 01 OKU, 6 people or 19% are included in the interval class 13-14, 10 people or 31% are included in the interval class 15-16, 12 people or 38% are included in the interval class 17-18, 4 people or 13% are included in the interval class 19-20, 0 people or 0% are included in the interval class 21-22, 0 people or 0% are included in the interval class 23-24. The frequency distribution of physical fitness of class IX students of SMP Negeri 01 Ogan Komering Ulu can be shown in the picture above.

Learning outcomes

Based on the results of the Physical Education learning of students at SMP Negeri 01 Ogan Komering Ulu, from 32 students, the average (mean) was 92.12, standard deviation = 2.87, maximum value = 97, minimum value = 87.

Table 6. Frequency distribution of learning outcomes of class IX students of SMP Negeri 01 OKU

NO	Interval Class	Frequency	Percentage (%)
1	87 - 88	4	13%
2	89 - 90	8	25%
3	91 - 92	5	16%
4	93 - 94	8	25%
5	95 - 96	5	16%
6	97 - 98	2	6%
Amount		32	100%

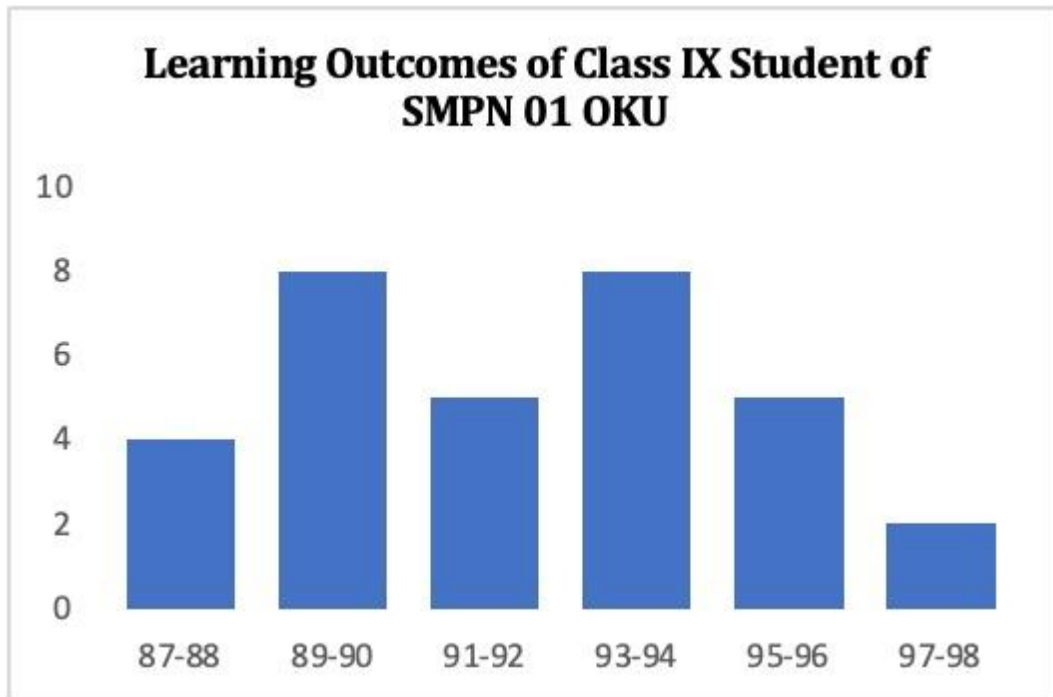


Figure 3. Graph of learning outcomes of class IX students of SMP Negeri 01 OKU

Based on table 4.3 above, it can be concluded that of the 32 students of class IX of SMP Negeri 01 OKU, 4 people or 13% are included in the interval class 87-88, 8 people or 25% are included in the interval class 89-90, 5 people or 16% are included in the interval class 91-92, 8 people or 25% are included in the interval class 93-94, 5 people or 16% are included in the interval class 95-96, 2 people or 6% are included in the interval class 97-98. Distribution of frequency distribution of the concentration of class IX students of SMP Negeri 01 Ogan Komering Ulu. Before conducting parametric analysis, a normality test was conducted to verify the distribution of the research data. This test is a primary prerequisite in the application of parametric statistical methods such as Pearson correlation and linear regression (Field, 2018). In this study, the normality test was conducted using the Kolmogorov-Smirnov method on three variables: (1) Learning Motivation, (2) TKSI PHASE D, and (3) Learning Outcomes.

Table 7. Normality of Residuals

	Tests of Normality					
	Kolmogorov-Smirnova			Shapiro-Wilk		
	Statistics	Df	Sig.	Statistics	Df	Sig.
MOTIVATION	,100	32	,200*	,972	32	,558
PHYSICAL FITNESS	,131	32	,172	,958	32	,250
LEARNING OUTCOMES	,145	32	,083	,958	32	,248

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

The Kolmogorov-Smirnov test with Lilliefors correction showed a significance value of 0.200 for motivation, 0.172 for physical fitness, and 0.083 for learning outcomes. Practically, meeting the normality assumption for these three variables guarantees the reliability of the regression analysis results, including the interpretation of the coefficient of determination (R^2), the t-test for the regression coefficients, and the confidence intervals generated by the model. The residual normality test output confirms the fulfillment of the normal distribution assumption in the regression model. This is evidenced by the convergence of the statistical method results.

Table 8. F Test (Simultaneous Test)

ANOVA						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	184,425	2	92,213	37,625	<,001b
	Residual	71,075	29	2,451		
	Total	255,500	31			

a. Dependent Variable: LEARNING OUTCOMES

b. Predictors: (Constant), PHYSICAL FITNESS, MOTIVATION

If the regression model is declared FIT if the significant value is <0.05 , it is known that the results of the data processing above the significant value are <0.001 (<0.05) then it is concluded that the independent variables have a significant effect simultaneously on the dependent variable.

Table 9. T-Test (Hypothesis Test)

Model	Coefficientsa			T	Sig.
	Unstandardized Coefficients		Standardized Coefficients		
	B	Std. Error	Beta		
(Constant)	76,093	2,431		31,300	<,001
MOTIVATION	,049	,009	,643	5,499	<,001
PHYSICAL FITNESS	,457	,175	,305	2,609	,014

a. Dependent Variable: LEARNING OUTCOMES

If the significant value <0.05 concludes that there is a significant influence and if the significant value is exactly at 0.05 then to find out whether or not there is an influence of the independent variable on the dependent variable, you can use the comparison of T Calculation with T Table. From the results of the data processing above, X1 has a significance value of <0.001 so it can be concluded that Motivation has a significant influence on learning outcomes and X2 has a significance value of 0.014, so physical fitness has a significant influence on learning outcomes. In the analysis of the multiple linear regression equation data, the constant value is 76.093, which means that if the independent variable is 0, then the dependent variable is 76.093. Therefore, it can be concluded that the regression coefficient value of X1 is positive at 0.049, which means that if X1 increases, the Y variable also increases, and vice versa. For the regression coefficient value of X2, the value is positive at 0.457, which means that if X2 increases, the Y variable also increases, and vice versa.

Discussion

The results of this study indicate that motivation has a significant influence on physical education learning outcomes, confirming that students with higher motivation tend to achieve better academic performance. This finding suggests that motivation functions as a fundamental psychological driver that shapes students' learning behavior and engagement. In practical terms, motivated students demonstrate greater attention during the learning process, allowing them to absorb both theoretical and practical aspects of physical education more effectively (Gaspar et al., 2021; Martín-Rodríguez & Madrigal-Cerezo, 2025). Motivation also encourages students to actively participate in physical activities, which is essential for achieving optimal performance in this subject. In physical education contexts, where learning involves both cognitive understanding and physical execution, motivation becomes a critical factor that determines students' overall success (Luo et al., 2020; Zhang et al., 2024). Students who are highly motivated are more likely to persist in challenging activities and show greater enthusiasm during lessons. This behavior contributes to deeper learning and improved outcomes. These findings are consistent with broader educational perspectives that

emphasize the importance of motivation in enhancing academic achievement. Furthermore, motivation supports the development of positive learning attitudes, which further reinforces students' commitment to the learning process. Therefore, motivation can be considered a key determinant of learning outcomes in physical education.

The findings also reveal that motivated students are better able to balance academic activities with physical exercise, leading to more optimal learning outcomes. This indicates that motivation not only influences cognitive engagement but also promotes active participation in physical tasks. Students who are motivated tend to approach learning activities with a sense of responsibility and discipline, which enhances their overall performance. The integration of enjoyable and structured learning methods, such as play-based and practice-based approaches, appears to strengthen students' motivation. These approaches create a learning environment that is both engaging and challenging, encouraging students to participate actively. As a result, students develop a stronger interest in physical education and are more willing to invest effort in improving their abilities. This aligns with previous findings that highlight the effectiveness of interactive and student-centered learning strategies in increasing motivation. In addition, such methods foster a sense of enjoyment, which is crucial for sustaining long-term engagement in physical activities. Students who enjoy the learning process are more likely to remain committed and achieve better outcomes. Therefore, the role of motivation extends beyond immediate performance and contributes to long-term learning development.

Another important finding of this study is that physical fitness significantly influences physical education learning outcomes. This suggests that students with higher levels of physical fitness are better equipped to perform physical tasks and meet the demands of physical education activities. Physical fitness enhances students' physical capabilities, including strength, endurance, and coordination, which are essential for successful performance (Pérez-Ramírez et al., 2024). In addition, physical fitness contributes to improved cognitive functioning, such as concentration and focus, which are necessary for understanding theoretical concepts (Brown et al., 2024; Latino & Tafuri, 2024). Students who are physically fit tend to demonstrate greater confidence in their abilities, which positively affects their participation and performance. This creates a positive cycle in which physical fitness enhances both physical and academic aspects of learning. The findings support the view that physical fitness is not only a health-related factor but also an important determinant of academic success. Furthermore, students with higher fitness levels are more likely to engage actively in learning activities, leading to improved outcomes. This relationship highlights the importance of incorporating physical fitness development into educational programs. Therefore, physical fitness plays a crucial role in supporting learning outcomes in physical education.

The combined effect of motivation and physical fitness provides a more comprehensive explanation of learning outcomes than either factor alone. The results show that these variables complement each other in influencing student performance. Motivation encourages students to participate actively in physical activities, while physical fitness enables them to perform these activities effectively. This interaction suggests that psychological and physiological factors are interconnected and should be considered together in educational analysis. The significant results of the statistical tests further support the strength of this relationship. The high explanatory power of the model indicates that motivation and physical fitness together account for a substantial proportion of the variation in learning outcomes. This finding emphasizes that learning outcomes in physical education cannot be fully understood without considering both factors simultaneously. In addition, the results suggest that improving one factor alone may not be sufficient to achieve optimal outcomes. Instead, a balanced approach that addresses both motivation and physical fitness is required. This integrated perspective provides a more holistic understanding of the learning process.

Overall, the findings of this study highlight the importance of integrating psychological and physiological aspects in physical education. Motivation and physical fitness not only influence learning outcomes individually but also interact to create a more effective learning process. From a practical perspective, this suggests that educators should design learning activities that simultaneously enhance student motivation and physical fitness. For example, incorporating game-based learning and structured physical exercises can create a more engaging and productive learning environment. These strategies can increase students' interest and participation while also improving their physical condition. In addition, the findings suggest that physical fitness development should be an integral part of the physical education curriculum. Schools should provide opportunities for students to engage in regular physical activities that promote fitness and well-being. By doing so, students can develop both the physical and psychological skills necessary for academic success. Furthermore, policymakers can use these findings to design educational programs that support holistic student development. Therefore, achieving optimal learning outcomes in physical education requires a balanced approach that integrates both motivational and physical dimensions.

Implications

The findings of this study have important theoretical and practical implications for the development of physical education. From a theoretical perspective, this study reinforces the concept that learning outcomes in physical education are influenced by an interaction between psychological and physiological factors rather than by isolated variables. The identification of physical fitness as a mediating variable provides a deeper understanding of the mechanism through which motivation influences academic performance. This contributes to the advancement of data-driven educational research by offering a more comprehensive analytical framework. From a practical standpoint, the results suggest that educators should adopt teaching strategies that simultaneously enhance student motivation and physical fitness. Instructional approaches that integrate enjoyable and structured physical activities can increase student engagement and participation. In addition, incorporating game-based and student-centered learning methods can help foster intrinsic motivation and sustained interest in physical education. Schools are also encouraged to design physical education programs that emphasize regular physical activity to improve students' fitness levels. Improved physical fitness can enhance not only students' physical performance but also their cognitive readiness and confidence in learning. Furthermore, policymakers can use these findings to develop educational policies that support the integration of physical and psychological development in school curricula. The use of data-driven approaches in this study also highlights the importance of evidence-based decision-making in educational planning. Therefore, these findings provide a foundation for improving the effectiveness of physical education through a holistic and integrated approach.

Limitations and Suggestions for Future Research

This study has several limitations that should be considered when interpreting the findings and developing future research. First, the sample size was relatively small and limited to a single class within one school, which may restrict the generalizability of the results to broader populations. Second, the use of a cross-sectional design limits the ability to establish causal relationships among motivation, physical fitness, and learning outcomes over time. Third, the reliance on self-reported questionnaire data for measuring motivation may introduce response bias and affect the accuracy of the results. Fourth, although physical fitness was measured using a standardized instrument, external factors such as students' health conditions and daily activities were not controlled. Fifth, the study focused only on one mediating variable, while other potential mediators such as self-efficacy, engagement, or learning environment were not included in the model. Sixth, the research context was limited to physical education, which may not fully represent the complexity of learning processes in other subject areas. Seventh, variations in teaching methods and teacher competencies were not

examined, even though they may influence both motivation and learning outcomes. Based on these limitations, future research is recommended to involve larger and more diverse samples across multiple schools or regions. Longitudinal studies are also needed to better understand the causal relationships and dynamic interactions among variables over time. In addition, future studies should consider incorporating multiple mediating and moderating variables to develop a more comprehensive analytical model. The use of advanced statistical techniques such as structural equation modeling is also recommended to improve analytical precision. Therefore, further research is essential to strengthen the validity and applicability of findings in this field.

CONCLUSION

This study concludes that motivation and physical fitness play significant roles in influencing physical education learning outcomes among students. The findings demonstrate that motivation has a direct effect on learning outcomes, indicating that students with higher levels of motivation tend to achieve better academic performance. In addition, motivation also significantly influences physical fitness, suggesting that motivated students are more likely to engage in physical activities that enhance their fitness levels. Physical fitness, in turn, has a direct impact on learning outcomes, highlighting its importance as a physiological factor supporting student performance. Furthermore, the results confirm that physical fitness functions as a mediating variable in the relationship between motivation and learning outcomes. This indicates that motivation not only affects learning outcomes directly but also indirectly through improvements in physical fitness. The integration of psychological and physiological factors provides a more comprehensive explanation of student achievement in physical education. The statistical findings further support the strength of this relationship, showing that the combined influence of motivation and physical fitness explains a substantial proportion of the variance in learning outcomes. These results emphasize the importance of adopting a holistic approach in physical education that considers both motivational and physical aspects of learning. From an educational perspective, enhancing student motivation and physical fitness should be prioritized to improve overall learning effectiveness. The study also highlights the value of using data-driven analysis to better understand complex relationships among educational variables. Therefore, this research contributes to the development of more effective strategies for improving learning outcomes in physical education through an integrated and evidence-based approach.

AUTHOR CONTRIBUTIONS STATEMENT

M. Dina Sefrianda designed the study, developed the research framework, and led the data analysis focusing on the relationships among motivation, physical fitness, and learning outcomes. Nurul Ihsan contributed to the conceptual and theoretical development of the study, refined the literature review, and supported the interpretation of the statistical findings. Masrun assisted in data collection procedures, instrument implementation, and contributed to the organization and validation of research data. Sepriadi provided expertise in physical education context, supported the analysis of physical fitness measurements, and contributed to the discussion of practical implications. Ardo Okilanda supervised the overall research process, contributed to methodological refinement, and ensured the scientific quality and coherence of the manuscript. All authors contributed to writing, reviewed the manuscript critically for important intellectual content, and approved the final version.

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