



Physical fitness and learning motivation in relation to physical education learning outcomes among elementary school students

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ABSTRACT

Physical education learning outcomes may be associated with students' physical fitness, learning motivation, physical activity, and nutritional status. This study examined the individual and joint associations of these four variables with physical education learning outcomes among male upper-grade elementary school students in Surakarta, Indonesia. A correlational study was conducted with 234 students selected using proportional random sampling. Data were collected through physical fitness testing, questionnaires on learning motivation and physical activity, body mass index (BMI) measurements, and students' physical education report-card grades. Pearson correlation and multiple linear regression analyses were used to examine the relationships between the study variables. Physical fitness ($r = 0.723$) and learning motivation ($r = 0.722$) showed strong positive correlations with physical education learning outcomes. In contrast, physical activity ($r = -0.002$) and nutritional status ($r = 0.001$) showed correlations close to zero. The reported multiple regression model had a correlation coefficient of ($R = 0.819$) and explained 67.1% of the variance in learning outcomes ($R^2 = 0.671$). These findings indicate that physical fitness and learning motivation were the strongest individual correlates of physical education learning outcomes in this sample. The results should be interpreted as associations rather than causal effects, given the correlational design. Further research should use transparent measurement procedures and more diverse samples to examine the generalizability of these findings.



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1. Introduction

Physical health is an important component of children's overall development because it is closely related to their ability to participate actively in daily activities and learning. Physical fitness enables children to perform activities efficiently without excessive fatigue and provides sufficient energy to participate in academic and physical activities. In elementary school, maintaining physical fitness is particularly important because students are experiencing rapid physical, psychological, and social development [1], [2]. Therefore, physical conditions may become one of the factors that support students' participation and achievement in learning, including Physical Education. Physical fitness is not only associated with health but also with students' ability to participate in physical activities and learn effectively. Regular and appropriate physical activity contributes to the development of endurance, strength, flexibility, speed, agility, coordination, balance, and other components of physical fitness. The thesis

underlying this study emphasizes that good physical fitness allows students to perform daily activities without significant fatigue while maintaining sufficient energy for other activities. The relationship between physical activity and physical fitness is also supported by previous research cited in the thesis, which indicates that higher levels of physical activity are associated with better physical fitness. In addition to physical fitness, learning motivation represents an important psychological factor in the learning process. Students with strong learning motivation tend to demonstrate greater willingness to participate, persistence in completing learning activities, and effort to achieve learning objectives. In Physical Education, motivation is particularly relevant because learning activities require students to participate actively in physical tasks, follow instructions, and engage continuously in various forms of exercise and movement. Consequently, differences in students' motivation may be reflected in their learning participation and achievement.

Physical activity is another factor that potentially contributes to students' learning outcomes. Elementary school students require adequate physical activity to support physical development and maintain health. However, technological developments have changed children's daily activity patterns. The thesis identifies the increasing use of gadgets and children's tendency to engage in less physically active activities outside school as emerging concerns. Preliminary observations reported in the study also indicated that some students had limited physical activity outside school because they preferred playing games. These conditions raise concerns about whether insufficient physical activity may be associated with students' physical fitness and learning outcomes. Although physical fitness, learning motivation, physical activity, and nutritional status are theoretically relevant to students' physical education learning outcomes, their individual contributions may differ across educational contexts.

Physical fitness and learning motivation may show more direct associations with students' participation and achievement, whereas the relationships involving physical activity and nutritional status may depend on how these variables are measured and how learning outcomes are assessed. Furthermore, examining each variable separately may not fully capture their combined associations with learning outcomes. Therefore, empirical investigation is needed to clarify both the individual and simultaneous associations of these four variables among upper-grade elementary school students in Surakarta. This approach provides a context-specific basis for understanding which variables are more strongly associated with physical education learning outcomes, without assuming causal relationships. Nutritional status is also an important factor in children's physical development and learning. Adequate nutrition supports physical growth, concentration, energy, and fitness, whereas inadequate nutritional conditions may interfere with children's physical condition and ability to focus during learning. The thesis reports that some students frequently consumed fast food and packaged beverages, which may influence their nutritional status. Nutritional status therefore needs to be considered together with physical fitness and physical activity when examining factors associated with students' learning outcomes.

Learning outcomes in Physical Education reflect students' achievement after participating in the learning process. In the present study, learning outcomes were represented by students' report-card grades. The theoretical framework developed in the thesis proposes that physical fitness, learning motivation, physical activity, and nutritional status may jointly contribute to students' learning outcomes. Good physical fitness may support students' learning readiness, adequate motivation may encourage active participation, appropriate physical activity may contribute to physical development, and adequate nutritional status may support concentration and physical performance. Thus, these factors should not only be examined individually but also considered collectively. Empirical conditions in elementary schools in Surakarta further demonstrate the relevance of examining these relationships. Preliminary observations involving Physical Education teachers at SD Negeri Kendarrejo and SD Kanisius Serengan indicated that several students had relatively low levels of physical fitness. Interviews with Physical Education teachers in several elementary schools in Surakarta also revealed limited student enthusiasm and participation during learning activities. Teachers reported that students' achievement in Physical Education was still at a minimum level, with some students requiring additional assistance to reach the minimum passing criteria. These findings indicate a practical problem concerning the achievement of Physical Education learning outcomes among elementary school students.

Although physical fitness, learning motivation, physical activity, and nutritional status are relevant to children's development, their associations with physical education learning outcomes may differ across populations and measurement contexts. In the present study, physical fitness and learning motivation showed strong positive bivariate correlations with learning outcomes, whereas physical activity and nutritional status showed virtually zero correlations. These differences highlight the importance of examining the variables separately rather than assuming that each is equally associated with achievement. Furthermore, bivariate correlations alone cannot establish whether the variables jointly account for variation in learning outcomes. Accordingly, this study examines both individual associations and the combined statistical contribution of the four variables among male upper-grade elementary school students in Surakarta. Its contribution lies in providing context-specific evidence on these relationships within a single analytical framework, rather than establishing causal effects.

Previous studies have examined the factors associated with physical education learning outcomes from different perspectives. Azizah Nur Indarti investigated factors associated with physical education achievement, including healthy lifestyle behaviours and learning motivation, while Azzaky examined the combined associations of physical fitness, intelligence, and motivation with physical education achievement among secondary school students [3]. The description of physical activity among elementary school students or the associations of physical activity and physical fitness with motor development, and the association between self-reported physical activity and cardiorespiratory fitness among adolescents [4], [5]. In addition, A'mir, examined the relationship between health-related physical fitness and academic achievement among male secondary school students [5], [6].

Taken together, these studies provide a foundation for examining physical, motivational, behavioural, and nutritional factors in physical education. However, the studies reviewed in the thesis proposal differ in their variable combinations, populations, and outcome measures. The extent to which physical fitness, learning motivation, physical activity, and nutritional status are jointly associated with physical education learning outcomes among elementary school students therefore warrants further empirical examination. Accordingly, this study aimed to achieve two primary objectives: (1) to examine the individual associations of physical fitness, learning motivation, physical activity, and nutritional status with physical education learning outcomes; and (2) to examine the combined associations of these four variables with learning outcomes among male upper-grade elementary school students in Surakarta. By examining both individual and combined associations, this study provides context-specific empirical evidence on the relative relevance of physical and motivational characteristics, physical activity, and nutritional status in relation to elementary school students' physical education learning outcomes.

2. Method

2.1. Research Design

This study employed a quantitative correlational approach with a cross-sectional design. The study was designed to examine the relationships between physical fitness, learning motivation, physical activity, nutritional status, and Physical Education learning outcomes among upper-grade male elementary school students. The correlational design was used because the study examined the relationships among variables without manipulating or providing experimental treatment. Data were collected during the same research period. The study was conducted in elementary schools in Surakarta, Indonesia, from January to March 2024 in Fig. 1.

2.2. Participants

The study involved 234 male students in Grades 4-6 at elementary schools in Surakarta, Indonesia. The thesis identified the target population as male students in the upper grades of elementary schools in Surakarta and reported a population of 248 elementary schools, comprising public and private schools. The initial sample-size calculation yielded 333 students; however, 234 students ultimately participated because of constraints related to respondent availability, time, and research costs. The study employed proportional random sampling. According to the thesis, students in Grades 4-6 were selected through a lottery procedure using students' names written on separate pieces of paper. The names were drawn and recorded until the required number of participants was obtained. The procedure was repeated to select additional students as needed. The final sample consisted of 234 male students. The study

examined associations between physical fitness, learning motivation, physical activity, nutritional status, and physical education learning outcomes in this group. The findings should therefore be interpreted in relation to the characteristics of the participating students and should not automatically be generalized to female students or elementary school students in other settings.

2.3. Instruments and Data Collection

Five measures were used to assess the study variables: the Indonesian Physical Fitness Test (Tes Kebugaran Jasmani Indonesia, TKJI), a learning motivation questionnaire, the Physical Activity Questionnaire for Older Children (PAQ-C), body mass index (BMI), and Physical Education report-card grades. Data were collected from 234 male students in Grades 4-6 attending elementary schools in Surakarta, Indonesia. Each measure was administered or obtained according to the procedures applicable to the corresponding variable.

- **Physical Fitness.** Physical fitness was assessed using the Indonesian Physical Fitness Test (TKJI). The test version, age-specific protocol, physical fitness components, testing procedures, and scoring criteria should be specified according to the manual used in the original study. Students' test results were scored and interpreted using the corresponding TKJI classification criteria. The manuscript should also identify the manual edition or authoritative source used to establish the test procedures and scoring system.
- **Learning Motivation.** Learning motivation was measured using a questionnaire administered to the participating students. To ensure reproducibility, the final manuscript should identify the questionnaire's original source or developer, the construct dimensions assessed, the number of items, the response scale, and the scoring procedure, including any reverse-scored items. Evidence of content validity, construct validity, and reliability should be reported according to the instrument's development or adaptation process. If reliability was examined using the study sample, the relevant coefficient and method should be provided.
- **Physical Activity.** Physical activity was assessed using the Physical Activity Questionnaire for Older Children (PAQ-C), as identified in the study materials. The final manuscript should specify the version and language used, the recall period, the number of items included in the scoring procedure, the response format, and the method used to calculate the overall physical activity score. Any adaptations to the original questionnaire should be documented. Evidence supporting the validity and reliability of the version administered to the participants should also be reported.
- **Nutritional Status.** Nutritional status was assessed using body mass index (BMI), calculated from measured body weight and height using the formula $BMI = \text{weight (kg)} / \text{height (m)}^2$. Because the participants were school-aged children, the manuscript should identify the age- and sex-specific reference standard used to classify nutritional status, including the source, reference edition, and applicable cut-off criteria. The procedures for measuring body weight and height, including the equipment and measurement units, should also be reported. The categories presented in the results should correspond exactly to the classification standard applied in the original analysis.
- **Physical Education Learning Outcomes.** Physical Education learning outcomes were obtained from students' first-semester report-card grades. The manuscript should specify the grading scale, the range of possible scores, the semester and academic year covered, and the procedure used to obtain the records. It should also clarify whether the grades represented a final composite score or a particular assessment component and how the researchers ensured that the records corresponded to the participating students.

All instrument descriptions, scoring procedures, and psychometric information should be verified against the original study records. These details are necessary to enable replication and to support an appropriate interpretation of the relationships between the study variables.

2.4. Data Analysis

Descriptive statistics were used to summarize the study variables. The dataset was then examined for completeness, coding errors, missing values, and potential outliers. Assumptions relevant to Pearson correlation and multiple linear regression were assessed before inferential analyses. Pearson product-moment correlation coefficients were calculated to examine the individual associations between physical fitness, learning motivation, physical activity,

nutritional status, and physical education learning outcomes. Correlation coefficients, p-values, and the number of observations used in each analysis were reported. Multiple linear regression was used to examine the joint association of the four independent variables with physical education learning outcomes. The analysis included the model correlation coefficient, coefficient of determination ((R²)), adjusted (R²)), F-statistic, regression coefficients, standard errors, p-values, and confidence intervals, where available. Multicollinearity and relevant residual diagnostics were also examined. Because the study used a correlational design, the results were interpreted as associations rather than evidence of causal effects. As can be seen in Fig. 1.

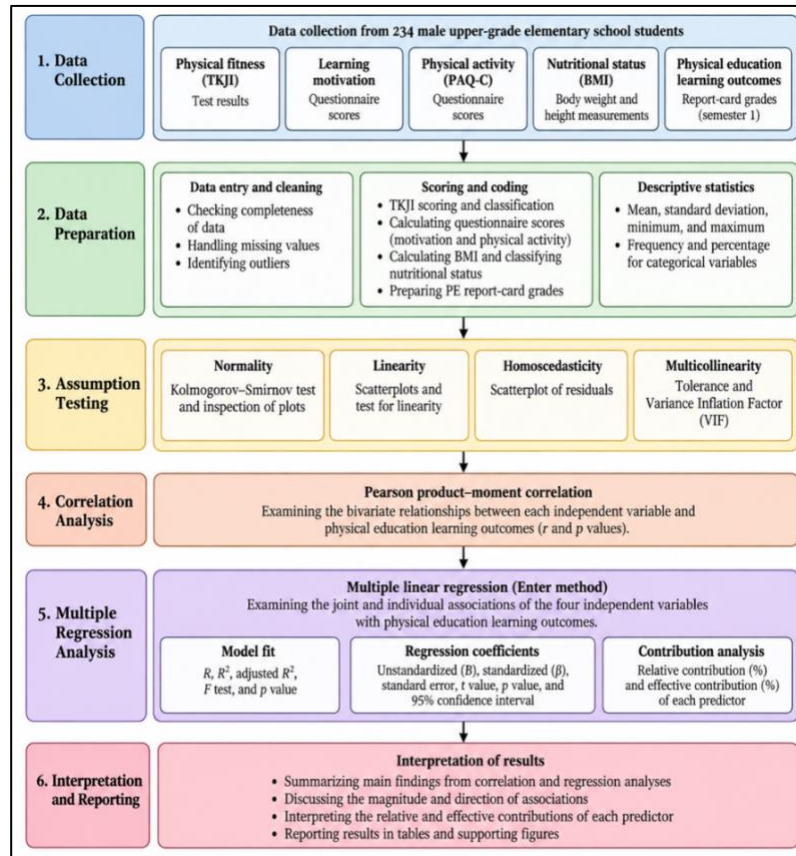


Fig. 1. Analytical Framework of The Research

3. Results and Discussion

3.1. Descriptive Results

The study involved 234 upper-grade male elementary school students in Surakarta. Descriptive analysis showed variation across physical fitness, learning motivation, physical activity, nutritional status, and Physical Education learning outcomes. Physical fitness scores ranged from 10 to 24, with a mean of 16.58 and a standard deviation of 4.06. The largest proportion of students was classified as having low physical fitness (72 students; 30.8%), followed by the good category (71 students; 30.3%), moderate category (56 students; 24.0%), and very good category (35 students; 14.9%). No students were classified in the very low category. Learning motivation scores ranged from 93 to 145, with a mean of 118.35 and a standard deviation of 14.05. Most students were classified in the low category (81 students; 34.6%), followed by the high and moderate categories, each involving approximately 27% of the sample. Nineteen students (8.2%) were classified as having very high motivation, while six students (2.6%) were in the very low category. Physical activity scores ranged from 49 to 112, with a mean of 81.68 and a standard deviation of 12.50. More than half of the students (132; 56.4%) were classified in the low physical activity category, whereas 102 students (43.6%) were classified in the good category. Nutritional status scores had a mean of 20.16 and a standard deviation of 1.525. Most students (218; 93.2%) were classified as having normal nutritional status, while 16 students (6.8%) were classified as underweight. No students were classified as overweight or obese according to the categories used in the study. Physical

Education learning outcomes ranged from 76 to 88, with a mean of 81.06 and a standard deviation of 2.63. The largest proportion of students obtained scores in the 81–83 interval (99 students; 42.3%), followed by 78-80 (62 students; 26.5%) and 75-77 (32 students; 13.7%). The varied learning outcomes in Physical Education are presented in [Table 1](#).

Table 1. Physical Education learning outcomes ranged

Variable	N	Mean	SD	Minimum	Maximum
Physical fitness	234	16.58	4.06	10	24
Learning motivation	234	118.35	14.05	93	145
Physical activity	234	81.68	12.50	49	112
Nutritional status	234	20.16	1.53	-	-
Physical Education learning outcomes	234	81.06	2.63	76	88

3.2. Correlation Results

Pearson correlation analysis was conducted among 234 male elementary school students to examine the relationships between physical fitness, learning motivation, physical activity, nutritional status, and physical education learning outcomes. The results revealed a strong positive correlation between physical fitness and learning outcomes ($r = 0.723$, $p < 0.001$). Similarly, learning motivation showed a strong positive correlation with learning outcomes ($r = 0.722$, $p < 0.001$). These findings indicate that higher levels of physical fitness and learning motivation were associated with better physical education learning outcomes in the studied sample. In contrast, physical activity ($r = -0.002$, $p = 0.979$) and nutritional status ($r = 0.001$, $p = 0.991$) showed no statistically significant correlations with learning outcomes. Given the correlational and cross-sectional design, these findings indicate associations rather than causal relationships in [Table 2](#).

Table 2. Pearson Correlations Between Predictor Variables and Physical Education Learning Outcomes

Predictor variable	<i>r</i>	<i>p</i>	Interpretation
Physical fitness	0.723	<0.001	Strong, positive, significant
Learning motivation	0.722	<0.001	Strong, positive, significant
Physical activity	-0.002	0.979	Not significant
Nutritional status	0.001	0.991	Not significant

These findings indicate that physical fitness and learning motivation were the two variables individually associated with Physical Education learning outcomes, whereas physical activity and nutritional status were not significantly associated with the outcome variable.

3.3. Multiple Regression Results

Multiple linear regression was subsequently conducted to examine the simultaneous relationship of physical fitness, learning motivation, physical activity, and nutritional status with Physical Education learning outcomes. The regression model produced an overall correlation coefficient of $R = 0.819$ and an R^2 of 0.671, indicating that the four predictors jointly accounted for 67.1% of the variance in Physical Education learning outcomes. The remaining 32.9% was attributable to other factors not examined in the study. The overall regression model was statistically significant, with $F(4, 226) = 116.580$ and $p < 0.001$. Thus, physical fitness, learning motivation, physical activity, and nutritional status were jointly significantly related to Physical Education learning outcomes. The effective contribution analysis indicated that learning motivation made the largest contribution to the explained variance (50.40%), followed by physical fitness (49.61%). Physical activity contributed 0.006%, while nutritional status contributed -0.01%. The total effective contribution was 67.1%, consistent with the reported R^2 . As can be seen in [Table 3](#).

Table 3. Multiple Regression Model

Statistic	Value
R	0.819
R^2	0.671
Adjusted R^2	0.665
$F(4, 226)$	116.580
<i>p</i>	<0.001
Explained variance	67.1%
Unexplained variance	32.9%

The results of the multiple regression analysis are presented in Table 3. The model showed a multiple correlation coefficient of ($R = 0.819$) and an (R^2) value of 0.671, indicating that the four predictors jointly explained 67.1% of the variance in physical education learning outcomes. The remaining 32.9% of the variance was attributable to other factors not included in the model. To further examine the relative contribution of each predictor, the effective contributions of physical fitness, learning motivation, physical activity, and nutritional status were calculated, as summarized in Table 4.

Table 4. Effective Contributions of the Predictors

Predictor	Relative contribution (%)	Effective Contribution (%)
Physical fitness	49.6	33.258
Learning motivation	50.40	33.790
Physical activity	0.006	0.004
Nutritional status	-0.01	-0.006
Total	≈ 100	67.1

Table 4 indicates that learning motivation and physical fitness accounted for the largest reported effective contributions to learning outcomes, whereas physical activity and nutritional status contributed minimally. The results of the hypothesis testing for each predictor, as well as for the regression model as a whole, are summarized in Table 5.

Table 5. Summary of Hypothesis Testing

Hypothesis	Relationship	Result
H1	Physical fitness $\rightarrow$ learning outcomes	Supported
H2	Learning motivation $\rightarrow$ learning outcomes	Supported
H3	Physical activity $\rightarrow$ learning outcomes	Not supported
H4	Nutritional status $\rightarrow$ learning outcomes	Not supported
H5	Four predictors jointly $\rightarrow$ learning outcomes	Supported

The detailed thesis results confirm that physical fitness and learning motivation had significant positive relationships with Physical Education learning outcomes, while physical activity and nutritional status did not show significant individual relationships. Nevertheless, the four variables together formed a statistically significant regression model with $R = 0.819$ and $R^2 = 0.671$.

3.4. Discussion

1) Physical Fitness and Physical Education Learning Outcomes

The findings demonstrate a strong and significant positive relationship between physical fitness and Physical Education learning outcomes ($r = 0.723$, $p < 0.001$). This result indicates that students with better physical fitness tend to achieve better learning outcomes in Physical Education. The finding is consistent with the conceptual framework of the study, which positions physical fitness as an important condition supporting students' participation and performance during learning activities. The thesis also describes physical fitness as a condition that enables students to perform activities without excessive fatigue, allowing them to participate more comfortably and actively in learning [7]–[9]. The relatively strong relationship may be explained by the characteristics of Physical Education learning, which directly involves physical performance. Students with adequate fitness are more likely to participate effectively in movement-based activities, maintain concentration during lessons, and complete physical tasks with less fatigue. In contrast, limited physical fitness may constrain students' participation and reduce their ability to perform optimally during learning activities. This interpretation is supported by the distribution of physical fitness in the present sample, where the largest group of students was classified in the low category (30.8%).

Aryanto and Wahyono, for example, examined the relationship between physical fitness and PJOK learning outcomes among elementary school students [7], [8], [10]. The thesis also cites Abduh *et.al*, who investigated the relationship between physical fitness and student learning outcomes [11]. Thus, the present findings strengthen the evidence that physical fitness is an important component associated with learning achievement in Physical Education at the elementary school level. However, the correlational nature of the present study should be emphasized. The result demonstrates an association rather than establishing that improving physical fitness will necessarily cause higher learning outcomes [10], [11]. Therefore, physical

fitness should be understood as one important component within a broader set of factors contributing to students' achievement.

2) *Learning Motivation and Physical Education Learning Outcomes*

Learning motivation also demonstrated a strong and significant positive relationship with Physical Education learning outcomes ($r = 0.722$, $p < 0.001$). This finding indicates that students who demonstrate stronger motivation to learn tend to obtain better learning outcomes. The result is theoretically consistent with the role of motivation in encouraging students to participate actively, persist when facing difficulties, and engage more intensively with learning activities. The thesis describes motivated students as being more likely to attend lessons actively, pay attention, make notes, review learning materials, and persist in solving difficulties. Strong learning motivation can therefore facilitate sustained engagement with the learning process. In Physical Education, this engagement is particularly relevant because successful learning requires not only physical participation but also willingness to follow instructions, practice skills, and respond to feedback [10]–[13]. The descriptive findings provide additional context for interpreting this result. Although 19 students (8.2%) were classified as having very high motivation and 64 students (27.4%) as having high motivation, the largest group was classified as having low motivation (34.6%). The coexistence of relatively low motivation and strong motivation-achievement association suggests that motivational factors may represent an important area for intervention in Physical Education learning. Interestingly, the effective contribution analysis showed that learning motivation contributed 50.40% of the explained variance, slightly exceeding the contribution of physical fitness (49.61%). This result suggests that, within the regression model, motivational conditions were at least as important as physical fitness in explaining differences in students' learning outcomes. Consequently, Physical Education instruction should not focus exclusively on improving students' physical capacities but should also create learning experiences that encourage interest, persistence, confidence, and active participation.

3) *Physical Activity and Physical Education Learning Outcomes*

In contrast to physical fitness and learning motivation, physical activity did not show a significant relationship with Physical Education learning outcomes ($r = -0.002$, $p = 0.979$). The correlation was essentially zero, indicating that differences in the level of physical activity reported by students were not systematically associated with differences in their Physical Education learning outcomes. This finding is noteworthy because the conceptual framework initially assumed that greater physical activity would support better learning outcomes. The thesis explains that physical activity can potentially support cognitive functioning, concentration, and academic behavior. Nevertheless, the empirical results did not support this expectation in the present sample. One possible explanation is the distinction between general physical activity and physical fitness. Physical activity represents the amount or frequency of movement undertaken by students, whereas physical fitness reflects the physiological capacity resulting from physical conditioning [12], [14], [15]. A student may engage in physical activity without necessarily achieving a level of fitness that directly supports performance in Physical Education [16]–[18]. In this study, more than half of the students (56.4%) were classified as having low physical activity, but this variation did not correspond to differences in learning outcomes. The measurement approach may also be relevant. Physical activity was assessed using a questionnaire, meaning that the data depended on students' self-reports [19], [20]. The thesis explicitly acknowledges that self-reported measures of motivation and physical activity may be subjective and may not capture these constructs comprehensively [13], [21]. Therefore, the absence of a significant relationship should not necessarily be interpreted as evidence that physical activity has no educational value. Rather, it may indicate that the measure used in this study did not sufficiently capture the dimensions of physical activity most relevant to Physical Education achievement.

4) *Nutritional Status and Physical Education Learning Outcomes*

The findings also showed no significant relationship between nutritional status and Physical Education learning outcomes ($r = 0.001$, $p = 0.991$). Thus, nutritional status did not explain meaningful differences in students' learning outcomes in this sample. This finding contrasts with the theoretical expectation that nutritional conditions may contribute to children's physical development, concentration, and learning. The theoretical framework in the thesis argues that adequate nutrition supports optimal growth and development and may contribute

to children's physical condition and learning performance. However, the empirical relationship observed in this study was virtually zero. A possible explanation is the highly homogeneous nutritional profile of the participants. The descriptive results showed that 93.2% of students were classified as having normal nutritional status, while only 6.8% were classified as underweight; no students were classified as overweight or obese according to the categories used in the study. Such limited variation reduces the possibility of detecting a meaningful statistical relationship between nutritional status and learning outcomes. In other words, when most students have relatively similar nutritional status, nutritional status may contribute little to explaining differences in achievement [22]–[24]. Therefore, the non-significant result should be interpreted cautiously. It does not imply that nutrition is unimportant for children's health or development. Rather, within this sample and measurement context, nutritional status did not demonstrate a statistically meaningful association with Physical Education learning outcomes.

5) Joint Relationship of Physical Fitness, Learning Motivation, Physical Activity, and Nutritional Status with Learning Outcomes

The relatively high R value indicates that the combination of physical and motivational characteristics provides a substantial explanation of variation in students' Physical Education learning outcomes. Importantly, however, the simultaneous significance of the model should not be interpreted as meaning that all four predictors individually have significant relationships with learning outcomes. The individual correlation analyses showed significant relationships only for physical fitness and learning motivation, whereas physical activity and nutritional status were not significant. The effective contribution analysis reinforces this distinction. Learning motivation contributed 50.40% and physical fitness 49.61% of the explained variance, whereas physical activity and nutritional status contributed only minimally. These findings suggest that the overall predictive strength of the model is primarily associated with physical fitness and learning motivation, rather than with physical activity and nutritional status. Idham et al. For example, examined physical fitness, nutritional status, and learning motivation in relation to *PJOK* learning outcomes [25]. The present findings extend this line of inquiry by simultaneously considering four factors and demonstrating that physical fitness and learning motivation remain the most prominent variables in the model [11], [26]. From an educational perspective, the findings indicate that improving Physical Education learning outcomes may require an integrated approach [27], [28]. Physical Education should provide sufficient opportunities for students to develop physical fitness while simultaneously fostering motivation to learn. The combination of these two dimensions may be more meaningful for learning achievement than simply increasing students' general physical activity.

6) Implications for Elementary Physical Education

The findings have several implications for elementary Physical Education practice. First, teachers should consider students' physical fitness as an important component of learning readiness [29], [30]. Learning activities should therefore provide opportunities for students to progressively develop endurance, strength, flexibility, and other components of fitness while remaining appropriate for their developmental level [10], [31]. Second, motivational strategies should be integrated into Physical Education instruction. Because learning motivation demonstrated a strong relationship with achievement and the largest effective contribution in the regression model [32]–[34]. Teachers can emphasize meaningful activities, achievable challenges, positive feedback, student participation, and opportunities for students to experience success [34]–[37]. Third, the non-significant findings for physical activity and nutritional status suggest that these variables should not be treated as direct substitutes for physical fitness or learning motivation [38], [39]. General physical activity and nutritional health remain relevant components of children's well-being, but their relationship with learning outcomes may depend on other factors, including the quality of physical activity, fitness level, learning environment, instructional processes, and student engagement [40], [41]. Finally, the R^2 of 0.671 indicates that approximately one-third of the variance in learning outcomes remains unexplained. This suggests that future research should examine additional factors, such as instructional quality, learning environment, socioeconomic conditions, attendance, psychological characteristics, motor skills, and students' prior achievement.

4. Conclusion

This study identified physical fitness and learning motivation as the two variables most strongly associated with physical education learning outcomes among male elementary school

students in Surakarta. Both variables demonstrated strong positive correlations with learning outcomes, whereas physical activity and nutritional status showed no statistically significant individual correlations in this sample. The multiple regression model explained 67.1% of the variance in learning outcomes, indicating that the four predictors jointly accounted for a substantial proportion of the observed variation. The main contribution of this study is its empirical examination of the relationships between physical fitness, learning motivation, physical activity, nutritional status, and physical education learning outcomes within an elementary school context. These findings highlight the relevance of considering both physical fitness and learning motivation when examining students' learning outcomes in physical education. However, the results should be interpreted as associations rather than causal effects because of the cross-sectional correlational design. This study has several limitations. The sample consisted exclusively of male elementary school students from Surakarta, which may limit the generalizability of the findings to female students and other educational contexts. In addition, the cross-sectional design does not establish temporal or causal relationships among the variables. Future research should include more diverse samples, employ longitudinal or intervention-based designs, and use comprehensive measurement approaches to examine these relationships further.

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Declarations

- Author contribution** : Author 1 contributed to the conceptualization, methodology, data collection, data analysis, interpretation of results, and preparation of the original manuscript. Author 2 contributed through supervision, research guidance, critical review, and validation of the manuscript. Author 3 contributed to article drafting, literature review, manuscript editing, and preparation of the final manuscript. All authors contributed to the revision of the manuscript, read, and approved the final version.
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