



Physical fitness and learning achievement among students with mild intellectual disabilities

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Abstract

Evidence regarding the relationship between physical fitness and learning achievement among students with mild intellectual disabilities remains limited, particularly in Indonesian special education settings. This study examined the association between physical fitness and learning achievement among students with mild intellectual disabilities at SDLB Negeri 2 Padang, a public special elementary school in Indonesia. A quantitative cross-sectional correlational design was employed involving 21 second-grade students selected through saturated sampling. Physical fitness was assessed using the Level 2 Indonesian Student Fitness Test (TKSI), while learning achievement was measured using students' official academic records. Data were analyzed using descriptive statistics and simple linear regression. The mean physical fitness score was 10.57 ($SD = 3.37$), while the mean learning achievement score was 77.07 ($SD = 7.77$). Regression analysis revealed a significant positive association between physical fitness and learning achievement ($b = 2.228$, $SE = 0.135$, $\beta = 0.967$, $p < 0.001$), with the model accounting for 93.5% of the variance in learning achievement ($R^2 = 0.935$). Students with higher physical fitness scores tended to demonstrate higher learning achievement within the observed sample. However, given the correlational design, small sample, and single-school setting, interpret the findings as preliminary evidence of association rather than causation. These findings provide context-specific evidence regarding the relevance of physical fitness assessment within adaptive physical education for students with mild intellectual disabilities.

Keywords: Physical fitness, learning achievement, mild intellectual disabilities, adaptive physical education.

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INTRODUCTION

Students with intellectual disabilities have the same right to access quality education and appropriate learning support to develop their potential. Equitable educational resources, individualized assistance, and supportive learning environments can facilitate their meaningful participation in the learning process (Rodríguez et al., 2024; Xie, 2024; Mara & Vlad, 2024). However, providing appropriate educational support remains challenging because of limited resources, inadequate teacher preparation, and persistent social stigma surrounding disability (Lu, 2024; Dewi & Nurfaidah, 2024). These challenges require sustained collaboration among teachers, families, and policymakers to ensure that students with intellectual disabilities receive educational opportunities that are responsive to their characteristics and learning needs.

Among this population, students with mild intellectual disabilities require particular attention because their cognitive, adaptive, and motor characteristics may influence their participation and achievement in the learning process. Compared with typically developing peers, these students generally demonstrate lower cognitive performance, which may affect memory, attention, problem-solving, and learning outcomes (Kholiliyah et al., 2022; Nurunnaja et al., 2024; Pirvan, 2022). Difficulties in communication, social interaction, and physical functioning may also occur alongside limitations in gross and fine motor abilities, balance, coordination, and movement skills (Arioli et al., 2021; Babys & Yunitasari, 2024; Hidayat et al., 2024; Sayed & Cenk, 2023). Such difficulties may restrict participation in physical activities, daily activities, and social interactions (Fauziyah & Nugraheni, 2021; Widodo et al., 2020). Nevertheless, positive educational experiences reported among students with intellectual disabilities indicate that appropriate support and adaptable learning environments can facilitate meaningful participation in educational settings (Szczipał, 2022). In this context, physical fitness may be a relevant factor associated with learning achievement.

Physical fitness is relevant to several cognitive and physical functions involved in learning. Previous studies have reported associations between physical fitness and concentration, cognitive abilities, and academic outcomes. Students with better physical fitness may be better able to maintain attention and participate effectively in learning activities (Gumilar et al., 2024). Sidik et al. (2024), for example, reported that physical fitness accounted for approximately 18.6% of the variance in students' concentration levels. Other studies have also identified positive relationships between physical fitness and academic outcomes (Priskila & Arief, 2024; Saputra et al., 2023; Zulpahmiri et al., 2024). These findings suggest that physical fitness may relate to cognitive functions that support learning and achievement. However, most of this evidence has been obtained from students without intellectual disabilities, making its applicability to students with mild intellectual disabilities uncertain.

This distinction is important because students with mild intellectual disabilities have cognitive, motor, and learning characteristics that differ from those of typically developing students. Although previous research has examined physical functioning, motor skills, adaptive movement, and related outcomes among students with intellectual disabilities, considerably less attention has been given to the relationship between physical fitness and learning achievement. Consequently, evidence derived from typically developing populations cannot necessarily explain whether differences in physical fitness are associated with differences in learning achievement among students with mild intellectual disabilities. Examining this relationship within the population itself is therefore necessary to establish evidence that is more relevant to their educational characteristics and needs.

The gap is particularly evident within Indonesian special education settings. Research specifically examining the relationship between physical fitness and learning achievement among students with mild intellectual disabilities in Special Elementary Schools (Sekolah Dasar Luar Biasa, SDLB) remains limited. Existing studies have predominantly involved students without

disabilities or have focused on physical fitness in relation to health, motor development, and physical functioning rather than learning achievement. Evidence using standardized physical fitness assessment within this population is also limited. These limitations leave an important empirical question regarding whether physical fitness is associated with learning achievement among students with mild intellectual disabilities in authentic special education settings.

The present study addresses this gap by examining physical fitness and learning achievement among students with mild intellectual disabilities at SDLB Negeri 2 Padang. The study employs the Level 2 Indonesian Student Fitness Test (TKSI) to assess physical fitness and students' learning records to measure learning achievement. This study extends previous research by examining the association between physical fitness and learning achievement among students with mild intellectual disabilities, an underrepresented population in this area of research, within the context of Indonesian special education. This approach is expected to provide contextually relevant empirical evidence for adaptive physical education and special education practices.

Therefore, this study aimed to investigate the association between physical fitness and learning achievement among students with mild intellectual disabilities at SDLB Negeri 2 Padang. Specifically, the study aimed to (1) describe the physical fitness and learning achievement of the participants and (2) determine whether a statistically significant association exists between physical fitness and learning achievement in the study population. The findings are expected to provide empirical and practical considerations for adaptive physical education and school-based physical fitness programs that are responsive to the characteristics and learning needs of students with mild intellectual disabilities.

METHOD

Research Design and Setting

This study employed a quantitative correlational design to examine the relationship between physical fitness and learning achievement among students with mild intellectual disabilities. The correlational design was selected because the study examined the statistical relationship between two naturally occurring variables without manipulating either variable. Simple linear regression was used to determine whether physical fitness was statistically associated with learning achievement. The study was conducted at SDLB Negeri 2 Padang, Jalan Teratai No. 38, Padang Sarai, Koto Tengah District, Padang City, Indonesia.

Participants

The participants were 21 second-grade students with mild intellectual disabilities enrolled at SDLB Negeri 2 Padang. Students were eligible for inclusion if they were officially enrolled in the specified grade and school, were classified as having mild intellectual disabilities based on available educational or relevant assessment records, could participate in the physical fitness assessment, and had complete learning achievement records available for analysis. Students were excluded if they were absent during data collection, had incomplete required data, or had physical or other conditions that prevented them from safely completing the physical fitness assessment. Total population sampling, also referred to as saturated sampling, was applied because all members of the accessible population who met the study criteria were included. Thus, the final sample comprised 21 students.

Variables and Operational Definitions

This study examined two variables: physical fitness as the independent variable (X) and learning achievement as the dependent variable (Y). Physical fitness was operationally defined as participants' performance on the Level 2 Indonesian Student Fitness Test (TKSI Level 2) administered during data

collection. Learning achievement was operationally defined as the students' average Indonesian Language report card scores for the second semester. The scores were obtained from official school academic records and retained in their original numerical form. These records were used as the primary source of learning achievement data because they represented students' documented attainment based on formal assessments conducted and officially recorded by the school.

Physical Fitness Assessment

Physical fitness was assessed using the Level 2 Indonesian Student Fitness Test (TKSI Level 2), a standardized physical fitness assessment used for students with mild intellectual disabilities. The assessment consisted of five components: the sit-and-reach test for flexibility, the Komata test for hand–eye coordination, the Dolan test for upper-body strength, the Folding test for running speed, and the Lalingku test for cardiovascular endurance. The subsequent analysis included only the TKSI Level 2 components administered to the participants. All tests were administered according to the applicable standardized TKSI Level 2 procedures to maintain consistency throughout the assessment.

Participants' height and body weight were measured before the physical fitness assessment and were used to calculate body mass index (BMI). The TKSI Level 2 was selected because its standardized procedures accommodate physical fitness assessment among students with mild intellectual disabilities in educational settings. Information on the instrument's validity and reliability was limited to what was reported in the official TKSI manual and supporting sources.

Research Procedure

The research was conducted systematically in several stages. Research permission was obtained from SDLB Negeri 2 Padang before data collection. Informed consent was obtained from the participants' parents or legal

guardians before any measurements or assessments were conducted. The researchers subsequently collected participants' demographic and anthropometric data, including height and body weight, followed by administration of the TKSI Level 2 according to the applicable testing procedures and guidelines. Learning achievement data were then obtained from the students' official school records for the designated assessment period. Throughout the research process, participant identities and personal information were kept confidential by using participant codes rather than names during data collection, analysis, and reporting.

Statistical Analysis

Data were analyzed using IBM SPSS Statistics version 27. Descriptive statistics summarized participants' physical fitness and learning achievement scores. Simple linear regression was subsequently performed to examine the statistical relationship between physical fitness and learning achievement. Before conducting the regression analysis, the normality of the regression residuals and the linearity of the relationship between physical fitness and learning achievement were examined.

Normality was assessed using the Kolmogorov–Smirnov test on the regression residuals; $p > 0.05$ indicated that the residuals did not significantly deviate from a normal distribution. Linearity was examined using the Test for Linearity, with $p > 0.05$ for deviation from linearity indicating that the relationship between physical fitness and learning achievement did not significantly depart from linearity. After these assumptions were satisfied, simple linear regression was performed using the following model:

$$Y = a + bX$$

where Y represents learning achievement, X represents physical fitness, a represents the intercept, and b represents the unstandardized regression coefficient. The statistical significance level was set at $\alpha = 0.05$.

The regression results were interpreted using the unstandardized regression coefficient (b), standardized regression coefficient (β), coefficient of determination (R^2), adjusted coefficient of determination (adjusted R^2), and statistical significance ($p < 0.05$). The unstandardized coefficient (b) represented the expected difference in learning achievement associated with a one-unit difference in physical fitness. *In contrast*, β represented the standardized strength and direction of the relationship. R^2 and adjusted R^2 represented the proportion of variance in learning achievement statistically accounted for by physical fitness. All regression parameters were interpreted as indicators of statistical association rather than evidence of a causal relationship.

RESULTS

Table 1 presents descriptive statistics for the study variables. The study included 21 students. Physical fitness scores ranged from 5 to 15 ($M = 10.57$, $SD = 3.37$), whereas learning achievement scores ranged from 63 to 88 ($M = 77.07$, $SD = 7.77$). Physical Fitness

Table 1. Descriptive Statistics

Variable	N	Min	Max	Mean	SD	Median	IQR
	21	5	15	10.57	3.37	11.00	5.00
Learning Achievement	21	63	88	77.07	7.77	78.00	11.00

Figure 1 presents a scatterplot illustrating the relationship between physical fitness and learning achievement among students with mild intellectual disabilities at SDLB Negeri 2 Padang. The distribution of the data points generally shows an upward pattern, indicating a positive linear relationship between the two variables. Students with higher physical fitness scores tended to have higher learning achievement scores, whereas students with lower physical fitness scores generally showed lower learning achievement scores. Although some variation can be observed in the distribution of the data points, the overall pattern is consistent with the linearity assumption reported in the analysis. Although some variation can be observed in the distribution of the

data points, the overall pattern is consistent with the linearity assumption reported in the analysis.

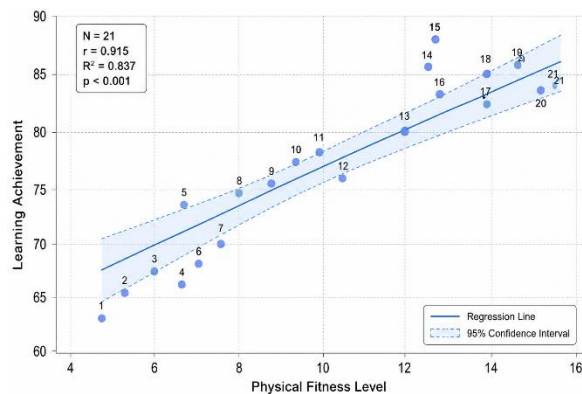


Figure 1. Scatterplot of the Relationship Between Physical Fitness and Learning Achievement

Table 2. Kolmogorov–Smirnov Normality Test Results for the Study Variables

Variable	Kolmogorov–Smirnov Statistic	df	p
	0.188	21	0.051
Learning Achievement	0.171	21	0.112

The Kolmogorov–Smirnov results presented in Table 2 describe the distributions of physical fitness and learning achievement. Physical fitness yielded a Kolmogorov–Smirnov statistic of 0.188 ($p = 0.051$), whereas learning achievement yielded 0.171 ($p = 0.112$). As shown in Table 2, the Kolmogorov–Smirnov test yielded a statistic of 0.188 ($p = .051$) for physical fitness and 0.171 ($p = .112$) for learning achievement. As both p -values were greater than .05, neither variable showed a statistically significant deviation from a normal distribution.

The simple linear regression model was statistically significant, $F(1, 19) = 273.31$, $p < 0.001$. Physical fitness was positively associated with learning achievement ($B = 2.228$, $SE = 0.135$, $\beta = 0.967$, $t = 16.506$, $p < 0.001$, 95% CI [1.945, 2.511]). The model yielded $R = 0.967$, $R^2 = 0.935$, adjusted $R^2 = 0.932$, and a standard error of the estimate of 2.031. The Test for Linearity showed no statistically significant deviation from linearity ($p = 0.105$). These results support

using the reported linear model to examine the statistical association between physical fitness and learning achievement, and the findings are interpreted as associative rather than causal.

Table 3. Linearity Test Results

Source of Variation	df	Mean Square	F	P
Linearity	1	3702.15	417.434	< .001
Deviation from Linearity	9	20.08	2.264	0.105

Table 3 presents the results of the linearity assessment between physical fitness and learning achievement. The deviation-from-linearity test yielded $F = 2.264$ with 9 numerator degrees of freedom and $p = 0.105$. The result showed no statistically significant evidence of deviation from a linear relationship between physical fitness and learning achievement. Therefore, the results supported using a linear model to examine the association between the two variables.

Table 4. Regression Coefficient Estimates

Predictor	b	SE	β	t	p	95% CI
Constant	53.524	1.494	-	35.822	< .001	50.397 to 56.651
	2.228	0.135	0.967	16.506	< .001	1.945 to 2.511

The estimated regression equation was:

$$\text{Learning Achievement} = 53.524 + 2.228 \times \text{Physical Fitness}.$$

The regression coefficient for physical fitness was positive and statistically significant ($b = 2.228$, $SE = 0.135$, $\beta = 0.967$, $t = 16.506$, $p < 0.001$). This indicates that higher physical fitness scores were statistically associated with higher learning achievement scores within the observed physical fitness score range (5–15). The statistical inference regarding the study hypothesis was based on the regression coefficient for physical fitness rather than on the intercept.

Table 5. Coefficient of Determination

Model	<i>R</i>	<i>R</i> ²	Adjusted <i>R</i> ²	Std. Error of the Estimate
1	0.967	0.935	0.932	2.031

The overall regression model was statistically significant, $F(1, 19) = 273.31$, $p < 0.001$. As presented in Table 6, the regression sum of squares was 1128.36, and the residual sum of squares was 78.44. These results indicate a statistically significant association between physical fitness and learning achievement in the observed sample.

Table 6. ANOVA Results for the Regression Model

Model	Sum of Squares	<i>df</i>	Mean Square	<i>F</i>	<i>p</i>
Regression	1128.36	1	1128.36	273.31	< .001
Residual	78.44	19	4.13	—	—
Total	1206.8	20	—	—	—

Taken together, the regression analysis showed a strong positive statistical association between physical fitness and learning achievement. The linearity assessment showed no significant deviation from linearity ($p = 0.105$). Because the available Kolmogorov–Smirnov results pertained to the individual study variables rather than the regression residuals, they were not used to support the residual normality assumption. The regression findings are therefore reported as statistical associations within the observed sample and are not interpreted causally.

DISCUSSION

The present study found a statistically significant positive association between physical fitness and learning achievement among students with mild intellectual disabilities at SDLB Negeri 2 Padang. Physical fitness scores ranged from 5 to 15, with a mean of 10.57, while learning achievement scores ranged from 63 to 88, with a mean of 77.07. Simple linear regression showed that physical fitness was positively associated with learning achievement ($b = 2.228$, 95% $CI = 1.95$ – 2.51 , $\beta = 0.967$, $p < .001$). The model yielded $R = 0.967$ and $R^2 = 0.935$, indicating that physical fitness statistically accounted for a high

proportion of the variance in learning achievement within the observed sample. Thus, students with higher physical fitness scores tended to have higher learning achievement scores. Although the scatterplot showed a corresponding upward pattern, interpretation of the relationship was based on the regression analysis rather than on visual inspection alone. Given the correlational design, these findings indicate an association between the variables and should not be interpreted as evidence of a causal relationship.

The finding is broadly consistent with previous research reporting relationships between physical fitness and learning-related outcomes. [Sidik et al. \(2024\)](#) found that physical fitness was associated with students' concentration in learning, while [Ramayandi et al. \(2022\)](#) reported a positive relationship between physical fitness and academic achievement. [Sidik et al. \(2024\)](#) reported that physical fitness explained approximately 18.6% of the variation in concentration, whereas [Ramayandi et al. \(2022\)](#) reported an association of approximately 41.8% with academic achievement. These findings support the broader pattern that physical fitness may be associated with learning-related outcomes. Nevertheless, concentration, academic achievement, and learning achievement are distinct constructs, and the studies involved different populations, educational settings, measurements, and analytical approaches. Direct comparison of the magnitude of these relationships should therefore be made cautiously.

The strength of the association identified in the present study also warrants careful interpretation. The standardized regression coefficient ($\beta = 0.967$) and coefficient of determination ($R^2 = 0.935$) were substantially higher than the associations reported in the previous studies discussed above. However, the present study involved only 21 students with relatively homogeneous characteristics from a single special education school. Estimates from a small, homogeneous sample may be sensitive to individual observations and characteristics specific to that sample. Moreover, influential-observation diagnostics were not available in the current analysis, so the

stability of the regression coefficient cannot be fully established. The regression model also did not control for potential confounding variables. Consequently, the high proportion of explained variance should be interpreted as a characteristic of the observed sample rather than as evidence that physical fitness independently determines learning achievement.

Several mechanisms identified in previous research may provide a context for understanding the observed relationship. Physical fitness has been associated with concentration and other functions relevant to students' engagement in learning (Sidik et al., 2024). Better physical fitness may also coexist with health and lifestyle characteristics, including adequate nutrition, healthier sleep patterns, and lower sedentary behavior, that may be related to learning outcomes (Thapa, 2024). Previous studies involving students with special educational needs have further indicated that structured physical activity may contribute to physical fitness, motor competence, and participation (Hu & Phucharoen, 2024; Lhendup et al., 2024; Sharma et al., 2024). For students with mild intellectual disabilities, these characteristics may be relevant to their readiness and capacity to participate in school activities. However, the present study did not directly assess nutrition, sleep quality, sedentary behavior, cognitive functioning, or other possible mechanisms. They should therefore be regarded as plausible contextual explanations rather than mechanisms established by the current findings.

The present study contributes to adaptive physical education and special education by providing empirical evidence from an Indonesian special education setting, where research examining physical fitness in relation to learning achievement among students with mild intellectual disabilities remains limited. The findings suggest that physical fitness assessment may provide useful information about students' physical characteristics alongside educational information already available to teachers. The Level 2 Indonesian Student Fitness Test (TKSI) also provides a context-specific approach to assessing physical fitness in this population. However, the findings do not show

that increasing physical fitness necessarily improves learning achievement. Rather, they indicate that physical fitness and learning achievement were closely associated within the students examined in this study.

From a practical perspective, the findings reinforce the relevance of providing appropriate opportunities for physical activity within adaptive physical education. Previous intervention studies have shown that structured physical activity can improve aspects of physical fitness among students with special educational needs (Hu & Phucharoen, 2024; Lhendup et al., 2024; Sharma et al., 2024), while Baías et al. (2023) reported improvements in gross and fine motor skills through the integration of sports activities into rehabilitation programs. Al Yaqoubi (2024) similarly emphasized the importance of adapting teaching strategies to diverse learner characteristics. In special elementary school settings, such considerations may involve simplifying verbal instructions, providing visual demonstrations, adjusting task complexity, intensity, and duration according to individual capacities, allowing sufficient recovery time, introducing progressive motor challenges, providing individualized assistance, and ensuring adequate teacher supervision. These strategies should be regarded as practical considerations informed by previous research rather than interventions whose effects the present study demonstrated.

Several limitations need to be considered when interpreting the findings. First, the study involved only 21 students from a single special elementary school, limiting the generalizability of the findings beyond the observed population and educational context. Second, the correlational design does not permit conclusions regarding causality or the direction of the relationship between physical fitness and learning achievement. Third, the regression analysis did not control for potentially relevant variables such as age, health condition, family support, teaching effectiveness, school attendance, socioeconomic status, nutrition, sleep quality, and sedentary behavior. BMI was measured to describe participants' physical characteristics but was not

incorporated as a control variable. As educational outcomes among students with special educational needs may be influenced by multiple educational and environmental factors (Mihajlovic & Meier, 2023), these uncontrolled variables may partly account for the observed association. The magnitude of the relationship should therefore be interpreted cautiously.

Future research should examine this relationship using larger and more diverse samples drawn from multiple special education settings. Multiple regression models could account for relevant demographic, physical, family, and educational factors, while longitudinal designs could clarify how physical fitness and learning achievement are associated over time. Experimental studies may subsequently examine whether interventions designed to improve physical fitness produce corresponding changes in learning-related outcomes. Such evidence is necessary before specific adaptive physical education programs can be recommended to improve learning achievement among students with mild intellectual disabilities.

CONCLUSION

This study found a significant positive association between physical fitness and learning achievement among students with mild intellectual disabilities at SDLB Negeri 2 Padang. Students with higher physical fitness scores tended to demonstrate higher learning achievement; however, this relationship should not be interpreted as causal. Given the small sample from a single school and the potential influence of uncontrolled confounding factors, the findings should be considered preliminary and context-specific. Future studies with larger, more diverse samples, consideration of relevant confounding variables, and longitudinal or intervention designs are needed to clarify this relationship further.

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