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ANALYSIS OF DETERMINANTS IN PHYSICAL EDUCATION ACHIEVEMENT: NUTRITIONAL KNOWLEDGE AND BODY MASS INDEX

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Abstract
Research on the determinants of Physical Education (PE) learning outcomes is still dominated by a fragmented approach that examines cognitive and physiological factors separately. As a result, the combined contribution of Nutritional Knowledge (NK) and Body Mass Index (BMI) to PE learning outcomes among elementary school students has not yet been fully understood. This study aims to analyze the effect of NK and BMI on PE learning outcomes in elementary school students, both partially and simultaneously. This study used an associative quantitative approach involving 28 third-grade students aged between 8-9 years. NK was measured using a multiple-choice questionnaire, BMI was obtained through anthropometric measurements, while PE learning outcomes were obtained from students' report card scores. The data were analyzed using simple and multiple linear correlation and regression. The results showed that the students' NK was in the adequate category (M=70.107±0.875), BMI was in the normal category (M=-1.626±0.977), and PE learning outcomes were in the adequate category (M=77.679±4.514). Regression analysis showed that NK and BMI had a positive and significant effect on PE learning outcomes, with BMI having a greater effect than NK (partially, R^2=0.360; R^2=0.472; p=0.001; and simultaneously, R^2=0.656; p=0.001). These findings indicate that good NK and normal BMI contribute to improved PE learning outcomes in elementary school students. Further research is recommended using a longitudinal design with a larger sample size and considering relevant behavioral and environmental factors to obtain a more comprehensive understanding of the factors that influence PE learning outcomes.
Keywords: Physical education, nutrition, elementary school.

INTRODUCTION

Physical Education (PE) is an important part of the elementary school curriculum because it plays a role in developing children's physical, cognitive, and social-emotional abilities (Eshiev et al., 2025; King et al., 2026; McPherson et al., 2025). Regular physical activity can improve physical fitness, motor skills, and support the learning process in the classroom (Firdaus et al., 2023; Sugiarto et al., 2026; Welis et al., 2026). In the context of education, PE learning outcomes reflect not only physical performance but also the integration of motor skills, participation in physical activities, and health and nutritional factors that influence students' physical capacity and motivation (Souza et al., 2023). Thus, PE learning outcomes should be understood as a multidimensional construct that combines physical and cognitive aspects in the learning process.

One of the cognitive factors that play a role in PE learning outcomes is Nutrition Knowledge (NK). NK includes understanding healthy food consumption, recognition of fast food, fruit and vegetable eating habits, and the impact of unhealthy food and beverage consumption on health (Jadgal et al., 2020; Mukhamedzhanov et al., 2023). Previous studies have shown that nutrition literacy is positively associated with healthy eating behaviors, nutritional status, and children's academic achievement (Akbar & Rehman, 2024). However, most studies still frame learning outcomes within a general academic framework and have not specifically examined the contribution of NK to PE learning outcomes, which are characterized by both physical performance and an understanding of movement concepts. For example, Doustmohammadian et al. (2022) highlighted the role of nutrition literacy in eating behaviors and obesity in children aged 10-12 years, while Akbar & Rehman (2024) studied university students and emphasized overall academic performance. This indicates a lack of research specifically examining the influence of NK on PE learning outcomes in elementary school children.

In addition to cognitive aspects, nutritional status as reflected by Body Mass Index (BMI) also influences PE learning outcomes. BMI is an indicator of the balance between body weight and height, used to categorize a person's nutritional status (Kemenkes, 2011; Oukheda et al., 2023; Roy et al., 2025). Children with a normal BMI tend to have optimal physical capacity to participate in physical activities, while children with underweight or overweight BMIs may experience limited movement, fatigue more quickly, and decreased motivation to learn (Liverti et al., 2023).

Several studies also show a positive relationship between nutritional status and children's motor skills or physical fitness (Irab et al., 2024; Morales-Suárez-Varela et al., 2024). However, these findings are not always consistent. For example, Monacis et al. (2022) reported that BMI only affects certain physical capacities when influenced by self-perception and enjoyment of physical activity, while Souza et al. (2023) emphasized that the effect of BMI on physical ability is

also influenced by the level of routine physical activity. These findings indicate that BMI does not operate in a linear or isolated manner but rather interacts with various other factors in influencing student performance. Therefore, a more comprehensive approach is needed to understand the role of BMI in the context of PE learning outcomes.

Although the relationship between nutrition literacy, nutritional status, and various indicators of learning outcomes has been widely reported, there are several fundamental limitations in the existing literature. First, most studies still employ a fragmented approach by testing a single variable in isolation and thus have not been able to explain the relative or simultaneous contributions of cognitive and physiological factors in the context of PE learning. Second, the outcomes used are generally general academic achievement or physical fitness indicators, rather than PE learning outcomes as an educational construct that encompasses motor skills, conceptual understanding, and engagement in learning. Third, there is still a limited number of studies that integrate NK and BMI into a single contextual analytical framework for elementary school students (Adugna et al., 2026; Alqahtani et al., 2020).

Based on these previous studies, this research offers a more integrative approach by analyzing NK and BMI as determinants of PE learning outcomes within a single empirical model. This study not only examines the partial effects of each variable but also emphasizes their simultaneous contribution in explaining the variation in PE learning outcomes. Thus, this study provides added value by (a) developing an integrated determinant model that combines cognitive and physiological factors, (b) positioning PE learning outcomes as education-specific outcomes that reflect students' motor skills, conceptual understanding, and engagement in learning, and (c) identifying the relative contributions of NK and BMI to PE learning outcomes among elementary school students, a topic that has rarely been examined within a single analytical framework. The uniqueness of this study lies in its effort to explain PE learning outcomes through a multidimensional approach that simultaneously combines aspects of students' knowledge and nutritional status, thereby providing a more comprehensive understanding of the factors influencing success in PE learning. Based on this foundation, this study aims to analyze the effects of NK and BMI on PE learning outcomes among elementary school students, both partially and simultaneously. The findings of this study are expected to serve as a basis for teachers, parents, and education policymakers in designing more effective nutrition intervention and PE programs.

Based on the quantitative associative design and regression analysis employed, the specific research hypotheses are formulated as follows: (a) H1: NK has a positive effect on PE learning outcomes; (b) H2: BMI has a positive effect on PE learning outcomes; and (c) H3: NK and BMI simultaneously have a significant positive effect on students' PE learning outcomes.

METHODOLOGY

Research design and participants

This study uses a quantitative approach with an associative design, which aims to analyze the relationship and influence of NK and BMI on PE learning outcomes in elementary school students. An associative design was chosen because it allows researchers to identify the relationship between independent variables, namely NK and BMI, and dependent variables in the form of PE learning outcomes. Through this approach, the study not only focuses on measuring the relationship between variables, but also on testing the influence of these two independent variables on student learning outcomes in PE.

The participants in this study were 28 third-grade elementary school students aged between 8-9 years old, consisting of 18 boys and 10 girls. The characteristics of the participants included a mean age of 8.32±0.48 years, weight of 26.36±3.32 kg, height of 1.34±0.09 m, and BMI of 14.98±2.95. The inclusion criteria for this study included the following requirements. First, third-grade elementary school students who were actively enrolled and aged between 8-9 years old. Second, students were in good physical health and had no history of health disorders that could affect the research process. Third, students were willing to participate in the entire research process voluntarily. Fourth, students obtained permission from their parents or guardians to participate in the study.

Instruments and procedures

Nutrition knowledge

NK was measured using a multiple-choice questionnaire consisting of 10 questions tailored to the cognitive characteristics of third-grade elementary school students. This instrument measures students' understanding of basic nutrition concepts, such as fast food, healthy eating habits, the importance of consuming fruits and vegetables, and the impact of consuming unhealthy foods and beverages on health (Table 1).

The questionnaire was adapted from Hani (2022) and Ma'ruf et al. (2024)**,** which had undergone reliability testing with a value of r=0.873, indicating a high level of internal consistency. Each item had three alternative answers with one correct answer. Correct answers were given a score of 10, while incorrect answers were given a score of 0, so that the total score ranged from 0 to 100. The NK level was classified into five categories, namely very low (0-30), low (40-50), moderate (60-70), high (80-90), and very high (100).

Table 1. Nutrition knowledge questionnaire

Questions	Answer choices
Fast food is usually made by …	a. Fast and lots of oil b. Long and lots of vegetables c. Very healthy
Examples of fast food are …	a. Rice, fish, vegetables b. Burgers, pizza, fried chicken c. Fruit, milk, tempeh
If you eat fast food too often, your body can become …	a. It's easier to get sick b. Stronger and healthier c. It's okay
Healthy drinks to consume daily are …	a. Plain water b. Carbonated drinks c. Energy drink
The habit of eating fruits and vegetables every day makes the body …	a. Easily tired b. Healthy and strong c. Frequent stomachaches
What are the consequences of drinking too many sugary and carbonated drinks?	a. Teeth decay quickly b. Teeth become strong c. No effect
Examples of healthy snacks at school are …	a. Apples and stuffed bread b. Spicy chips and soda c. Burger and french fries
Fast food usually contains a lot of …	a. Salt, sugar, and oil b. Vitamins and fiber c. Plant protein
If you want to stay healthy, you should …	a. Only eating instant noodles b. Eat more fruits and vegetables c. Not eating at all
Fast food should be eaten …	a. As many as possible every day b. Only occasionally, not too often c. Don't eat anything

Note- The answer key for the questionnaire is: (1) a; (2) b; (3) a; (4) a; (5) b; (6) a; (7) a; (8) a; (9) b; and (10) b; the maximum score is 100 and the minimum is 0.

Body mass index

BMI is measured using anthropometric methods by measuring the weight and height of participants (Welis et al., 2023). Weight is measured using digital scales in kilograms (kg), while height is measured using a stadiometer in meters (m). BMI values are calculated using the standard formula, which is weight (kg) divided by height squared (m^2).

Furthermore, BMI values are classified based on the nutritional status standards for children aged 5-18 years set by the Indonesian Ministry of Health using BMI indicators according to age (BMI/A) with a Z-score approach (Kemenkes, 2011). The nutritional status categories used include malnutrition, underweight, normal, overweight, and obesity (Table 2).

Table 2. Categories and thresholds for child nutritional status

Index	Threshold (Z-Score)	Category
Children aged 5-18 years (BMI/A)	< -3 SD	Malnutrition
	-3 SD to < -2 SD	Underweight
	-2 SD to +1 SD	Normal
	+ 1 SD to +2 SD	Overweight
	> +2 SD	Obesity

Note- BMI by age (BMI/A).

Physical education learning outcomes

PE learning outcome data was obtained from student report card scores. These scores were collected through documentation obtained from homeroom teachers with the school's approval. Report card scores were used as an indicator of student learning outcomes because they represent a comprehensive assessment covering aspects of knowledge, skills, and attitudes in PE learning. Learning outcome scores are expressed on a scale of 0-100 and are further classified into several categories of learning outcome levels based on the criteria used by Firdaus et al. (2023), namely: 91-100 (excellent), 81-90 (good), 70-80 (fair), and <70 (poor).

Statistical analysis

The research data was analyzed using SPSS software through three stages of analysis, namely descriptive statistics, prerequisite tests, and hypotheses. Descriptive statistics were used to describe the characteristics of each research variable, including the mean (M), standard deviation (SD), minimum value, maximum value, range, and variance. The prerequisite analysis test was conducted to ensure that the data met the assumptions required before inferential analysis was performed. The data normality test was performed using Kolmogorov-Smirnov, while the linearity

test was performed through regression significance analysis to ensure a linear relationship between variables.

Furthermore, hypothesis testing was conducted using correlation and regression analysis to determine the relationship and influence of NK and BMI on PE learning outcomes. Simple linear regression was used to analyze the partial influence of each independent variable (NK and BMI) on the dependent variable (PE learning outcomes), while multiple linear regression was used to test the simultaneous influence of both independent variables (NK and BMI). The magnitude of the contribution of the independent variables (NK and BMI) to the dependent variable (PE learning outcomes) is indicated by the coefficient of determination (R^2) value.

RESULTS

In general, the average NK of students was in the adequate category with an average score of 70.107±0.875. Meanwhile, the average BMI of students was -1.626±0.977, which was in the normal nutrition category. The PE learning outcomes show an average score of 77.679±4.514, which is in the adequate category. These results indicate that, in general, the students' NK, BMI, and PE learning outcomes are in the adequate to normal category (Table 3).

The results of the normality test using Kolmogorov-Smirnov showed that all research variables were normally distributed (NK, p=0.072 and BMI, p=0.200) (Table 4). Furthermore, the results of the linearity test show that the values of each variable in the deviation from linearity are p=0.130 and p=0.857 (Table 5). Thus, the data meet the assumptions for correlation and regression analysis.

Table 3. Summary of descriptive analysis

Variable	n	Min	Max	Range	M±SD	Var	Category
Nutritional knowledge	28	50.000	90.000	40.000	70.107±0.875	0.766	Adequate
Body mass index	28	-3.729	-0.036	3.693	-1.626±0.977	0.955	Normal
PE learning outcomes	28	70.000	85.000	15.000	77.679±4.514	20.374	Adequate

Table 4. Summary of data normality testing

Source		Unstandardized Residual	
		Nutritional knowledge	Body mass index
N		28	28
Normal Parameters[a, b]	M	0.001	0.001
	SD	8.001	7.264
Most Extreme Differences	Abs	0.158	0.122
	Pos	0.099	0.097
	Neg	-0.158	-0.122
Test Statistic		0.158	0.122
p		0.072[c]	0.200[c]

Note- Normal (p>0.05); variable dependen: PE learning outcomes; [a]test distribution is normal; [b]calculated from data; and [c]lilliefors significance correction.

Table 5. Summary of data linearity testing

Variable	Source	df	SS	MS	F	p
PE learning outcomes*NK (Y-X_1)	Between Groups	4	1340.505	335.126	5.672	0.003
	Linearity	1	970.882	970.882	16.431	0.001
	Deviation from Linearity	3	369.623	123.208	2.085	0.130*
	Within Groups	23	1359.034	59.088		
	Total	27	2699.539			
PE learning outcomes*BMI (Y-X_2)	Between Groups	14	1777.525	126.966	1.790	0.151
	Linearity	1	1275.048	1275.048	17.977	0.001
	Deviation from Linearity	13	502.477	38.652	0.545	0.857*
	Within Groups	13	922.039	70.926		
	Total	27	2699.565			

Note- *Linier (p>0.05).

Partially, the results of correlation and regression analysis show that NK has a significant positive relationship with PE learning outcomes (r=0.600; F=14.603; p=0.001), with a contribution of 36.00% (R^2=0.360). Furthermore, BMI also shows a significant positive correlation with PE learning outcomes (r=0.687; F=23.272; p=0.001), with a contribution of 47.20% (R^2=0.472) (Table

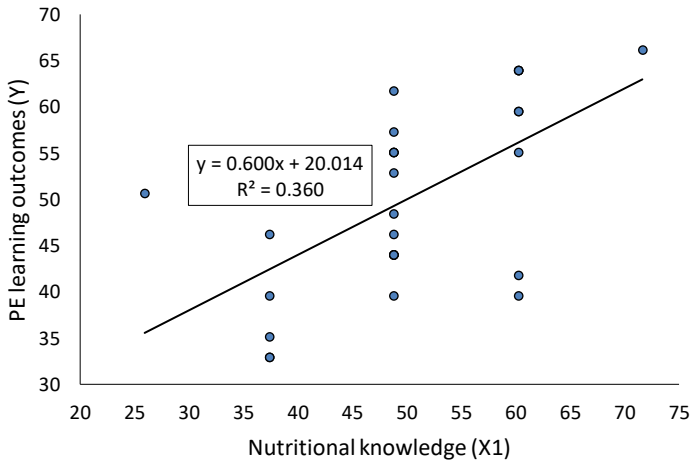
6).

Simultaneously, the results of multiple regression analysis showed that NK and BMI had a strong relationship with PE learning outcomes (r=0.810; F=23.828; p=0.001), with a contribution of 65.60% (R^2=0.656), while the rest was influenced by other factors outside this study (Table 6). Furthermore, the linear relationship patterns between NK and PE learning outcomes, as well as BMI and PE learning outcomes, produced $Y = 0.600X_1 + 20.014$ and $Y = 0.687X_2 + 15.642$ (Figure 1).

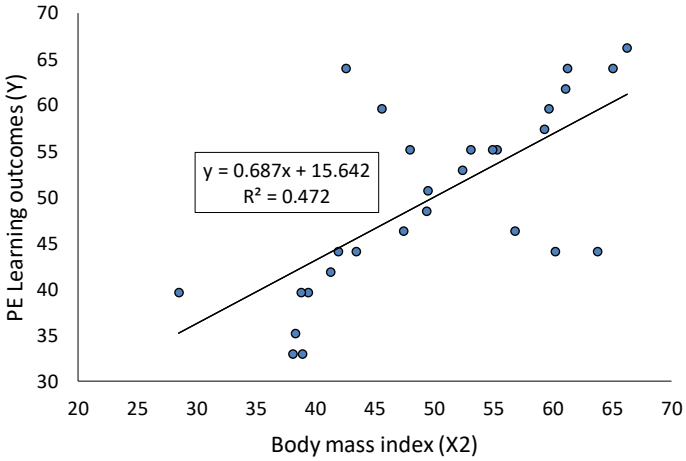
Table 6. Summary of correlation and regression analysis

Variable	Correlation			Regression			
	r	R^2	p	F	p	t	p
Nutritional knowledge	0.600	0.360	0.001	14.603	0.001	3.821	0.002
Body mass index	0.687	0.472	0.001	23.272	0.001	4.824	0.000
Simultaneously	0.810	0.656	0.001	23.828	0.001		

Note- Dependent variable: PE learning outcomes; p<0.05.



a)



b)

Figure 1. (a) Linearity curve of physical education learning outcomes with nutritional knowledge; and (b) body mass index

DISCUSSION

The results of the study indicate that correlation and regression analysis show a significant positive relationship between NK and PE learning outcomes (r=0.600; R^2=0.360; p=0.001), as well as between BMI and PE learning outcomes (r=0.687; R^2=0.472; p=0.001). Simultaneously, NK and BMI contributed 65.60% to the variation in PE learning outcomes (r=0.810; R^2=0.656; p=0.001). These findings are consistent with previous studies emphasizing the importance of nutrition literacy in supporting children's academic achievement and physical skills (Arenasa et al., 2024; Doustmohammadian et al., 2022; Liu et al., 2025). Adequate NK enables students to choose foods that support physical and cognitive growth, thereby positively impacting their performance in PE (Abderbwih, 2024; Çağıran, 2025; Mukhamedzhanov et al., 2023). Research in various countries, including Bangladesh, Ethiopia, Portugal, and China, shows that students with higher nutrition literacy tend to have better academic achievement and physical abilities (Adugna et al., 2026; Biswas, 2020; Guiné et al., 2023).

The results of this study also show that a normal BMI has a positive relationship with PE learning outcomes. These findings are in line with studies by Monacis et al. (2022), Oukheda et al. (2023), and Martinovic et al. (2021), which emphasize that healthy nutritional status and body composition improve children's physical capacity, energy, stamina, and motor skills. Optimal physical condition allows students to participate more actively in physical activities during PE lessons. Other studies also show that good nutritional status is associated with higher levels of

physical fitness, muscle strength, and athletic performance in children and adolescents (Soto-Sánchez et al., 2023; Souza et al., 2023). In addition, a BMI within the normal range is also associated with higher levels of physical activity and more active participation in school sports activities (Vasileva et al., 2022; Welis et al., 2023).

Interestingly, the results of this study show that BMI contributes more to PE learning outcomes (R^2=0.472) than NK (R^2=0.360). This can be explained because BMI represents actual physiological conditions that directly affect students' ability to perform physical activities. In the context of PE learning, student performance is highly dependent on physical capacities such as strength, endurance, coordination, and physical fitness. Good nutritional status allows the body to obtain sufficient energy to perform physical activities and supports optimal muscle and cardiorespiratory system function. Research shows that students with good nutritional status have higher levels of physical activity and fitness than students with poor or excessive nutritional status (Oukheda et al., 2023; Souza et al., 2023). Studies in Indonesia also show that nutritional status is related to students' physical activity and learning achievement, indicating that a healthy body plays an important role in supporting learning success (Irab et al., 2024).

Conversely, NK more closely reflects the cognitive aspects of nutritional understanding, which do not always directly translate into healthy eating behaviors or optimal physical condition. Several studies show that increased nutritional knowledge is not necessarily followed by changes in consumption behavior if it is not supported by environmental factors, family habits, and access to healthy foods (Çağıran, 2025; Jadgal et al., 2020). In other words, students may have good NK levels, but if their daily eating habits are not supportive or their physical activity is low, their physical condition will remain suboptimal for participating in PE activities. Research by Muderedzwa & Matsungo (2020) also found that even though students have adequate NK, nutritional status and physical activity remain stronger factors in determining their physical fitness. Similar findings were reported by Amenya et al. (2021), which showed that the relationship between NK and BMI in school children is not always linear because it is influenced by various behavioral and environmental factors.

Furthermore, the simultaneous relationship between NK and BMI with PE learning outcomes emphasizes the importance of a holistic approach that integrates nutrition education with children's physical development. These results are in line with the research by Akbar & Rehman (2024) and Bello et al. (2024), which shows that a combination of nutrition literacy and optimal nutritional status contributes significantly to students' academic and athletic performance. The research by Hussain et al. (2017) also emphasizes that eating habits, social relationships, and BMI

affect children's academic performance. Thus, interventions that improve NK and maintain BMI within the normal range can be effective strategies to support PE success in elementary schools.

However, this study has limitations. The sample was limited to 28 students in one school, so the results should be generalized with caution. BMI measurements used single data points without taking into account long-term growth variations, which may limit the interpretation of nutritional status. Other factors such as motivation, teacher teaching quality, family support, eating habits at home, or physical activity outside of school were not analyzed, so the remaining 34.40% variation in learning outcomes may have been influenced by these factors. In addition, NK measurement is only quantitative and does not assess practical application in daily life. Therefore, further research is recommended using a longitudinal design, a larger sample, and more comprehensive measurements, including environmental factors, eating habits, and physical activity, to obtain a more comprehensive overview.

CONCLUSION

Based on the results of the study, it can be concluded that students' NK is in the adequate category and has a significant positive influence on PE learning outcomes, contributing 36.00% to the variation in PE learning outcomes. In addition, students' BMI in the normal category also shows a significant positive relationship with PE learning outcomes and contributes more, namely 47.20%. These findings indicate that physiological conditions reflected in BMI play a more direct role in supporting student participation and performance in PE learning activities. Simultaneously, NK and BMI have a very strong influence on PE learning outcomes, contributing 65.60%. This shows that a combination of good nutritional understanding and optimal nutritional status can support physical performance and learning achievement in elementary school students more effectively. In practical terms, the findings of this study recommend the importance of implementing school-based nutrition education programs integrated with monitoring of students' nutritional status. This approach is expected to help improve NK while maintaining students' BMI within the normal range, thereby supporting the success of PE learning and improving students' physical and academic well-being. Further research is recommended using a longitudinal design with a larger sample size and considering behavioral and environmental factors to obtain a more comprehensive understanding.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest in this research.

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REFERENCE

Abderbwih, E. (2024). *The impact of school-based nutrition interventions on the nutrition knowledge of children and their parents*.

Adugna, Y. M., Ayelign, A., & Zerfu, T. A. (2026). Nutrition, diet, and academic performance among school-age children in urban low-income settings: A case-control study in Addis Ababa, Ethiopia. *Preventive Medicine Reports*. https://doi.org/10.1016/j.pmedr.2026.103429

Akbar, M., & Rehman, S. U. (2024). Assessing the role of nutrition awareness and dietary diversity on academic performance of university students: A survey-based regression analysis. *Forman Journal of Economic Studies*, *20*(2), 95–110. https://doi.org/10.32368/FJES.20242011

Alqahtani, Y., Assiri, O. A., Al-Shahrani, N. S., Alyazidi, N. S., & Alshahrani, M. S. (2020). Relationship between nutritional habits and school performance among primary school students in Asser Region. *Journal of Family Medicine and Primary Care*, *9*(4), 1986–1990. https://doi.org/10.4103/jfmpc.jfmpc_885_19

Amenya, P. C. A., Annan, R. A., Apprey, C., & Agbley, E. N. (2021). The relationship between nutrition and physical activity knowledge and body mass index-for-age of school-aged children in selected schools in Ghana. *Heliyon*, *7*(11). https://doi.org/10.1016/j.heliyon.2021.e08298

Arenasa, L. S., Baul, J. L., Bustillos, V., & Bacatan, J. R. (2024). Correlational analysis of food and nutrition literacy and academic performance among intermediate-level students. *International Journal of Innovative Research in Multidisciplinary Education*, *3*(8), 1370–1376. https://doi.org/10.58806/ijirme.2024.v3i8n10

Bello, Z. A., Obebe, S. F., Ayilara, T. T., Sulaiman, M. M., Abdulazeez, B. T. A., & Rasheed, O. A. (2024). Impact of nutrition on academic performance of boarding science students in selected secondary schools in Ilorin metropolis, Kwara State, Nigeria. *Faculty of Natural and Applied Sciences Journal of Health, Sports Science and Recreation*, *2*(1), 97–110.

Biswas, T. K. (2020). *The impact of nutrition in the academic performance of primary school graduates in Bangladesh*. University of Dhaka.

Çağıran, İ. H. (2025). Investigation of the effect of nutrition education on nutrition knowledge level and nutritional habits. *Sakarya University Journal of Holistic Health*, *8*(2), 80–91. https://doi.org/10.54803/sauhsd.1697901

Carayanni, V., Vlachopapadopoulou, E., Koutsouki, D., Bogdanis, G. C., Psaltopoulou, T., Manios, Y., Karachaliou, F., Hatzakis, A., & Michalacos, S. (2021). Effects of nutrition, and physical activity habits and perceptions on body mass index (BMI) in children aged 12–15 years: A cross-sectional study comparing boys and girls. *Children*, *8*(4), 277.

https://doi.org/10.3390/children8040277

Doustmohammadian, A., Omidvar, N., Keshavarz-Mohammadi, N., Eini-Zinab, H., Amini, M., & Abdollahi, M. (2022). The association and mediation role of Food and Nutrition Literacy (FNLIT) with eating behaviors, academic achievement and overweight in 10–12 years old students: A structural equation modeling. *Nutrition Journal*, *21*(1), 45. https://doi.org/10.1186/s12937-022-00796-8

Eshiev, A., Alshuwaili, H., Usonuulu, Z., Omorov, T., Kudryavtsev, M., Osipov, A., & Dalykh, A. (2025). Efficiency of using track and field in physical education training for senior schoolchildren. *Journal of Physical Education and Sport*, *25*(2), 269–276. https://doi.org/10.7752/jpes.2025.02030

Firdaus, K., Hartoto, S., Hariyanto, A., Subagya, I., Nikmatullaili, Mario, D. T., & Zulbahri. (2023). Evaluation of several factors that affect the learning outcomes of Physical Education. *International Journal of Human Movement and Sports Sciences*, *11*(1), 27–36. https://doi.org/10.13189/saj.2023.110104

Guiné, R. P. F., Florença, S. G., Aparício, M. G., Cardoso, A. P., & Ferreira, M. (2023). Food knowledge for better nutrition and health: A study among university students in Portugal. *Healthcare*, *11*(11), 1597. https://doi.org/10.3390/healthcare11111597

Hani, N. A. (2022). *Hubungan antara kebiasaan konsumsi makanan cepat saji dengan status gizi pada anak usia sekolah 6-12 tahun (Studi di SD N Patereman 1 Kec. Modung Kab. Bangkalan)*. Stikes Ngudia Husada Madura: Doctoral dissertation.

Hussain, I., Kumar, P., & John, A. A. (2017). Social relationships, academic performance, dietary habits and body mass index in school children: A comparative study. *International Journal for Innovative Research in Multidisciplinary Field*, *3*(7), 193–201.

Irab, S. P., Flassy, M., Zainuri, A., Sinaga, E., Hidayat, R. R., Wandik, Y., & Putra, M. F. P. (2024). Determinants of nutritional status, students' learning achievement and physical activity: A cross sectional study in Jayapura City, Papua, Indonesia. *Retos*, *58*, 485–494. https://doi.org/10.47197/retos.v58.107422

Jadgal, M. S., Sayedrajabizadeh, S., Sadeghi, S., & Nakhaei-Moghaddam, T. (2020). Effectiveness of nutrition education for elementary school children based on the theory of planned behavior. *Current Research in Nutrition and Food Science Journal*, *8*(1), 308–317. https://doi.org/10.12944/CRNFSJ.8.1.29

Kemenkes. (2011). *Standar antropometri untuk menilai status gizi anak-anak*. Direktorat Jenderal Kesehatan Ibu dan Anak serta Pengembangan Gizi.

King, D., Killian, C. M., Kern, B. D., Paulson, L., Wilson, W. J., Woo, D. S., & Wallhead, T. (2026). State of the states policy report: Physical education and physical activity policy in the United States and its territories. *Journal of Physical Education, Recreation & Dance*, *97*(1), 20–74. https://doi.org/10.1080/07303084.2025.2579457

Liu, L., Ren, X., Li, W., Zhao, S., Guo, X., Yan, R., & Li, R. (2025). Nutritional literacy and health behaviors in primary school students in China: a cross-sectional study. *BMC Public Health*, *25*(1), 2275. https://doi.org/10.1186/s12889-025-23420-w

Liverti, D. P., Manullang, J. G., & Hermansah, B. (2023). The relationship between nutritional status (BMI) and stress levels on physical fitness of extracurricular sports students. *Journal of Social Work and Science Education*, *4*(3), 283–288.

Ma'ruf, M., Rais, I. R., & Bachri, M. S. (2024). Peran edukasi dalam pemilihan makanan sehat pada anak sekolah. *Jurnal Pembelajaran Pemberdayaan Masyarakat (JP2M)*, *5*(1), 172–178. https://doi.org/10.33474/jp2m.v5i1.21427

Martinovic, M. B., Jaksic, M. Z., Spahic, E. S., Lukic, M. Z., & Nedovic-Vukovic, M. M. (2021). Physical activity and nutritional status of schoolchildren in Montenegro. *Sport Mont*, *19*(1), 65–70. https://doi.org/10.26773/smj.210216

McPherson, A., Kunkel, J., Mackay, L., Garrett, N., Duncan, S., & McPherson, C. (2025). Step to it: Exploring longitudinal associations between physical activity and cognition in children. *Journal of Physical Activity and Health*, *22*(12), 1539–1548. https://doi.org/10.1123/jpah.2025-0103

Monacis, D., Trecroci, A., Invernizzi, P. L., & Colella, D. (2022). Can enjoyment and physical self-perception mediate the relationship between BMI and levels of physical activity? Preliminary results from the regional observatory of motor development in Italy. *International Journal of Environmental Research and Public Health*, *19*(19), 12567. https://doi.org/10.3390/ijerph191912567

Morales-Suárez-Varela, M., Peraita-Costa, I., Llopis-Morales, A., & Llopis-González, A. (2024). Cross-sectional assessment of nutritional status, dietary intake, and physical activity levels in children (6–9 Years) in Valencia (Spain) using nutrimetry. *Nutrients*, *16*(16), 2649. https://doi.org/10.3390/nu16162649

Muderedzwa, T. M., & Matsungo, T. M. (2020). Nutritional status, physical activity and associated nutrition knowledge of primary school learners. *Nutrition and Health*, *26*(2), 115–125. https://doi.org/10.1177/0260106020910625

Mukhamedzhanov, E., Tsitsurin, V., Zhakiyanova, Z., Akhmetova, B., & Tarjibayeva, S. (2023). The effect of nutrition education on nutritional behavior, academic and sports achievement and attitudes. *International Journal of Education in Mathematics, Science, and Technology*, *11*(2), 358–374. https://doi.org/10.46328/ijemst.3133

Oukheda, M., Bouaouda, K., Mohtadi, K., Lebrazi, H., Derouiche, A., Kettani, A., Saile, R., & Taki, H. (2023). Association between nutritional status, body composition, and fitness level of adolescents in physical education in Casablanca, Morocco. *Frontiers in Nutrition*, *10*, 1268369. https://doi.org/10.3389/fnut.2023.1268369

Roy, T., Barlian, E., & Donie, D. (2025). The role of pulmonary vital capacity, hemoglobin levels and body mass index in determining maximum oxygen volume in non-athlete students. *STAMINA*, *8*(3), 116-124. https://doi.org/10.24036/jst.v8i3.1279

Soto-Sánchez, J., Leyton-Dinamarca, B., Fernández-Valero, P., Magnere, P., Cantillana, J. C., & Valenzuela, J. (2023). Differences in nutritional status, risk factors for metabolic syndrome, physical fitness and physical activity according to hours of weekly physical education practice. *Journal of Physical Education and Sport*, *23*(2), 517–524. https://doi.org/10.7752/jpes.2023.02064

Souza, G. A. C., Maia, C. S. C., de Oliveira, K. A., Braga, R. A. M., Soares, E. S., Verde, S. M. M. L., Magalhaes, S. C., Oliveira, A. C. D., & Loureiro, A. C. C. (2023). Evaluation of the relationship between nutritional status, levels of physical activity and physical strength in adolescents. *Clinical Nutrition ESPEN*, *53*, 182–188. https://doi.org/10.1016/j.clnesp.2022.12.007

Sugiarto, D., Hadi, H., & Kusumawardana, B. (2026). The effect of physical education learning based on direction guessing game and compact game on increasing student active participation. *STAMINA*, *9*(1), 41-48. https://doi.org/10.24036/jst.v9i1.1320

Vasileva, F., Shukova-Stojmanovska, D., Vasilev, A., & Georgiev, G. (2022). BMI and nutritional status in physical active population involved in recreational sport. *Journal of Anthropology of Sport and Physical Education*, *6*(1), 13–19. https://doi.org/10.26773/jaspe.220103

Welis, W., Prayoga, R., Mario, D. T., Komaini, A., Ayubi, N., & Effendi, R. (2026). Comparison of physical fitness based on sedentary lifestyle levels in adolescents: A comparative analysis. *Physical Activity Review*, *14*(1), 67–77. https://doi.org/10.16926/par.2026.14.06

Welis, W., Yendrizal, Darni, & Mario, D. T. (2023). Physical fitness of students in Indonesian during the COVID-19 period: Physical activity, body mass index, and socioeconomic status. *Physical Activity Review*, *11*(1), 77–87. https://doi.org/10.16926/par.2023.11.10