Available online at https://journal.uny.ac.id/index.php/jorpres

JORPRES (Jurnal Olahraga Prestasi), 19 (2), 2023, 178-189

The effect of physical activity, nutritional status and learning motivation on the physical fitness of public elementary school students 02 Senamat Bungo Regency

Muhammad Afdhori[1*], Damrah[1], Willadi Rasyid[1], Hendri Neldi[1]

[1]Sports Education, Faculty of Sports Science, Universitas Negeri Padang, Prof. Dr. Hamka Street, Padang Freshwater Campus, West Sumatra, Indonesia.

[*]Corresponding Author. Email : afdhorimuhammad@gmail.com

Abstract

The purpose of this study was to determine the effect of physical activity, nutritional status and learning motivation on students' physical fitness. This type of quantitative research, with the research design carried out with a Path Analysis approach. The sample in this study amounted to 50 students, data was collected using the PAQ-C questionnaire to measure students' physical activity, and using the Nusantara Student Physical Fitness Test (TKPN) to measure students' nutritional status and physical fitness, while to measure learning motivation using questionnaires. Research Results (1). that physical activity on physical fitness is 30.91%. (2). The effect of nutritional status on physical fitness is 12.25%. (3). The effect of learning motivation on physical fitness is 5.56%. (4). The effect of physical activity through learning motivation on physical fitness is 11.25%. (5). The effect of nutritional status through learning motivation on physical fitness is 8.89%. This means that hypotheses related to the indirect influence of nutritional status through learning motivation on physical fitness are acceptable. (6). Physical activity, nutritional status and learning motivation affect physical fitness. The similarity of pathways from various physical activity, nutritional status, and learning motivation to affect physical fitness (X1, X2 and X3 to Y) is 92%. This figure shows that the magnitude of the influence of physical activity variables, nutritional status and learning motivation has a significant effect on physical fitness. Physical activity, nutritional status, and learning motivation had a significant influence on students' physical fitness, and the complex interactions between the three had a strong impact in the context of this study.

Keywords: Physical Activity; Nutritional Status; Learning Motivation; Physical Fitness; and Elementary School Students

INTRODUCTION

In the modern era with the presence of technological devices and a less active lifestyle, there is a decrease in the level of physical fitness in a person, especially in school-age children (Uebelacker et al., 2020). Many students prefer to spend time in front of a gadget or computer screen rather than participate in physical activity or sports (Freshwater et al., 2022). This decline in physical fitness can have a negative impact on students' physical and mental health. Physical fitness is a person's ability when doing activities without fatigue and still have energy reserves for the next activity. In other words, fitness can be defined as the ability to do activities even in difficult circumstances, where someone whose fitness is not good cannot do it (Farrokhi et al., 2021).

Physical activity is one of the external factors that affect a person's physical fitness condition (Farrokhi et al., 2021). But nowadays there are many who do not know that physical fitness is very important. To maintain physical fitness is maintained, at least do physical activity approximately 3-5 days a week with a duration of 20-60 minutes. In this question, of course, the environment is very influential in the implementation of physical activity, both the residential environment and the school environment, how will we carry out physical activity if the support for the implementation of physical activity in the environment is inadequate or even non-existent (Laukkanen et al., 2023).

ISSN 0216-4493 (print), ISSN 2597-6109 (online)

A student will be able to perform physical activity optimally if he has excellent physical fitness (Anderson et al., 2009; Braithwaite et al., 2011). One that describes a person's physical fitness level is physical activity, nutritional intake, and health. Adequate physical activity is important to maintain physical health and fitness. However, many students face obstacles in increasing their physical activity levels. Factors such as high learning demands, lack of opportunities to exercise in the school environment, and lack of support from family or peers can be barriers to student participation in physical activity (Smith et al., 2018; Uebelacker et al., 2023)

As for nutritional status, if the child's nutritional status is low, of course he cannot move properly, the consequence is of course his low physical fitness level (Hjorth et al., 2016; Vella et al., 2023). Poor or poor nutrition in children can result in impaired physical growth and intelligence. If physical growth is stunted, then his physical and motor abilities will be difficult to develop. The intake of food consumed by a person is very influential on his physical growth and development. To meet the needs of life in order to grow well, children should consume nutrients that meet their needs, both in terms of quantity and quality; (Edna Mayela et al., 2023; Oc & Plangger, 2022).

Learning motivation is a factor that can influence the extent to which students participate in physical activity and sports (McGowan et al., 2021; op den Akker et al., 2015). Low levels of motivation can lead to a lack of interest in learning especially in sports learning, so students tend to be less active and have less opportunities to improve their physical fitness (Diamant et al., 2023; Sherf-Dagan et al., 2021).

The gap in this study is the lack of research that investigates the interaction between physical activity, nutritional status, and learning motivation in shaping students' physical fitness. Most previous studies have only examined these factors separately, so there is still a need for a more holistic understanding. The urgency of the study is particularly high due to increasing health concerns among students, such as obesity and lack of physical activity. This research can provide important guidance for schools and educational institutions in designing comprehensive programs to improve student well-being. The results of the study can also be used to design policies and intervention programs aimed at improving student health and wellness, thus becoming particularly relevant in the context of overall student well-being.

Through this research, it is expected to provide guidance and recommendations for schools and related parties to develop effective programs and strategies in improving students' physical fitness and promoting a healthy lifestyle among them, especially SDN 02 Senamat, Bungo Regency. The results of this study will provide a deeper understanding of the effect of physical activity, nutritional status, and learning motivation on physical fitness, which can help sports teachers and parents in finding appropriate solutions in improving students' overall fitness levels more effectively and according to student needs (Ryom et al., 2022; Wieland et al., 2016).

The relationship between physical activity, nutritional status, and learning motivation and students' physical fitness is an increasingly interesting topic in education and health research (Chakraborty et al., 2022). Previous research has consistently shown that physical activity plays a significant role in improving students' physical fitness. Regular exercise not only improves heart health and muscle strength, but also contributes to general well-being. It is important to note that most of the variation in students' physical fitness can be explained by their level of physical activity, as shown by the influence of 30.91% in a study conducted at SDN 02 Senamat Bungo Regency. This reinforces the importance of encouraging physical activity among students to improve their physical fitness.

This study is an emphasis on the complex interaction between physical activity, nutritional status, and learning motivation as key factors influencing students' physical fitness. This study differentiates itself by exploring not only the direct influence of each factor on physical fitness (Jurić et al., 2023; Vandelanotte et al., 2023), but also indirect influence through learning motivation. The results showed that not only physical activity and nutritional status were influential, but also learning motivation had an important role in shaping students' physical fitness. These findings reveal the complexity of these relationships and highlight that encouraging students to be physically active must be supported by strong learning motivation. A major contribution of the study is a deeper understanding of how these factors interact with each other and how they can be optimized to improve students' physical fitness. The practical implication is that a comprehensive approach to education and health should consider all three of these factors together, rather than focusing on just one aspect (Arellano-Gómez et al., 2023).

With an emphasis on the influence of learning motivation in relation to students' physical fitness, this study provides very sharp and powerful insights. Knowing that learning motivation plays a significant role in encouraging student participation in physical activity can help schools and educational institutions to design more effective physical education programs (Gomes et al., 2014). The evaluations in this study provide a basis for identifying areas where schools and other interested parties can focus on improving overall student well-being. Thus, the study not only provides a deeper understanding of the factors affecting students' physical fitness, but also provides concrete guidance for actions and improvements in students' educational and health environments.

METHOD

The research method used in this study is a quantitative research method using a path analysis approach, namely a structural equation that looks at the causality of the dimensions of the influence of physical activity (X1) and nutritional status (X2) as exogenous variables, Learning Motivation (X3) as intervening variables. While the endogenous variable is Physical Fitness (Y). Where this study was conducted to see the presence or absence of the influence of causal variables on consequent variables through the use of the Path Analysis method.

Population and Sample are The population in this study is all students of SDN 02 Senamat, Bungo Regency. Which totaled 281 people. The sample that can be examined in this study is students who are in high grades, amounting to 51 people consisting of 25 male students and 26 female students selected using purposive sampling techniques. Place and Time of Research This research was conducted at SDN 02 Senamat, Bungo Regency. The research was conducted on October 13-14.

Research Instrument To measure the fitness level of students' services, the Nusantara Student Fitness Test (TKPN) is used. Students' physical activity was measured by the developed Physical Actifity Questionnaire For Children (PAQ-C) questionnaire. Meanwhile, to find out Learning Motivation by filling out questionnaires based on the Likert Scale approach. This questionnaire has been pre-validated to ensure its validity.

Data Collection Techniques through direct observation of students of SDN 02 Senamat, Bungo Regency with high classes, filling out motivational questionnaires, filling out physical activity questionnaires and collecting nutritional status data. Data will be collected then afterwards a fitness test of Indonesian students is carried out to see the influence of the previous three variables on the physical fitness of students at SDN 02 Senamat, Bungo Regency. Before hypothesis testing, analysis requirements testing is first carried out including regression estimation error normality tests, significance tests and simple regression model linearity. Regression estimation error normality test, performed with liliefors technique and regression model significance and linearity test with Anava. And testing the homogeneity of variance using the barlet test. Path analysis is used to determine the direct influence on each variable studied in testing the hypothesis of this study. With this method, it is hoped that this research can provide a deeper understanding of the influence of physical activity, nutritional status and learning motivation on the physical fitness of SDN 02 Senamat students, Bungo Regency.

RESULTS AND DISCUSSION

Results

A. Test Analysis Requirements

Test requirements analysis is carried out as a basis for consideration to select and establish data analysis techniques used in hypothesis testing. The prerequisite testing of the analysis includes, normality testing, Linearity testing, and Multicollinearity testing. Before testing the prerequisites of analysis and hypothesis testing, the raw data obtained is converted first to T-score. Because the data obtained is data with different score units.

1. **Normality Test**

The normality test aims to determine whether the residual value is normally distributed or not. The normality test used in this study is the Kolmogorov-Smirnov normality test with two versions, namely based on residual values and normality tests based on each variable with the help of the SPSS program version 25.0. A good regression model is to have normally distributed residual values. The basis for decision making is as follows:

ISSN 0216-4493 (print), ISSN 2597-6109 (online)

If the Sig value > 0.05, then the residual value is normally distributed.
If the Sig value < 0.05, then the residual value is not normally distributed.

The results of the normality test based on residual values using the help of SPSS Program version 25.0 can be seen in the table below.

Table 1. Normality Test Based on Residual Value

	Tests of Normality			
	Kolmogorov-Smirnov[a]			
	Statistic	df	Sig.	Statistic
Standardized Residual	0,104	36	0,200*	0,975
	*. This is a lower bound of the true significance.			
	a. Lilliefors Significance Correction			

Based on the results of the Kolmogorov-Smirnov normality test residual values with the help of the SPSS program version 25.0, it is known that Sig values = 0.200 > α = 0.05. Thus, it can be concluded that the residual values are normally distributed. Furthermore, for more details the normality test based on variables can be seen in the table below.

Table 2. Normality Test Summary

No	Variable	Value *Sig*	A	Information
1	Y	0,200	0,05	Usual
3	X_1	0,123	0,05	Usual
3	X_2	0,144	0,05	Usual
4	X_3	0,124	0,05	Usual

a. Physical Fitness Level (Y) Results Normality Test

Based on the results of the Kolmogorov-Smirnov normality test data on the value of the physical fitness level of students (Y) with the help of the SPSS program version 25.0, it is known that the value of Sig = 0.200 > α = 0.05. Thus, it can be concluded that the data on the value of students' physical fitness levels are normally distributed.

b. Physical Activity Normality Test (X1)

Based on the results of the Kolmogrov-Smirnov normality test of physical activity data (X1) with the help of the SPSS program version 25.0, it is known that Sig values = 0.123 > α = 0.05. Thus, it can be concluded that the data on the results of students' physical activity are normally distributed.

c. Nutritional Status Normality Test (X2)

Based on the results of the Kolmogorov-Smirnov normality test nutritional status data (X2) with the help of the SPSS program version 25.0, it is known that Sig values = 0.144 > α = 0.05. Thus, it can be concluded that the data on nutritional status results are normally distributed.

d. Learning Motivation Normality Test (X3)

Based on the results of the Kolmogorov-Smirnov normality test of learning motivation data (X3) with the help of the SPSS program version 25.0, it is known that the value of Sig = 0.124 > α = 0.05. Thus, it can be concluded that the data on the value of student learning motivation is normally distributed.

2. Linearity Test

The Linearity Test aims to see whether each data from the variables of physical activity (X1), nutritional status (X2), and learning motivation (X3) tends to form a linear (straight) line with respect to the variable level of physical fitness (Y). Test criteria if the Sig value > α value = 0.05 then the data is said to be linear, if otherwise the data is not linear. The following will be presented a description of the results of the Linearity test.

ISSN 0216-4493 (print), ISSN 2597-6109 (online)

Table 3. Linearity Test Summary

Test *Linieritas*	**A**	*Sig.*	Information
X_1 with Y	0,05	0,321	*Linier*
X_2 with Y	0,05	0,071	*Linier*
X_3 with Y	0,05	0,182	*Linier*
X_1 with X_3	0,05	0,547	*Linier*
X_2 with X_3	0,05	0,068	*Linier*

3. Multicollinearity Test

The Multicollinearity Test aims to see whether or not there is a high correlation between independent variables in a model. That is, if there is a high correlation between independent variables, then the relationship between the independent variable and the dependent variable becomes disrupted. According to Ghozali (2011: 107-108) said, "there are no symptoms of Multicollinearity, if the Tolerance value > 0.100 and the VIF value < 10.00". The results of the multicollinearity test can be seen in the table below

.

Table 4. Multicollinearity Test Results

Variable	*Collinearity Statistics*		Information
	Tolerance	***VIF***	
X_1	0.396	2.523	***Not happening Multikolinieritas***
X_2	0,405	2,469	
X_3	0,824	1.214	

That the variables X1, X2 and X3 obtained Tolerance values, 0.396, 0.405 and 0.824, this means that the Tolerance value > 0.100. While the VIF values of the independent variables X1, X2 and X3 are obtained, 2.523, 2.469 and 1.214, this means that the VIF values < 10.00. Thus, that between the independent variables X1, X2 and X3 no symptoms of multicollinearity occur.

B. Calculating the path coefficient

The calculation of the path coefficient is divided into 2 structural models, structural model 1 calculates the coefficient of physical activity path (X1) and nutritional status (X2) on learning motivation (X3) of SDN 02 Senamat students. Structural model 2 calculates physical activity pathways (X1), nutritional status (X2) and learning motivation (X3 against physical fitness levels (Y). For more details will be explained in the following structural testing**.**

1. Structural Model 1

Structural model 1 calculates physical activity (X1) and nutritional status (X2) against learning motivation (X3). Based on calculations using the SPSS application version 25.00, results are obtained as in the table below.

Table 5. Structural Model Summary 1

Type Summary									
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	,420[a]	,576	,510	9,60658	,576	32,672	2	25	,039
a. Predictors: (Constant), Status Gizi (X2), Aktivitas Fisik (X1)									

Based on table 21 above, the dissolution coefficient (R square) of 0.576 means that 5.76% of sleep quality variability (X3) can be explained by physical activity variables (X1) and nutritional status (X2). So that the magnitude of structural model error 1 or the magnitude of the influence of other variables outside the model on exogenous variables X3 is $\varepsilon 1 = 1 – R2 = 1 – 0.576 = 0.424$.

To see the magnitude of the path coefficient between the physical activity variable (X1) to learning motivation (X3) and the path coefficient between the nutritional status variable (X2) to learning motivation (X3) can be seen in the Coefficients table below.

ISSN 0216-4493 (print), ISSN 2597-6109 (online)

Table 6. Structural Line Coefficients 1

Coefficients[a]						
Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	T	Sig.
1	(Constant)	31,039	18,447		1,683	,105
	Aktivitas Fisik (X1)	,593	,403	,473	2,964	,033
	Status Gizi(X2)	,499	,986	,372	2,607	,049
a. Dependent Variable: Motivasi Belajar (X3)						

a. Coefficient of Physical Activity Pathway (X1) to Learning Motivation (X3)

From table 16 structural coefficients 1 path coefficients are obtained in the Beta column (standardized Coefficients), namely the coefficient of the physical activity path (X1) to learning motivation (X3) symbolized by p31 = 0.473 with t0 = 2.964, and p-value (sig) = 0.033/2 = 0.0165 < α 0.05 which means that physical activity (X1) has a positive direct influence on learning motivation (X3).

b. Coefficient of Nutritional Status Pathway (X2) to Learning Motivation (X3)

From the path coefficient table in the Beta column (standardized Coefficients), it is also obtained that the coefficient of the Nutritional Status (X2) path to learning motivation (X3) is symbolized by p32 = 0.372, with t0 = 2.607, and p-value = 0.049/2 = 0.0245< α 0.05 which means that Nutritional Status (X2) has a positive direct influence on learning motivation (X3).

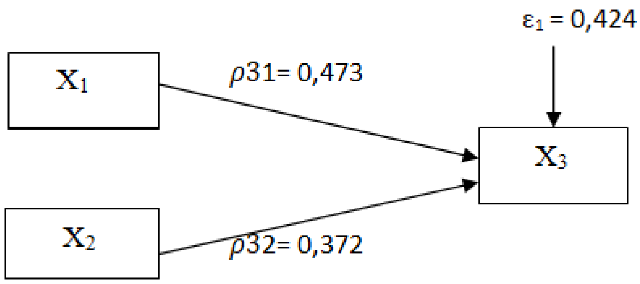

Figure 1. Structural Casual Models 1 X1, X2 and X3

2. Structural Model 2

2. Stru ModelThis structural model 2 calculates physical activity (X1), nutritional status (X2) and learning motivation (X3) against physical fitness outcomes (Y). Based on calculations using the SPSS application version 25.00, the results are obtained as in the table below initural 2.

Table 7. Structural Model Summary 2

Model Summary									
					Change Statistics				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	F Change	df1	df2	Sig. F Change
1	,959[a]	,920	,910	3,05231	,920	92,183	3	24	,000
a. Predictors: (Constant), Teaching Motivation (X3), Nutritional Status (X2), Physical Activity (X1)									

Based on the table above, the termination coefficient (R2) of 0.920 is obtained, which means that 92% variability in physical fitness results (Y) can be explained by variables of physical activity (X1), nutritional status (X2), and learning motivation (X3). So that the magnitude of the error of

ISSN 0216-4493 (print), ISSN 2597-6109 (online)

model 2 or the magnitude of the influence of other variables outside the model on the exogenous variable X3 is ε2 = 1–R2 = 1 – 0.920 = 0.08.

To see the magnitude of the path coefficient between physical activity (X1), nutritional status (X2) and learning motivation (X3) on the results of increasing physical fitness (Y) can be seen in table 18 below.

Table 8. Structural Line Coefficients 2

Coefficients[a]						
Type		Unstandardized Coefficients		Standardize d Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	25,198	6,184		3,590	,001
	Physical Activity(X1)	,010	,001	,556	5,337	,000
	Nutritional Status(X2)	,173	,015	,350	2,549	,048
	Learning Motivation (X3)	,138	,064	,238	2,179	,039
a. Dependent Variable: Physical Fitness (Y)						

a. Physical activity path coefficient (X1) to physical fitness outcome (Y)

Based on the table of structural Coefficients 2, the path coefficients are obtained in the Beta column (standardized Coefficients), namely the coefficient of the physical activity path (X1) to the results of physical fitness (Y) symbolized py1 = 0.556 with t0 = 5.337, and p-value = 0.000/2 = 0.000 < α 0.05 which means that physical activity (X1) has a positive direct influence on physical fitness results (Y). The magnitude of the effect is = (0.556^2) x 100 = 30.09%.

b. Coefficient of Nutritional Status Pathway (X2) to Physical Fitness Results (Y)

Based on the table of structural Coefficients 2, the path coefficients are obtained in the Beta column (standardized Coefficients), which is the coefficient of the nutritional status path (X2) to the results of physical fitness (Y) symbolized py2 = 0.350, with t0 = 2.459, and p-value = 0.048/2 = 0.024 < α 0.05 which means that nutritional status (X2) has a direct positive influence on physical fitness results (Y). The magnitude of the influence of nutritional status (X2) is = (0.350^2) x 100 = 12.25%.

c. Learning Motivation Path Coefficient (X3) to Physical Fitness Results (Y)

Based on table 18 structural coefficients 2, the path coefficients are obtained in the Beta column (standardized coefficients), namely the coefficient of the learning motivation path (X3) to physical fitness results (Y) symbolized py3 = 0.238, with t0 = 2.179 and p-value = 0.039/2 = 0.0115 < α 0.05 which means that learning motivation (X3) has a positive direct influence on physical fitness results (Y). The effect of learning motivation (X3) on physical fitness outcomes (Y) is = (0.238^2) = 0.0566 or 5.66%. It can be concluded that the path coefficient The effect of physical activity, nutritional status and learning motivation on physical fitness results can be visualized as follows.

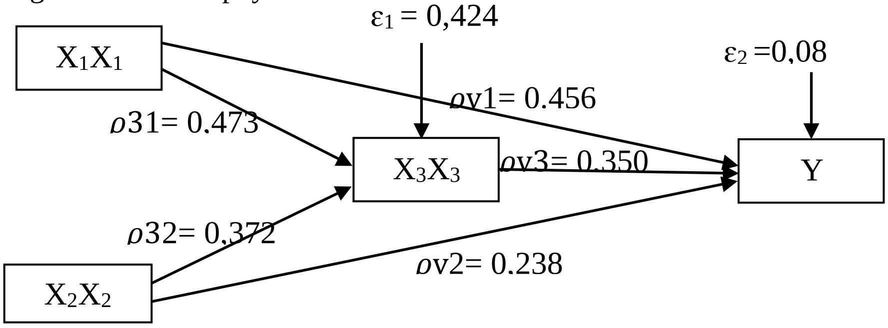

Figure 2. Structural Casual Model 2 Variables X1, X2, X3, and Y

ISSN 0216-4493 (print), ISSN 2597-6109 (online)

Table 9. Summary of Hypothesis Testing Results

Koefisien Line	Standardized Coefficients Beta	Types of Influence %				Total Influence Direct + Indirect	
		Immediately		**Indirect Through X_3**			
		^2	**%**	**Coefficient Multiplication**	**%**	**Total**	**%**
$X_1 \Rightarrow Y$	0,556	0,3091	30.91	0,1125	11.25	0,4216	32.04
$X_2 \Rightarrow Y$	0,350	0,1225	12.25	0,0889	8.89	0,2114	21.14
$X_3 \Rightarrow Y$	0,238	0,0566	5.66			0,0566	5.66
Total Direct + Indirect Influence						**0.6896**	**68,96**
Other variables						**0,3104**	**31.04**

Discussion

In this study, there are several findings that deserve more in-depth attention. First, the finding that physical activity had a significant effect of 30.91% on students' physical fitness underscores the importance of encouraging students to be physically active (Han, 2023; M. Wilson et al., 2017). This reflects that promoting an active lifestyle among students not only positively impacts their physical health, but also contributes to improved overall physical fitness. It illustrates that efforts to improve students' physical fitness should begin by motivating them to participate in regular physical activity, both inside and outside of school (Hosker et al., 2019; Plotnikoff et al., 2017).

Furthermore, the effect of nutritional status on physical fitness by 12.25% shows that diet and nutritional intake also have an important role in shaping student fitness. This highlights that schools and educational institutions need to pay special attention to ensuring that students get a balanced and quality food intake (Scott et al., 2017; Szeszulski et al., 2020; O. W. A. Wilson et al., 2023). In addition to physical activity, nutritional aspects should be an important part of school health programs to ensure that students have sufficient energy sources to participate in physical activity and maintain their physical fitness (Carraça et al., 2019; Chen et al., 2021; Clemente-Suárez et al., 2022).

Finally, the findings on the influence of learning motivation by 5.56% broaden our understanding of psychological factors in motivating students to maintain physical fitness. This indicates that how students feel compelled to learn and achieve their academic performance also affects their involvement in physical activity and, consequently, their physical fitness (Demetriou et al., 2015; Eather et al., 2013). In other words, strong learning motivation may not only improve academic performance, but also encourage students to become more physically active (de Moraes Lopes et al., 2020; Venkatachalam & Ray, 2022). This opens up opportunities to integrate a more holistic approach to education and health in an effort to improve student well-being (Ketcheson & Pitchford, 2021; Palmer et al., 2020)**.**

The implications of this research are particularly relevant in the context of education and student health. First of all, the study highlights the importance of encouraging student participation in regular physical activity. Given the finding that physical activity has a significant effect on physical fitness, schools and educational institutions should prioritize programs that encourage exercise and physical activity inside and outside the classroom. This can create an environment that supports an active lifestyle that benefits students' physical health (Bafirman, Munir, et al., 2023).

Furthermore, this study underscores the importance of nutrition and nutritional status in shaping students' physical fitness (Bafirman, Wahyuri, et al., 2023). With the finding that nutritional status has a significant impact, nutrition and health education initiatives need to be stepped up to ensure that students get a balanced and quality food intake. This can support students' growth and development, as well as improve their physical fitness. Lastly, this study shows that learning motivation also plays a role in encouraging students to maintain physical fitness (Nugroho, 2022; Sania et al., 2022). Therefore, educators and schools need to integrate motivational aspects of learning in a holistic educational approach, creating an environment that stimulates students' physical and psychological

ISSN 0216-4493 (print), ISSN 2597-6109 (online)

well-being simultaneously. Overall, the study provides valuable guidance for educational institutions in their efforts to improve student well-being through a comprehensive and integrated approach.

CONCLUSION

Based on this study, the conclusion is that physical activity, nutritional status, and learning motivation have a significant impact on students' physical fitness. Physical activity played a central role with an influence of 30.91%, underscoring the urgency of encouraging student participation in regular physical activity. In addition, nutritional status with an influence of 12.25% and learning motivation of 5.56% also plays a role in shaping students' physical fitness. These results provide a solid understanding of the complex interactions between these factors, and suggest that efforts to improve students' physical fitness should integrate approaches that consider all three together. With this understanding, educational institutions and interested parties can design more effective education and health programs to improve students' physical and psychological well-being.

REFERENCES

Anderson, L. M., Quinn, T. A., Glanz, K., Ramirez, G., Kahwati, L. C., Johnson, D. B., Buchanan, L. R., Archer, W. R., Chattopadhyay, S., Kalra, G. P., & Katz, D. L. (2009). The Effectiveness of Worksite Nutrition and Physical Activity Interventions for Controlling Employee Overweight and Obesity: A Systematic Review. *American Journal of Preventive Medicine*, *37*(4), 340–357. https://doi.org/10.1016/j.amepre.2009.07.003

Arellano-Gómez, L. P., Chávez-Palencia, C., Ramos-García, C. O., Orozco-Hernández, R. P., Rodríguez-Preciado, S. I., Ochoa-González, H., Balderas-Arteaga, N., González-Rocha, A., & Denova-Gutiérrez, E. (2023). Participatory intervention to improve nutrition and physical activity of school-age children in Mexico. *Contemporary Clinical Trials*, *127*, 107138. https://doi.org/10.1016/j.cct.2023.107138

Bafirman, B., Wahyuri, A. S., Vellya, V., Zarya, F., & Munir, A. (2023). Comparison of VO2Max Capacity and Lung Vital Capacity of Junior High School Students: Highlands and Lowlands. *JOSSAE (Journal of Sport Science and Education)*, *8*(1), 69–76. https://doi.org/10.26740/jossae.v8n1.p69-76

Bafirman, Munir, A., Zarya, F., & Nia, T. A. (2023). Comparison of Learning Methods Based on Animals Name and Conventional Learning to Improve Free Throw Shooting Skills in Basketball Games. *International Journal of Human Movement and Sports Sciences*, *11*(5), 1150–1157. https://doi.org/10.13189/saj.2023.110524

Braithwaite, R., Spray, C. M., & Warburton, V. E. (2011). Motivational climate interventions in physical education: A meta-analysis. *Psychology of Sport and Exercise*, *12*(6), 628–638. https://doi.org/10.1016/j.psychsport.2011.06.005

Carraça, E. V, Leong, S. L., & Horwath, C. C. (2019). Weight-Focused Physical Activity Is Associated with Poorer Eating Motivation Quality and Lower Intuitive Eating in Women. *Journal of the Academy of Nutrition and Dietetics*, *119*(5), 750–759. https://doi.org/10.1016/j.jand.2018.09.011

Chakraborty, D., Singu, H. B., & Patre, S. (2022). Fitness Apps's purchase behaviour: Amalgamation of Stimulus-Organism-Behaviour-Consequence framework (S–O–B–C) and the innovation resistance theory (IRT). *Journal of Retailing and Consumer Services*, *67*, 103033. https://doi.org/10.1016/j.jretconser.2022.103033

Chen, S., Sun, H., Zhu, X., Chen, A., & Ennis (Posthumous), C. D. (2021). Learners' motivational response to the Science, PE, & Me! curriculum: A situational interest perspective. *Journal of Sport and Health Science*, *10*(2), 243–251. https://doi.org/10.1016/j.jshs.2019.11.001

ISSN 0216-4493 (print), ISSN 2597-6109 (online)

Clemente-Suárez, V. J., Beltrán-Velasco, A. I., Ramos-Campo, D. J., Mielgo-Ayuso, J., Nikolaidis, P. A., Belando, N., & Tornero-Aguilera, J. F. (2022). Physical activity and COVID-19. The basis for an efficient intervention in times of COVID-19 pandemic. *Physiology & Behavior*, *244*, 113667. https://doi.org/10.1016/j.physbeh.2021.113667

de Moraes Lopes, M. H. B., Ferreira, D. D., Ferreira, A. C. B. H., da Silva, G. R., Caetano, A. S., & Braz, V. N. (2020). Chapter 20 - Use of artificial intelligence in precision nutrition and fitness. In D. Barh (Ed.), *Artificial Intelligence in Precision Health* (pp. 465–496). Academic Press. https://doi.org/10.1016/B978-0-12-817133-2.00020-3

Demetriou, Y., Sudeck, G., Thiel, A., & Höner, O. (2015). The effects of school-based physical activity interventions on students' health-related fitness knowledge: A systematic review. *Educational Research Review*, *16*, 19–40. https://doi.org/10.1016/j.edurev.2015.07.002

Diamant, É., Perez, T., & Drouin, O. (2023). Nudging interventions to improve children's sleep, physical activity and sedentary behavior: A scoping review. *Preventive Medicine*, *173*, 107572. https://doi.org/10.1016/j.ypmed.2023.107572

Eather, N., Morgan, P. J., & Lubans, D. R. (2013). Improving the fitness and physical activity levels of primary school children: Results of the Fit-4-Fun group randomized controlled trial. *Preventive Medicine*, *56*(1), 12–19. https://doi.org/10.1016/j.ypmed.2012.10.019

Edna Mayela, D. L. V.-C., Miriam, L.-T., Ana Isabel, G.-G., Oscar, R.-C., & Alejandra, C.-A. (2023). Effectiveness of an online multicomponent physical exercise intervention on the physical performance of community-dwelling older adults: A randomized controlled trial. *Geriatric Nursing*, *54*, 83–93. https://doi.org/10.1016/j.gerinurse.2023.08.018

Farrokhi, A., Farahbakhsh, R., Rezazadeh, J., & Minerva, R. (2021). Application of Internet of Things and artificial intelligence for smart fitness: A survey. *Computer Networks*, *189*, 107859. https://doi.org/10.1016/j.comnet.2021.107859

Freshwater, M., Christensen, S., Oshman, L., & Bays, H. E. (2022). Behavior, motivational interviewing, eating disorders, and obesity management technologies: An Obesity Medicine Association (OMA) Clinical Practice Statement (CPS) 2022. *Obesity Pillars*, *2*, 100014. https://doi.org/10.1016/j.obpill.2022.100014

Gomes, E., Bastos, T., Probst, M., Ribeiro, J. C., Silva, G., & Corredeira, R. (2014). Effects of a group physical activity program on physical fitness and quality of life in individuals with schizophrenia. *Mental Health and Physical Activity*, *7*(3), 155–162. https://doi.org/10.1016/j.mhpa.2014.07.002

Han, H. (2023). Fuzzy clustering algorithm for university students' psychological fitness and performance detection. *Heliyon*, *9*(8), e18550. https://doi.org/10.1016/j.heliyon.2023.e18550

Hjorth, M. F., Sørensen, L. B., Andersen, R., Dyssegaard, C. B., Ritz, C., Tetens, I., Michaelsen, K. F., Astrup, A., Egelund, N., & Sjödin, A. (2016). Normal weight children have higher cognitive performance – Independent of physical activity, sleep, and diet. *Physiology & Behavior*, *165*, 398–404. https://doi.org/10.1016/j.physbeh.2016.08.021

Hosker, D. K., Elkins, R. M., & Potter, M. P. (2019). Promoting Mental Health and Wellness in Youth Through Physical Activity, Nutrition, and Sleep. *Child and Adolescent Psychiatric Clinics of North America*, *28*(2), 171–193. https://doi.org/10.1016/j.chc.2018.11.010

Jurić, P., Dudley, D. A., & Petocz, P. (2023). Does incorporating high intensity interval training in physical education classes improve fitness outcomes of students? A cluster randomized controlled trial. *Preventive Medicine Reports, 32,* 102127. https://doi.org/10.1016/j.pmedr.2023.102127

Ketcheson, L. R., & Pitchford, E. A. (2021). Promoting physical activity participation and nutrition education through a telehealth intervention for children on the autism spectrum and their caregivers. *Contemporary Clinical Trials*, *107*, 106496. https://doi.org/10.1016/j.cct.2021.106496

Laukkanen, A., Niemistö, D., Aunola, K., Barnett, L. M., & Sääkslahti, A. (2023). Child perceived motor competence as a moderator between physical activity parenting and child objectively measured physical activity. *Psychology of Sport and Exercise*, *67*, 102444. https://doi.org/10.1016/j.psychsport.2023.102444

McGowan, A. L., Chandler, M. C., & Pontifex, M. B. (2021). Aerobic fitness relates to superior exact and approximate arithmetic processing in college-aged adults. *Trends in Neuroscience and Education*, *23*, 100154. https://doi.org/10.1016/j.tine.2021.100154

Nugroho, W. (2022). Motivasi dan aktifitas olahraga pada masa new normal pandemi covid-19. *Jorpres (Jurnal Olahraga Prestasi)*, *18*(1), 44–51. https://doi.org/10.21831/jorpres.v18i1.55656

Oc, Y., & Plangger, K. (2022). GIST do it! How motivational mechanisms help wearable users develop healthy habits. *Computers in Human Behavior*, *128*, 107089. https://doi.org/10.1016/j.chb.2021.107089

op den Akker, H., Cabrita, M., op den Akker, R., Jones, V. M., & Hermens, H. J. (2015). Tailored motivational message generation: A model and practical framework for real-time physical activity coaching. *Journal of Biomedical Informatics*, *55*, 104–115. https://doi.org/10.1016/j.jbi.2015.03.005

Palmer, K., Robbins, L. B., Ling, J., Kao, T.-S. A., Voskuil, V. R., & Smith, A. L. (2020). Adolescent Autonomous Motivation for Physical Activity: A Concept Analysis. *Journal of Pediatric Nursing*, *54*, e36–e46. https://doi.org/10.1016/j.pedn.2020.04.020

Plotnikoff, R. C., Wilczynska, M., Cohen, K. E., Smith, J. J., & Lubans, D. R. (2017). Integrating smartphone technology, social support and the outdoor physical environment to improve fitness among adults at risk of, or diagnosed with, Type 2 Diabetes: Findings from the 'eCoFit' randomized controlled trial. *Preventive Medicine*, *105*, 404–411. https://doi.org/10.1016/j.ypmed.2017.08.027

Ryom, K., Simonsen, C. B., Rau, S. R., Maindal, H. T., & Agergaard, S. (2022). Newly arrived refugees' perception of health and physical activity in Denmark. *Journal of Migration and Health*, *6*, 100111. https://doi.org/10.1016/j.jmh.2022.100111

Sania, A., Arsil, A., Argantos, A., Rifki, M. S., & Zarya, F. (2022). Pengaruh metode pembelajaran dan motivasi belajar terhadap keterampilan dasar bolavoli mini di SDN 09 Lanai Sinuangon. *Jorpres (Jurnal Olahraga Prestasi)*, *18*(2), 30–43. https://doi.org/10.21831/jorpres.v18i2.57303

Scott, S. P., De Souza, M. J., Koehler, K., & Murray-Kolb, L. E. (2017). Combined Iron Deficiency and Low Aerobic Fitness Doubly Burden Academic Performance among Women Attending University1. *The Journal of Nutrition*, *147*(1), 104–109. https://doi.org/10.3945/jn.116.240192

Sherf-Dagan, S., Sinai, T., Goldenshluger, A., Globus, I., Kessler, Y., Schweiger, C., & Ben-Porat, T. (2021). Nutritional Assessment and Preparation for Adult Bariatric Surgery Candidates: Clinical Practice. *Advances in Nutrition*, *12*(3), 1020–1031. https://doi.org/10.1093/advances/nmaa121

ISSN 0216-4493 (print), ISSN 2597-6109 (online)

Smith, J. J., Beauchamp, M. R., Faulkner, G., Morgan, P. J., Kennedy, S. G., & Lubans, D. R. (2018). Intervention effects and mediators of well-being in a school-based physical activity program for adolescents: The 'Resistance Training for Teens' cluster RCT. *Mental Health and Physical Activity*, *15*, 88–94. https://doi.org/10.1016/j.mhpa.2018.08.002

Szeszulski, J., Vega-López, S., Todd, M., Ray, F., Behar, A., Campbell, M., Chavez, A., Eckert, R., Lorenzo-Quintero, A., Hartmann Manrique, L., & Crespo, N. C. (2020). Athletes for life: Rationale and methodology of a community- and family-based randomized controlled trial to promote cardiovascular fitness among primarily Latino families. *Contemporary Clinical Trials*, *91*, 105956. https://doi.org/10.1016/j.cct.2020.105956

Uebelacker, L. A., Epstein-Lubow, G., Sillice, M. A., O'Keeffe, B., Kraines, M., Battle, C. L., Anderson, B., Miller, I. W., & Abrantes, A. M. (2023). Project MOVE: A randomized controlled trial of interventions for initiating and maintaining physical activity in depressed individuals. *Mental Health and Physical Activity*, *24*, 100508. https://doi.org/10.1016/j.mhpa.2023.100508

Uebelacker, L. A., Sillice, M. A., Epstein-Lubow, G., Battle, C. L., Anderson, B., Caviness, C., Miller, I. W., & Abrantes, A. M. (2020). Combined intervention approaches for initiating and maintaining physical activity in depressed individuals: design and rationale of the Project MOVE randomized clinical trial. *Contemporary Clinical Trials*, *91*, 105974. https://doi.org/10.1016/j.cct.2020.105974

Vandelanotte, C., Trost, S., Hodgetts, D., Imam, T., Rashid, M., To, Q. G., & Maher, C. (2023). Increasing physical activity using an just-in-time adaptive digital assistant supported by machine learning: A novel approach for hyper-personalised mHealth interventions. *Journal of Biomedical Informatics*, *144*, 104435. https://doi.org/10.1016/j.jbi.2023.104435

Vella, S. A., Sutcliffe, J. T., Fernandez, D., Liddelow, C., Aidman, E., Teychenne, M., Smith, J. J., Swann, C., Rosenbaum, S., White, R. L., & Lubans, D. R. (2023). Context matters: A review of reviews examining the effects of contextual factors in physical activity interventions on mental health and wellbeing. *Mental Health and Physical Activity*, *25*, 100520. https://doi.org/10.1016/j.mhpa.2023.100520

Venkatachalam, P., & Ray, S. (2022). How do context-aware artificial intelligence algorithms used in fitness recommender systems? A literature review and research agenda. *International Journal of Information Management Data Insights*, *2*(2), 100139. https://doi.org/10.1016/j.jjimei.2022.100139

Wieland, M. L., Weis, J. A., Hanza, M. M. K., Meiers, S. J., Patten, C. A., Clark, M. M., Sloan, J. A., Novotny, P. J., Njeru, J. W., Abbenyi, A., Levine, J. A., Goodson, M., Porraz Capetillo, M. G. D., Osman, A., Hared, A., Nigon, J. A., & Sia, I. G. (2016). Healthy immigrant families: Participatory development and baseline characteristics of a community-based physical activity and nutrition intervention. *Contemporary Clinical Trials*, *47*, 22–31. https://doi.org/10.1016/j.cct.2015.12.004

Wilson, M., Ramsay, S., & Young, K. J. (2017). Engaging Overweight Adolescents in a Health and Fitness Program Using Wearable Activity Trackers. *Journal of Pediatric Health Care*, *31*(4), e25–e34. https://doi.org/10.1016/j.pedhc.2017.03.001

Wilson, O. W. A., Ikeda, E., Hinckson, E., Mandic, S., Richards, J., Duncan, S., Kira, G., Maddison, R., Meredith-Jones, K., Chisholm, L., Williams, L., & Smith, M. (2023). Results from Aotearoa New Zealand's 2022 Report Card on Physical Activity for Children and Youth: A call to address inequities in health-promoting activities. *Journal of Exercise Science & Fitness*, *21*(1), 58–66. https://doi.org/10.1016/j.jesf.2022.10.009

ISSN 0216-4493 (print), ISSN 2597-6109 (online)