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Correlation of knowledge of balanced nutrition and eating patterns with biology learning outcomes through students' physical activity

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Abstract

Insufficient nutritional knowledge, diets that do not meet nutritional adequacy levels, and excessive physical activity for the body affect the learning outcomes of some students. This study aims to investigate the relationship between knowledge about balanced nutrition and diet with biology learning outcomes through physical activity. This study is an ex post facto, which is correlational in knowing the relationship between knowledge of balanced nutrition and diet with biology learning outcomes through physical activity. The population in this study were all students of class XI of State Senior High School in Polewali Sub-district, Polewali Mandar Regency, 2023/2024 school year, which includes SMAN 1 Polewali, SMAN 2 Polewali, SMAN 3 Polewali and SMAN 4 Polewali. The sample in this study was taken as many as 210 using simple random sampling. The research instruments used in this study were a balanced nutrition knowledge test, a dietary pattern questionnaire in the form of a Food Frequency Questionnaire (FFQ) form, and a Global Physical Activity Questionnaire (GPAQ) physical activity questionnaire. The data obtained in this study were analyzed using descriptive statistical analysis and inferential path analysis with the help of the SPSS program. The results showed that knowledge of balanced nutrition with diet can affect biology learning outcomes, and diet with physical activity can affect biology learning outcomes. This research can impact the improvement of the health and wellbeing of learners by improving concentration and overall performance. It can assist in developing more effective educational strategies to promote health and academic achievement.

Abstrak. *Pengetahuan gizi yang kurang, pola makan yang tidak sesuai dengan tingkat kecukupan gizi, dan aktivitas fisik yang berlebihan untuk tubuh mempengaruhi hasil belajar beberapa peserta didik. Penelitian ini bertujuan untuk menyelidiki hubungan antara pengetahuan tentang gizi seimbang dan pola makan dengan hasil belajar biologi melalui aktivitas fisik. Penelitian ini adalah ex post facto yang bersifat korelasional dengan tujuan untuk mengetahui hubungan pengetahuan gizi seimbang dan pola makan dengan hasil belajar biologi melalui aktivitas fisik. Populasi dalam penelitian ini adalah seluruh peserta didik kelas XI SMA Negeri se-Kecamatan Polewali, Kabupaten Polewali Mandar, tahun ajaran 2023/2024 yang meliputi SMAN 1 Polewali, SMAN 2 Polewali, SMAN 3 Polewali dan SMAN 4 Polewali. Sampel dalam penelitian ini diambil sebanyak 210 dengan menggunakan teknik simple random sampling. Instrumen penelitian yang digunakan dalam penelitian ini berupa tes soal pengetahuan gizi seimbang, kuisioner pola makan berupa formulir Food Frequency Questionnaire (FFQ), dan kuisioner aktivitas fisik Global Physical Activity Questonnaire (GPAQ). Data yang diperoleh dalam penelitian ini dianalisis menggunakan analisis statistik deskriptif dan inferensial analisis jalur (path analysis) dengan bantuan program SPSS. Hasil penelitian menunjukkan bahwa pengetahuan gizi seimbang dengan pola makan dapat mempengaruhi hasil belajar Biologi dan pola makan dengan aktivitas fisik dapat mempengaruhi hasil belajar Biologi dalam pembelajaran. Penelitian ini dapat berdampak terhadap peningkatan kesehatan dan kesejahteraan peserta didik untuk meningkatkan konsentrasi serta kinerja secara keseluruhan. Ini dapat membantu dalam pengembangan strategi Pendidikan yang lebih efektif untuk mempromosikan kesehatan dan prestasi dalam bidang akademik.*

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A. Introduction

Education is an essential need for humans because it can help them achieve progress in various areas of life, significantly improving the quality of human resources (HR). The formation of the quality of HR begins during school and greatly influences the quality when they reach a productive age. Various nutritional problems are generally vulnerable to occurring at school age, especially during adolescence (Hakim & Darojat, 2023).

The Population and Family Planning Agency (BKKBN) for teenagers is generally in the age range of 10-18 years. Individuals transitioning from childhood to adulthood are marked by changes in emotional, sexual, and financial maturity (World Health Organization). As the nation's next generation, teenagers must have a good quality of life. Many factors must be considered to improve the quality of life today, including knowledge of nutrition and health, education, information, and technology. Nutritional knowledge is an essential factor to pay attention to in order to maintain health (Wigati & Nisak, 2022).

Knowledge of balanced nutrition provides teenagers with how to choose healthy foods and understand that eating is closely related to nutrition and health (Fitriani et al., 2020). Good knowledge, if not supported, good attitudes and behavior cannot change nutritional behavior (Condo et al., 2019). Teenagers' lack of nutrition knowledge causes them to have difficulty maintaining a balance in the food they consume, which can lead to problems with undernutrition or overnutrition. Overnutrition can occur due to an imbalance between energy intake and expenditure. Teenagers need high levels of nutrition to support their growth and development processes, which are greatly influenced by teenagers' knowledge and good eating patterns.

A dietary pattern is a reference that provides information about the type and amount of food eaten daily by one person and is a characteristic (habit) of eating for a particular group. A good diet can be seen in the quantity and quality of the food consumed. This can happen because the level of individual and community health can be influenced by the quantity and quality of food and drink consumed (Tampatty et al., 2020). If the food intake consumed exceeds the nutritional requirements and there is less physical activity, it will cause fat accumulation in the body.

Physical activity is any planned, structured, and repetitive movement produced by skeletal muscles and requires energy expenditure to maintain or improve components of physical fitness. Physical activity can also overcome stress and increase a person's emotional intelligence, showing how vital physical activity is in human life (Zhang et al., 2020). Activities carried out by students when they come to school include the learning process in class, carrying out activities using school facilities and infrastructure by paying attention to health protocols in the school environment, and sports activities (Tomasoa et al., 2021). Balanced physical activity will influence students' physical condition in participating in learning at school and can influence their learning outcomes.

Learning outcomes are some experiences gained and describe the overall learning achievements of students, and these occur because of changes in behavior. Various internal and external factors influence the achievement of student learning outcomes. One of the internal factors is physical factors (physical health) (Amenya et al., 2021). Learning outcomes can show individual success in learning, which can be measured by taking learning tests. Children's intelligence can be influenced by nutritional intake. The intake of nutrients needed by the body is fulfilled to increase students' concentration in the learning process and influence their learning achievement (Silaban et al., 2017).

Several research results reveal that students' knowledge of balanced nutrition, eating patterns, and physical activity is still in the low category, as revealed by Yuniarsih (2021) that students' knowledge of balanced nutrition is still in the low category. Utami (2020) stated that students' eating patterns still have bad eating patterns. This is because the type, frequency, and quantity of students' food are insufficient, or they are not following the recommendations for balanced nutrition guidelines. Research by Sulistia et al. (2019) shows that the low physical activity category gets the highest percentage. The existence of low physical activity in adolescents is caused by a decrease in organizing to exercise and a lack of enthusiasm for exercise. Research related to knowledge of balanced nutrition, eating patterns, physical activity, and biology learning outcomes has been carried out. However, previous research discussing the relationship between knowledge of balanced nutrition and eating patterns and biology learning outcomes through physical activity is still limited.

Based on the results of field observations, some students have insufficient nutritional knowledge, so they have eating patterns that do not follow the level of nutritional adequacy and do excessive physical activity for their bodies, ultimately affecting their learning outcomes. Based on the explanation above, it is necessary to investigate the relationship between knowledge of balanced nutrition and eating patterns with biology learning outcomes through physical activity.

B. Material and method

This research uses a quantitative approach. The research was conducted at state high schools in Polewali District, Polewali Mandar Regency. The

population in this study were class XI students in public high schools in Polewali District, Polewali Mandar Regency.

Data, instruments, and data collection techniques
The instruments in this research were a balanced nutrition knowledge test consisting of 20 multiple choice questions and five essay questions, a dietary pattern questionnaire in the form of a Food Frequency Questionnaire (FFQ), a physical activity questionnaire, the Global Physical Activity Questionnaire (GPAQ), and biology learning outcomes obtained from grades from the subject teacher. All instruments were analyzed first using the normality test and path analysis using the multiple regression test.

Data analysis technique
The analysis used in this research is path analysis. Data analysis used IBM SPSS 22 software. The path analysis used was a multiple regression test based on significance values.

The path analysis technique tests the magnitude of the contribution shown by the path coefficient on each path diagram of the causal relationship between variables X1 and from an independent variable to the dependent variable in a particular path model. The beta coefficient is also called beta weight (β). This value is used as the value in the path coefficient (ρ) or the total contribution of each exogenous variable to the endogenous variable individually or as a partial relationship.

C. Results and discussion

The normality test is used to determine whether the research data is normal. Kolmogorov-Smirnov significance level is 5%. The data distribution is normal if the analysis obtains a p-value > 0.05, while a sig < 0.05 indicates that the research data distribution is not normally distributed. For a more detailed explanation of the normality test for all variables can be seen in Table 1.

Based on the data analysis in Table 1, the significance value (P) for the four variables is on the normal threshold, so it can be concluded that the data from the analysis of variables in balanced nutritional knowledge, eating patterns, physical activity, and biology of learning outcomes are normally distributed. The results of data analysis on the relationship between knowledge of balanced nutrition and eating patterns with biology learning outcomes through physical activity of class XI can be seen in Table 2.

The calculation results from Table 2 show that the path coefficient in substructure-1 is the path coefficient X1 to Y (ρyx1) = 0.825, and the path coefficient X2 to Y (ρyx2) = 0.107. Ho is rejected for each Sig value <0.05, meaning it is significant. This shows that knowledge of balanced nutrition (X1) changes physical activity to 0.825 or 82.5%. Meanwhile, the dietary pattern variable (X2) provides a change in physical activity of 0.107 or 10.7%.

Table 1 Normality test

Test statistics	Sig. (2-tailed)	Description
Unstandardized residual	0,050	Normally distributed

Table 2 Regression analysis of the relationship between knowledge of balanced nutrition, eating patterns and physical activity

Coefficients[a]				
		Standardized coefficients		
Model		Beta	t	Sig.
1	(Constant)		-14.269	.000
	Nutrition knowledge	.825	11.814	.000
	Eating patterns	.107	1.534	.026

Table 3 Regression determination coefficient value I

Model summary				
Model	R	R square	Adjusted R square	Std. error of the estimate
1	.925a	.855	.853	539.36247

Table 4 Regression analysis of the relationship between knowledge of balanced nutrition, eating patterns and physical activity with biology learning outcomes

Coefficients[a]				
		Standardized coefficients		
Model		Beta	T	Sig.
1	(Constant)		-4.281	.000
	Nutrition knowledge	.345	6.298	.000
	Eating patterns	.619	14.561	.000
	Physical activity	.029	.679	.034

Table 5 Regression determination coefficient value II

Model summary				
Model	R	R square	Adjusted R square	Std. error of the estimate
1	.973a	.947	.946	4.65176

Several studies regarding the relationship between knowledge of balanced nutrition and physical activity also show similar results. The research results of Muftuoglu & Bayram (2020); Rumondor et al. (2019) show a significant relationship between nutritional knowledge and physical activity in adolescents. The research results of Chen et al. (2017), that nutritional knowledge can

significantly predict sedentary behavior, especially in groups with low knowledge. This emphasizes the importance of physical nutrition education to encourage more physical activity and reduce sedentary behavior. Apart from that, other factors influence the physical activity of children and adolescents, such as the level of parental education which has an inverse relationship with the level of physical activity of children (Kelishadi et al., 2010).

The results of research by Babio et al. (2009); Fernandes et al. (2023) show that adults who adopt a healthier diet tend to have more regular physical activity levels. Adequate and appropriate nutritional intake is needed to provide the energy needed for physical activity. Regular physical activity can improve focus and mental strength, improving school performance. Students may learn and achieve better with sufficient energy levels and mental focus (Li et al., 2020).

The coefficient of determination values are presented in Table 3. The R Square value states the contribution of the independent variable (knowledge of balanced nutrition and eating patterns) to the dependent variable (physical activity), namely 0.855 or 85.5%. At the same time, the remainder is the contribution of other variables not examined in this research. The value of ε1 can be found using the formula $\varepsilon 1 = \sqrt{(1 - R2)}$, ε1 = 0.518. Thus, the substructural path equation I can be stated as follows.

$$\mathbf{Y = 0.825x1 + 0.107x2 + 0.518}$$

The equation means (1) X_1 can explain y of 82.5% or each change of one unit X_1 can result in changes in y by 82.5% and (2) X_2 can explain y will decrease by 10.7% or each change one Unit X_2 can result in changes in Y by 10.7%.

Analysis of the relationship between knowledge of balanced nutrition, eating patterns and physical activity with biology learning outcomes is presented in Table 4. The calculation results show that the path coefficient in substructure-2 is the path coefficient X1 to Z (ρzx1) = 0.345, the path coefficient for each Sig value <0.05, Ho is rejected, meaning it is significant. This shows that knowledge of balanced nutrition (X1) changes biology learning outcomes by 0.345 or 34.5%. The dietary pattern variable (X2) changes biology learning outcomes of 0.619 or 61.9%. Physical activity changes biology learning outcomes of 0.034 or 3.4%.

Several studies regarding the relationship between knowledge of balanced nutrition and learning outcomes also show similar results. The research results of Ruhmanto & Ramadhan (2022); Kupolati et al. (2019) show a significant and meaningful relationship between knowledge of balanced nutrition and learning achievement. Knowledge about balanced nutrition can closely relate to students' biology learning outcomes. Several factors cause nutritional knowledge to influence learning, namely (1) cognition and academic performance: good nutrition is essential for optimal brain function. (2) health and attendance: good health maintained through balanced nutrition directly affects student attendance at school. Consistent attendance enables continuity of learning and improved learning outcomes. Moreover, (3) self-efficacy: students with good nutritional knowledge may have confidence in pursuing and achieving academic goals, including biology (Jakstas et al., 2023).

The research findings of Harpina & Andres (2022); Faizi & Kazmi (2017) show a significant and meaningful relationship between diet and children's learning achievement at school. While a healthy diet provides essential nutrients that affect cognitive function, a lack of essential nutrients can reduce cognitive abilities and concentration, ultimately affecting understanding and retention of course material. Apart from that, nutrition also functions to provide energy for learning. Energy is the key to a student's ability to focus attention and participate actively during learning sessions (Hou et al., 2020).

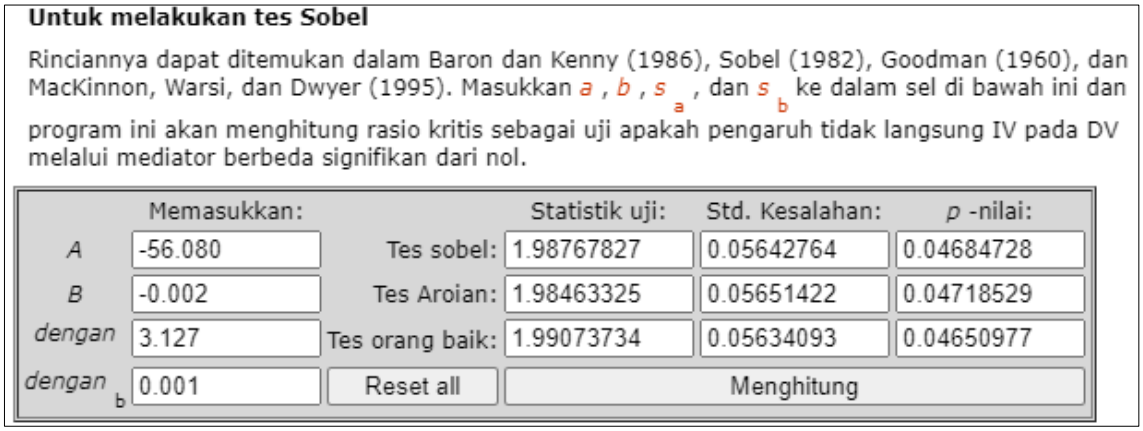
The results obtained above follow research by Adhianto & Arief (2023); Riyanto (2020), which states a relationship between physical activity and academic achievement. Several aspects of physical activity can influence academic achievement, namely (1) Providing oxygen and nutrients to the brain: physical activity increases blood flow which supplies more oxygen and nutrients to the brain. 2) Stress management: physical activity is an effective way to manage stress. With better stress management, students can have a sharper focus when studying biology material, (3) Fitness and academics: students who are fit and frequently engage in physical activity tend to have better academic performance (Phansikar et al., 2019).

The coefficient of determination for regression II is presented in Table 5. The R Square value states the contribution of the variable's knowledge of balanced nutrition, eating patterns and physical activity to biology learning outcomes, namely 0.947 or 94.7%. At the same time, the remainder is the contribution of other variables not examined in this research. The value of ε2 can be found using the formula $\varepsilon 2 = \sqrt{(1 - R2)}$, ε2 = 0.322. Thus, the substructural path equation II can be stated as follows.

$$\mathbf{Z = 0.345x1 + 0.609x2 + 0.029y + 0.322}$$

The equation means (1) X_1 can explain Z of 34.5% or each change of one-unit X_1 can result in changes in Z of 34.5%, (2) X_2 can explain z of 60.9% or each change of one-unit X_2 can result in changes in Z of 60.9%, and (3) Y can explain Z of 2.9%or each change of one-unit X_1 can result in changes in Z of 2.9%. Figure 1 is the Sobel test results.

Based on the results of analysis and calculations using the Sobel test in Figure 1, a p-value of 0.004 < 0.05 was obtained. This means that knowledge of balanced nutrition is indirectly related to biology learning outcomes through physical activity or knowledge of balanced nutrition through physical activity is related to biology learning outcomes. This means that the higher the knowledge of balanced nutrition, the higher the results of learning biology through physical activity.

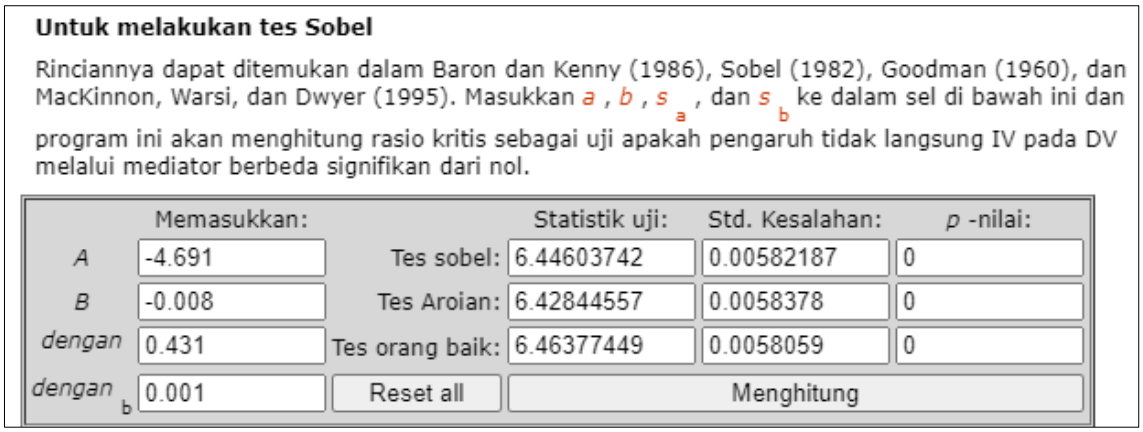


Untuk melakukan tes Sobel

Rinciannya dapat ditemukan dalam Baron dan Kenny (1986), Sobel (1982), Goodman (1960), dan MacKinnon, Warsi, dan Dwyer (1995). Masukkan *a* , *b* , s_a , dan s_b ke dalam sel di bawah ini dan program ini akan menghitung rasio kritis sebagai uji apakah pengaruh tidak langsung IV pada DV melalui mediator berbeda signifikan dari nol.

	Memasukkan:		Statistik uji:	Std. Kesalahan:	*p* -nilai:
A	-56.080	Tes sobel:	1.98767827	0.05642764	0.04684728
B	-0.002	Tes Aroian:	1.98463325	0.05651422	0.04718529
dengan	3.127	Tes orang baik:	1.99073734	0.05634093	0.04650977
dengan $_b$	0.001	Reset all	Menghitung		

Figure 1
Sobel test results of indirectly related between knowledge of balanced nutrition with learning biology through physical activity (in Indonesian)



Untuk melakukan tes Sobel

Rinciannya dapat ditemukan dalam Baron dan Kenny (1986), Sobel (1982), Goodman (1960), dan MacKinnon, Warsi, dan Dwyer (1995). Masukkan *a* , *b* , s_a , dan s_b ke dalam sel di bawah ini dan program ini akan menghitung rasio kritis sebagai uji apakah pengaruh tidak langsung IV pada DV melalui mediator berbeda signifikan dari nol.

	Memasukkan:		Statistik uji:	Std. Kesalahan:	*p* -nilai:
A	-4.691	Tes sobel:	6.44603742	0.00582187	0
B	-0.008	Tes Aroian:	6.42844557	0.0058378	0
dengan	0.431	Tes orang baik:	6.46377449	0.0058059	0
dengan $_b$	0.001	Reset all	Menghitung		

Figure 2
Sobel test results of indirectly related between eating patterns with learning biology through physical activity (in Indonesian)

The research results of Egg et al. (2020); Tandon et al. (2016) show that the relationship between knowledge of balanced nutrition and learning outcomes through physical activity is significant. Knowledge of good balanced nutrition can lead to healthier food choices, which can affect concentration and learning stamina. In biology, students who understand balanced nutrition have better concentration when studying complex subject matter or doing practicums that require precision (Said et al., 2020). Meanwhile, physical activity has been linked to improved cognitive function and school achievement. Physically active students show higher conceptual understanding in biology subjects (Liu, 2016).

The path diagram shows the indirect relationship between diet and biology learning outcomes. In this case, the physical activity variable bridges the relationship between the diet variable and biology learning outcomes. Students with high eating patterns have high biology learning outcomes because they have good physical activity. Figure 2 is the Sobel test results.

Based on the results of analysis and calculations using the Sobel test in Figure 2, a p-value of 0.000 < 0.05 was obtained. This means that eating patterns are indirectly related to biology learning outcomes through physical activity or eating patterns through physical activity are related to biology learning outcomes. This means that the higher the diet, the higher the results of learning biology through physical activity. Donnelly et al.'s (2011) research results show that a healthy and balanced diet and regular physical activity can increase blood and

oxygen flow to the brain, providing the nutritional intake needed to support cognitive function and learning concentration. Irianto et al. (2021) show that a healthy diet and sufficient physical activity significantly improve academic performance. A healthy diet, including fruit, vegetables, whole grains and high-quality protein consumption, has positively impacted cognitive function and learning ability. Regular physical activity is also associated with increased focus and concentration in learning.

Students who have a balanced diet and regularly engage in physical activity will experience benefits such as better concentration and attention when learning biology concepts which often require critical thinking and deep understanding. Higher energy, a better ability to carry out active learning activities, and improved long-term memory can help students remember complex and complicated biological information (Kavi & Walvekar, 2022).

Based on the results of the research above, we can see some of the impacts that will be caused in the future, namely: (1) contribute to health and education, (2) policy implications, with this study can affect public education and health policies in including nutritional programs and physical activities More integrated at school, (3) Curriculum development, findings from this study can support more holistic curriculum development that includes health and nutrition aspects to improve students' understanding. Thus, this research not only contributes to scientific understanding of health and education, but also has the potential to bring positive changes in educational practices and public health policies.

D. Conclusion

Based on the research, it can be concluded that there is a relationship between knowledge of balanced nutrition and eating patterns and Biology learning outcomes through physical activity. The results show that knowledge of balanced nutrition with physical activity can influence biology learning outcomes, and eating patterns with physical activity can influence biology learning outcomes.

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