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Investigating the Effects of Nutrition, Concentration, and Motor Development on Physical Education Outcomes in Elementary School Students

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Abstract

This study examines the low learning outcomes of students at SD Negeri 004 Tanjungpinang Barat, which are allegedly influenced by nutritional status, concentration, and self-control skills. This quantitative study uses a correlational design with an ex-post-facto method. The research sample was 100 students selected through purposive sampling technique. Nutritional status data were obtained from height and weight measurements, concentration was measured by the grid concentration test, self-control skills by the TGMD-2 subtest, and learning outcomes were obtained from school data. The data were analyzed using path analysis. The results showed that there was a direct relationship between nutritional status, concentration, and self-control skills on student learning outcomes. The contribution of nutritional status to learning outcomes was 16.66%, concentration was 21.48%, and self-control skills were 19.75%. In addition, there is an indirect relationship between nutritional status and concentration on learning outcomes through self-control skills. Overall, nutritional status, concentration, and self-control skills contribute significantly to student learning outcomes by 35.04%..

INTRODUCTION

The current industrial revolution has permeated all aspects and sectors of human life, with education being no exception. Consequently, the quality and output of a nation's education system will significantly determine its future. Education is expected to produce future generations of the nation who possess strong character, critical thinking skills, resilience, physical and mental well-being, and devotion to God Almighty. This is in line with Article 3 of Law Number 20 of 2003 concerning the National Education System, which states:

“National education serves to cultivate the capabilities and shape the character and civilization of the nation, fostering a dignified society in the pursuit of intellectual enlightenment. This endeavor aims to nurture the potential of students, molding them into individuals who are not only devout and God-fearing but also possess noble character, robust health, intellectual prowess, competence, creativity, and independence. Furthermore, it aspires to cultivate responsible and democratic citizens”.

To achieve the goals of national education, individuals must engage in a learning process encompassing diverse subjects within formal educational institutions, spanning from elementary school through secondary education. Physical Education (PE) constitutes an integral component of this holistic educational endeavor at the primary school level. Similar to other subjects within the formal education curriculum, PE as a scientific entity possesses competency standards and learning objectives that must be achieved by students. Therefore, to be considered complete in undertaking the PJOK subject, a student must obtain optimal learning outcomes. This achievement is not only limited to mastering theories and concepts related to physical activity and health, but also to demonstrating relevant psychomotor abilities, as well as internalizing noble values contained in sports activities, such as cooperation, sportsmanship, and fair play. Comprehensive PE learning outcomes will become an important foundation for the development of healthy, fit, and characterful individuals who possess adequate movement literacy throughout their lives.

Learning outcomes serve as a benchmark for student success in comprehending the material presented by teachers over a specific period. Susanto, as cited in Sari (2017), posits that: “Learning outcomes are the changes that occur within students, encompassing affective, cognitive, and psychomotor domains, as a result of learning activities.” Learning outcomes constitute evidence of an individual's learning process, observable through behavioral changes, transitioning from unfamiliarity to familiarity and from incomprehension to comprehension (Hamalik, as cited in Utomo et al., 2018).

Learning outcomes in Physical Education among elementary school students are influenced by a variety of complex factors. From a sports perspective, three primary factors can be identified as playing crucial roles. Firstly, students' nutritional status forms a fundamental basis for optimizing physical and cognitive performance. Adequate and balanced nutrition provides the necessary energy and nutrients for motor development. Secondly, students' learning concentration affects their ability to receive, understand, and apply PJOK learning materials. Good concentration enables students to focus on teacher instructions, comprehend correct movement techniques, and enhance basic movement skills

Third, well-developed fundamental movement skills are an essential foundation for the development of more complex motor abilities in Physical Education (Komaini, 2017). Gusril, as cited in Indra and Gusril (2019), argues that "movement should not only be viewed from changes in location, position, and speed of the body performing motor actions, but also as a tangible result of motor processes." Fundamental movement skills are categorized into two types: object control skills and locomotor skills. Object control skills involve manipulating and moving objects from one place to another, such as kicking, striking, and throwing. Meanwhile, locomotor skills are the skills possessed by a person to move from one place to another (Goodway et al., 2019). From the perspective of sports experts, fundamental movement skills such as running, jumping, throwing, and catching a ball are not merely physical activities, but also an important basis for the cognitive,

social, and emotional development of students. A good combination of optimal nutritional status, high learning concentration, and well-developed fundamental movement skills will make a significant contribution to the learning outcomes of elementary school students in PE.

SDN 004 Tanjungpinang Barat is one of the elementary schools in Tanjungpinang with a total of 504 students. However, despite being equipped with adequate facilities, students at this school have not been able to achieve satisfactory learning outcomes. In order for student scores to reach the Minimum Completeness Criteria (KKM) set by the school, it is not uncommon for physical education teachers to hold remedial sessions. After conducting observations and interviews with the physical education teacher at this school in March 2023, out of 504 students, only about 44.37% of students successfully achieved the KKM without participating in the remedial process. There are various factors that influence the low physical education learning outcomes at this school, including factors that come from within the students themselves (internal factors) and some that come from outside the students (external factors). Based on observations and interviews that researchers have conducted at this school, the researchers are interested in conducting further research to determine what variables affect student learning outcomes at State Elementary School 004 Tanjungpinang Barat. Based on field observations, the researcher is interested in conducting a study entitled Investigating the Investigating the Effects of Nutrition, Concentration, and Motor Development on Physical Education Outcomes in Elementary School Students.

METHODS

This research is an ex post facto study conducted to investigate the causes of past events by comparing previously determined conditions. The analytical method used is path analysis, which aims to analyze the pattern of relationships between variables in order to determine the direct and indirect effects of a set of 1 independent (exogenous) variables on the dependent (endogenous) variable. The independent variables are nutritional status (X1), concentration (X2), and object control skills (X3), while the dependent variable is learning outcomes (Y), studied at SD Negeri 004 Tanjungpinangbarat. The sampling method used in this study is purposive sampling, which involves selecting research samples based on specific criteria. The sample comprised 100 students from SD Negeri 004 Tanjungpinangbarat, ranging in age from 8 to 11 years and enrolled in grades 2nd through 5th.

Several instruments were used in this study, namely: BMI to measure students' nutritional status, a grid concentration test to measure students' concentration in learning, the TGMD-2 subtest to measure students' fundamental motor skills, and learning achievement assessments from physical education teachers. The data were processed using SPSS 26 with descriptive statistics (mean, standard deviation, highest and lowest scores), followed by classical assumption tests and hypothesis testing using path analysis techniques.

RESULT AND DISCUSSION

Nutritional status directly and significantly influences learning outcomes

The individual test conducted by X1 on Y revealed a path coefficient result of $\rho_{X3X1} = 0.215$. Based on calculations using SPSS 26, a significance value of 0.019 was obtained, which is smaller than the α value of 0.05. Therefore, the alternative hypothesis (H_a) is accepted, and the null hypothesis (H_0) is rejected, indicating a significant path analysis coefficient. The influence of

nutritional status on learning outcomes is 16.66%. Thus, it can be concluded that the relationship between nutritional status and learning outcomes is 16.66%, while the remaining 83.34% is influenced by other factors. Furthermore, the product moment correlation analysis showed a calculated r value of 0.408, which is greater than the table r value of 0.196. This result supports the acceptance of H_a and the rejection of H_0 , confirming a relationship between nutritional status and student learning outcomes. To determine the significance of the correlation between X_1 and Y , a significance test was conducted, yielding a calculated t value of 2.38, which is greater than the table t value of 1.98. This finding demonstrates that the correlation between X_1 and Y is significant.

Concentration has a direct and significant impact on learning outcomes

The individual assessment conducted by X_2 on Y revealed a path coefficient result of $\rho_{X_2Y} = 0.305$. Based on calculations using SPSS 26, a significance value of 0.001 was obtained, which is smaller than the α value of 0.05. Therefore, H_a is accepted and H_0 is rejected, indicating a significant path analysis coefficient. The magnitude of the relationship between concentration and learning outcomes is 21.48%. Thus, it can be concluded that the relationship between concentration and learning outcomes is 21.48%, while the remaining 78.52% is influenced by other factors. Furthermore, the researcher calculated the product moment correlation coefficient, which showed that the calculated r value (0.463) is greater than the table r value (0.196). This means that H_a is accepted and H_0 is rejected, confirming the existence of a relationship between concentration and student learning outcomes. To determine the significance of the correlation between X_2 and Y , a significance test was conducted, yielding a calculated t value of 3.4, which is greater than the table t value of 1.98. This demonstrates that the correlation between X_2 and Y is significant.

Object control skills have a direct and significant impact on learning outcomes

In the single test conducted by X_3 on Y , it was found that the path coefficient result $\rho_{X_3Y} = 0.273$. Based on the calculation results using the SPSS 26 program, a sig value of 0.003 was obtained, which is smaller than the α value of 0.05. In this case, H_a is accepted and H_0 is rejected, which means the path analysis coefficient is significant. The magnitude of the relationship between control object skills and learning outcomes is 19.75%. Therefore, based on the above, it can be concluded that the relationship between control object skills and learning outcomes is 19.75%, while the remaining 20.25% is influenced by other factors. Furthermore, the researcher also calculated the product moment correlation value, which showed that the calculated r value of 0.444 > r table 0.196. This means that H_a is accepted and H_0 is rejected, indicating that there is indeed a relationship between control object skills and student learning outcomes. To determine the significance of the correlation between X_3 and Y , a significance test was conducted, which yielded a calculated t value of 3.05 > t table 1.98, proving that the correlation between X_3 and Y is significant.

The concurrent influence of nutritional status, concentration, and object control skills on students' learning outcomes

Based on the R-squared calculation table, an R-squared value of 0.592 was obtained, while the Anova table showed an F value of 17.26 with a significance value of 0.000. Since the significance value was less than $\alpha = 0.05$, the null hypothesis (H_0) was rejected and the alternative hypothesis (H_a) was accepted. From the explanation above, it can be concluded that nutritional status (X_1), concentration (X_2), and control object skills (X_3) simultaneously influence students' learning outcomes (Y). The equation for each variable uses the formula:

$$Y = \rho_{X1} X1 + \rho_{X2} X2 + \rho_{Y} Y + \rho_{\epsilon 1}$$

$$\rho_{\epsilon 1} = 1 - R^2_{YX12} = 1 - 0.592 = 0.408$$

The preceding discussion suggests a causal relationship between X1, X2, and X3, and Y

$$Y = 0.215 + 0.305 + 0.273 + 0.408$$

The R-squared value of 0.592 indicates that nutritional status (X1), concentration (X2), and object control skills (X3) are simultaneously related to students' learning outcomes (Y):

$$KD = r^2 \times 100\%$$

$$= 0.592 \times 100\%$$

$$= 59.2\%$$

Based on the explanation above, it can be concluded that the simultaneous relationship between nutritional status (X1), concentration (X2), and object control skills (X3) on student learning outcomes (Y) is 59.2%. The remaining 40.8% is influenced by other factors.

Discussion

Optimal nutritional status in elementary school children is a highly significant determinant of physical growth and cognitive development (Prangtip et al., 2021; Wrottesley et al., 2023). Beyond body mass index, a healthy nutritional status represents a holistic state of well-being, where all organ systems function optimally. Nutrition experts emphasize the importance of a balanced nutritional intake encompassing macronutrients such as complex carbohydrates, proteins, and fats, as well as micronutrients like vitamins and minerals (Ofoedu et al., 2021). This nutritional combination not only provides the necessary energy for physical and mental activities but also serves as a crucial substrate in growth processes, tissue repair, and metabolic regulation.

Educational psychologists further assert that optimal nutritional status not only impacts students' physical well-being but also their cognitive and emotional development (Wang & Degol, 2016). Adequate nutrition has been shown to enhance students' concentration, memory, and learning capacity, thereby facilitating their comprehension of instructions, recall of movements, and development of effective strategies for mastering object control skills. Moreover, a positive nutritional status contributes to improved mood and learning motivation, fostering students' enthusiasm to engage in physical activities and achieve optimal performance (Filgona et al., 2020).

Optimal nutritional status has significant implications for cognitive development and academic achievement (Bassuoni et al., 2021; Donnelly et al., 2016). Complex carbohydrates, as the primary energy source, support neuronal activity, while protein plays a role in the synthesis of neurotransmitters and nerve growth factors (Falkowska et al., 2015; Welis, 2019). Vitamins and minerals, such as iron, iodine, and folic acid, have essential roles in various cognitive processes, including learning, memory, and concentration (Das & Das, 2024). Protein, as the main component of brain cells, is involved in the formation of neurotransmitters that regulate communication between nerve cells.

Conversely, nutritional deficiencies can lead to impaired growth, anemia, and diminished cognitive function, thereby negatively impacting academic performance and children's quality of life (Swaminathan et al., 2013; Kiani et al., 2022). Therefore, efforts to achieve optimal nutritional status in elementary school children represent a long-term investment in the health and well-being of future generations.

From an educational standpoint, well-nourished children tend to exhibit greater focus, enhanced learning endurance, and more active engagement in educational activities (Ungar et al., 2014). Furthermore, adequate nutritional status supports the development of children's motor skills,

better preparing them for physical activities such as sports, which can improve coordination, balance, and flexibility (Rivilis et al., 2011; Andrieieva et al., 2021). These physical capabilities are not only crucial for health but also contribute to cognitive abilities such as problem-solving and creativity.

Educational psychologists posit that concentration is an indispensable cognitive foundation in the learning process (Rahmawati et al., 2022; Wei & Wang, 2022) and contributes to academic achievement (Parthasarathy, 2011). The ability to optimally focus attention on a stimulus or task enables students to process information more efficiently and effectively (Wulf & Lewthwaite, 2016; Koedinger et al., 2016). Nutrients such as protein, complex carbohydrates, and omega-3 fatty acids serve as brain fuel that supports cognitive functions, including concentration and memory (Muth & Park, 2021). Nutrition and sports experts highlight that a balanced nutritional intake and adequate physical activity play a significant role in enhancing concentration.

Educational psychologists have long investigated the factors influencing students' concentration abilities, one of which is their physical and mental condition (Lindsay, 2007; Subotnik et al., 2011). In line with the views of nutrition and sports experts, optimal physical condition, supported by balanced nutritional intake and sufficient physical activity, is a major determinant of concentration ability (Shao et al., 2017; Kushi et al., 2012).

Another crucial variable in academic achievement among elementary school students is the mastery of object control skills. This ability to manipulate and control objects forms a fundamental basis for motor development in elementary school children (Bakhtiar et al., 2017; Famelia, 2018; Goodway et al., 2015). Educational psychologists posit that this skill extends beyond mere physical competence, holding significant implications for children's cognitive and socio-emotional growth (Craven et al., 2008; Schonert-Reichl et al., 2015). As children engage in object control, they simultaneously cultivate spatial awareness, hand-eye coordination, and problem-solving abilities (MacDonald et al., 2016; Sadha et al., 2024; Chan et al., 2019). This process aligns with Piaget's theory of cognitive development, which emphasizes the importance of active interaction with the physical environment in constructing an understanding of the world.

Consistent with the views of educational psychologists, physical education experts also emphasize the importance of object control skills in the context of physical education learning (Putri et al., 2024). Object control skills are a crucial component in the motor development of elementary school children (Syahpputra et al., 2021; Bakhtiar et al., 2020). From the perspective of physical education experts, object control skills constitute a fundamental foundation in the development of students' motor abilities (Newell et al., 2020; Eather et al., 2018). The ability to control objects accurately and efficiently will enable students to actively participate in various physical activities, as well as enhance their self-confidence (Bessa et al., 2021). Research has demonstrated a positive correlation between object control skills and learning outcomes in physical education (Haningsih et al., 2023). Students who possess well-developed object control skills tend to be more active, more engaged in learning, and exhibit higher motivation to continue engaging in sports. The self-assurance that stems from mastering these skills can also have a positive impact on other facets of their lives, such as social relationships and emotional well-being.

Concentration serves as a crucial link between object control skills and physical education learning outcomes (Fenanlampir et al., 2021). In other words, a high level of concentration facilitates the development of optimal object control skills. When students are able to fully

concentrate on the movement being performed, they will find it easier to master the correct technique, thereby improving their performance in various motor tasks. Furthermore, a high degree of concentration can also assist students in overcoming challenges and errors that may occur during the learning process.

The relationship between nutritional status, concentration, and object control skills in Physical Education (PE) learning outcomes is a complex and multifaceted interaction. From a nutritionist's perspective, adequate nutrition serves as the foundation for optimal physical activity. Sufficient nutrition provides the necessary energy for activities, as well as building and repairing body tissues damaged by physical exertion (Rock et al., 2012). Furthermore, nutrition also influences cognitive functions, including concentration and memory, which are crucial in the learning process. Nutrients such as protein, complex carbohydrates, and healthy fats play a vital role in maintaining cognitive function (Muth & Park, 2021; Wahl et al., 2016).

On the other hand, regular physical activity is not only beneficial for physical health but can also improve blood circulation to the brain, thereby triggering the production of endorphins that can improve mood and reduce stress (Hossain et al., 2024). Thus, the combination of a healthy diet and sufficient exercise can significantly enhance students' concentration abilities and ultimately have a positive impact on their academic achievement.

CONCLUSIONS

Based on the research conducted, it was found that nutritional status, concentration, and object control skills have a significant relationship with students' learning outcomes. Nutritional status makes a direct contribution of 16.66% to learning outcomes, which means that the better the nutritional status of students, the better their learning outcomes. Concentration also has a direct influence on learning outcomes with a contribution of 21.48%, indicating that students with good concentration tend to achieve better learning outcomes. In addition, object control skills also make a direct contribution to learning outcomes of 19.75%, which means that the better the object control skills of students, the better their learning outcomes. Not only that, nutritional status and concentration also have an indirect relationship to learning outcomes through object control skills, respectively by 8.22% and 9.6%. Overall, nutritional status, concentration, and object control skills together make a significant contribution of 35.04% to students' learning outcomes..

Based on the research findings, several interventions can be recommended to improve student learning outcomes. Firstly, nutrition improvement programs need to be intensified, considering that nutritional status makes a significant contribution to learning outcomes, both directly and indirectly through object control skills. This intervention can take the form of providing a balanced nutritious diet, nutrition education, and periodic monitoring of nutritional status. Secondly, concentration training needs to be integrated into the learning process. Exercises that improve focus and memory can help students achieve better learning outcomes. Thirdly, the development of object control skills is also important. These skills can be improved through activities that involve coordination between mind and action, such as art, sports, or games that demand accuracy and speed. These programs need to be designed comprehensively and sustainably, involving the active participation of students, teachers, parents, and other relevant parties.

CONFLICTS OF INTEREST STATEMENT

Regarding this study, the author declares that there is no conflict of interest.

AUTHOR CONTRIBUTIONS

Study concept and design: Khairul Afriadi. Acquisition of data: Wilda Welis. Analysis and interpretation of data: Eri Barlian. Drafting the manuscript: Khairul Afriadi. Critical revision of the manuscript for important intellectual content: Hastria Effendi. Statistical analysis: Khairul Afriadi.

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