RESEARCH ARTICLE

Physical fitness and BMI in Men's Vocational Sailing School

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Abstract

The maritime industry is known for its high physical demands. Students in maritime vocational programs, who will eventually work on ships, must have a good level of physical fitness to perform demanding tasks. Without adequate physical fitness, the risk of injury and fatigue increases, which can ultimately affect workplace safety and operational efficiency. This study aims to determine the Body Mass Index (BMI) and physical fitness levels of male students at SMK Baruna Pemalang. The research design uses a descriptive quantitative method to determine BMI and physical fitness levels. The test instruments are based on the Guidelines for the Nusantara Student Fitness Test from the Ministry of Youth and Sports of the Republic of Indonesia, with a validity of 0.471 and a reliability of 0.232. A sample of 61 male students was selected from a total population of 90 students. Data analysis in this study uses SPSS 26 to describe the BMI and physical fitness levels of the male students. The results indicate that the Body Mass Index of the students falls within the normal (healthy) range for a total of 35 students, while the average physical fitness level of the students is categorized as poor, with 46 students falling into this category. The findings of this study are expected to serve as baseline data for further research to improve the physical fitness levels of maritime vocational students.

Keywords
Body Mass Index, Physical Fitness, Sailing Vocational School Students

INTRODUCTION

Physical fitness stimulates body growth, prevents obesity or overweight, reduces stress, and increases happiness during adolescence. Therefore, it is necessary to deepen the understanding of the importance of physical fitness for the body. A healthy body is achieved through a balanced diet or nutrition that matches the body's activity needs (Indah et al., 2021; Sofianita et al., 2020; Syah et al., 2020).

The fitness level of the Indonesian population categorized as unfit reaches 76%. Those categorized as very unfit reach 53.63%. Only 5.86% of the population is in very fit or prime condition (Saputra, 2022). The Assistant Deputy for Educational Sports Management of the Ministry of Youth and Sports (Kemenpora)

Ary Moelyadi mentioned that the physical fitness of students in Indonesia is still low (Shanti, 2021), supported by a statement from the Deputy III for Sports Culture of Kemenpora, Raden Isnanta, during a webinar with the theme "Socialization of the National Sports Grand Design (DBON)", Out of about 45 million students in Indonesia, only around 2.1 percent are known to be active in physical exercise (Suaramerdeka, 2021).

The rapid development of technology leads to changes in behavior, such as a decrease in physical activity (Ksajikyan et al., 2024; Y. Zhang, Xu, et al., 2021). If food intake increases while physical activity decreases, it results in accumulation in the body. The accumulation of energy materials in the body is usually in the form of fat or glycerides. Excess fat accumulation increases body weight, reducing physical agility. It can also cause pressure

on several internal organs, such as the heart and lungs, and even muscles, which disrupts blood flow and metabolic processes, thus reducing fitness (Murphy et al., 2021).

Factors that influence physical fitness include physical activity, health promotion, yoga, gender, age, genetic and household registration characteristics (Huang et al., 2023; Kwon & Kwon, 2024; Lv et al., 2023; Soon Kim & Sung Lee, 2024; Tong et al., 2023; Yoo & Lee, 2022; Özdemir, 2023). Physical activity is one of the factors that can affect physical fitness (Di Maglie et al., 2022; López et al., 2021; Thomas et al., 2020). Other factors that can influence a person's level of physical fitness include nutritional adequacy (Lu et al., 2022; Oukheda et al., 2023; Rajabi et al., 2021), nutritional status (Boquete-Pumar et al., 2023; Liu et al., 2022; Machado et al., 2021; Zhang, Lai, et al., 2021), and physiological function (Zhang et al., 2022).

The importance of physical fitness and Body Mass Index (BMI) for maritime vocational students cannot be underestimated (Zalal et al., 2023). Maritime vocational education has specific characteristics that demand optimal physical and mental abilities from its students. Maritime vocational students are expected to face challenging working conditions at sea, such as extreme weather changes, heavy physical work, and the need to stay alert and responsive in emergency situations. Therefore, physical fitness and an ideal BMI status become crucial factors that must be considered. Especially for those who will work in the maritime industry.

The maritime world is known for its high physical demands. Maritime vocational students, who will later work on ships, must have good physical fitness to be able to carry out heavy tasks such as cargo handling, ship maintenance, and various other operational activities (Arleiny & Prastyanti, 2019). Good physical fitness ensures they have sufficient stamina, physical strength, as well as optimal coordination and balance abilities (Guo et al., 2022). Without adequate physical fitness, the risk of injury and fatigue increases, which can ultimately impact work safety and operational efficiency (INABA et al., 2021).

Body Mass Index (BMI) is an important indicator to assess whether a person has a healthy weight (Ben Brahim et al., 2023a; Li et al., 2023; Wang et al., 2023; Xie et al., 2023). An ideal BMI reflects a balance between weight and height, which

can reduce the risk of chronic diseases such as obesity, diabetes, and cardiovascular diseases (CDC, 2021). For maritime vocational students, having a healthy BMI means they are more likely to have good fitness levels and optimal body endurance. Conversely, an unhealthy BMI can indicate health problems that could potentially hinder their physical performance in the field (WHO, 2017; Arleiny & Prastyanti, 2019).

Fitness and elements such as games, when used in accordance with the principles of self-determination theory, can enhance physical activity and student motivation (Ha et al., 2020; Martin et al., 2023; Mokmin & Jamiat, 2021). Fitness programs and health education should be integrated into the curriculum to ensure that students gain the knowledge and skills necessary to maintain their physical fitness. Additionally, regular health check-ups and BMI monitoring can help in the early detection of health issues and provide appropriate interventions.

Good physical fitness and BMI are not only important during education but also have long-term impacts on the careers and quality of life of maritime vocational students (Kubiyeva et al., 2019). Maintaining physical fitness will enable them to work more effectively and safely, as well as potentially have a longer and more successful career in the maritime field (Ilyas et al., 2021). Furthermore, healthy lifestyle habits formed during education will bring long-term benefits in terms of overall health and well-being.

Physical fitness and Body Mass Index (BMI) are crucial aspects for maritime vocational students. The profession of a sailor requires excellent physical condition to perform heavy tasks on board. Several reasons highlight the importance of good physical fitness and BMI for maritime vocational students: work on a ship involves quite heavy physical activities, such as lifting heavy loads, climbing ropes, and working in extreme weather conditions. Physical condition and BMI indicate that better physical fitness is positively correlated with lower BMI (Andrade-Lara et al., 2024).

The working environment on board can be hazardous, with risks of falling, slipping, or being hit by heavy objects. A physical health system that controls cleanliness, noise, and thermal comfort is essential for students' health (Appau et al., 2024).

Sailors often face stress, fatigue, and long working hours. Good physical fitness can improve

mental health, reduce fatigue, and enhance concentration and performance (Patel et al., 2019).

The physical fitness of students, especially in maritime vocational schools, is a crucial aspect that must be developed as part of their preparation for working on ships. However, in reality, some students are unaware of their fitness levels and whether their height and weight proportions are ideal. Therefore, the researcher intends to provide an overview and education to help students achieve an ideal level of fitness and Body Mass Index (BMI).

MATERIALS AND METHODS

Research Design

This study uses a quantitative approach with a descriptive research design. The aim of this study is to measure the physical fitness and Body Mass Index (BMI) of maritime school students using the Nusantara Student Fitness Test (TKPN) instrument (Rusdiana et al., 2022).
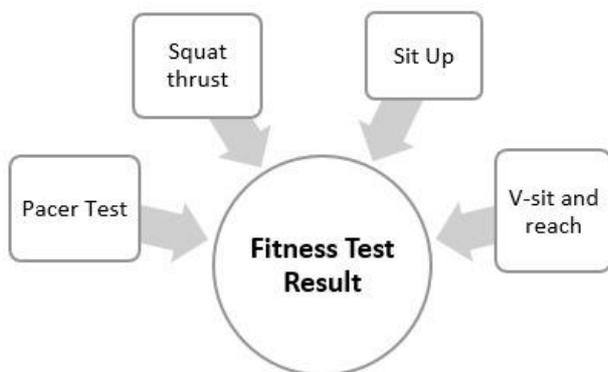

Figure 1. TKPN fitness test design

Population and Sample

This research was conducted in accordance with the Helsinki Declaration. Ethical approval for this study was obtained from the Ethics Committee of Universitas Negeri Semarang on November 1, 2023, with approval number 411/KEP/EC/2023. Participant provided informed consent, with the volunteer form covering research details, risks, benefits, confidentiality, and participant rights. The research strictly adhered to the ethical principles of the Declaration of Helsinki, prioritizing participant's rights and well-being in design, procedures, and confidentiality measures.

The population in this study consists of all male and female students at SMK Baruna Pemalang, a maritime vocational high school in Pemalang Regency, totaling 90 students. The sample for this study comprises 61 male students

selected based on their willingness to participate in the test and their health status.

Research Instrument

The Nusantara Student Fitness Test (TKPN) is a measurement tool used to assess students' physical fitness levels, with established validity and reliability according to the formula in the Nusantara Student Fitness Test Handbook published by the Ministry of Youth and Sports of the Republic of Indonesia. The validity is 0.471, and the reliability is 0.232 based on research findings (Rusdiana et al., 2022). TKPN consists of several tests, including:
V Sit and Reach: Measures flexibility.
60-second Sit Up: Measures abdominal muscle strength and endurance.
30-second Squat Thrust: Measures strength endurance, body control, balance, coordination, and agility.
Pacer Test: Measures the maximum working capacity of the heart and lungs.
Body Mass Index (BMI) measurement:
BMI is calculated using the following formula (Rusdiana et al., 2022):

$$BMI = \frac{Weight\ (Kg)}{Height\ (m^2)}$$

Research Procedure

The initial preparation involves obtaining research permits from the school, preparing the necessary instruments and equipment such as digital scales, a stadiometer, and tools for the TKPN. Then, a briefing should be conducted for the research assistants who will help with data collection. Next, the process includes measuring the students' weight and height alternately, recording the weight and height data for each student. Following this, students will be instructed to complete a series of tests according to the TKPN guidelines, with a brief explanation of the procedure for each test given to the students, and recording the results of each test for each student.

Data Analysis

Calculate the BMI for each student using the predetermined formula. Assess the TKPN results according to the applicable assessment standards.
Process the data using SPSS 26 statistical software to obtain statistical descriptions (mean, median, standard deviation, and frequency distribution) of the TKPN and BMI results.

Data Analysis Techniques

The collected data were analyzed using descriptive statistical methods to provide an overview of the students' physical fitness levels and BMI status. The analyses performed include; Statistical Description: Calculating the mean, median, and standard deviation for TKPN and BMI results.

Frequency Distribution; Determining the frequency distribution for various fitness and BMI categories (e.g., poor, fair, good, and very good for fitness; underweight, normal, overweight, and obese for BMI). Correlation; Analyzing the relationship between TKPN results and BMI using Pearson correlation coefficients to see if there is a significant relationship between physical fitness and BMI among the students.

RESULTS

Table 1 above shows the data distribution for the age variable of students from grade X to grade XII. This variable was measured by collecting primary data from students' birth dates and years, calculated as of June 1, 2024. The data distribution shows a minimum value of 14 and a maximum of 18 with an average of 16.14 years and a standard deviation of 1.013. These results indicate that the average student is over 16 years old, as seen from the proximity of the average and maximum values. Meanwhile, the data variance is relatively small, as evidenced by the close proximity of the average and standard deviation values.

The weight data for students in grades X and XII, measured using a digital scale in kilograms, show a minimum value of 34 and a maximum value of 120, with an average of 59.9. This indicates that the students' weight is above average, given the large difference between the average and maximum values. The standard deviation is 14.75, indicating that the data variance is relatively large, as evidenced by the large difference between the average and standard deviation values.

The height data for students from grade X to grade XII show a minimum value of 144 and a maximum of 185, with an average student height of 165.52. This indicates that most students' heights are below 165, given the large difference between the average and minimum values, meaning the data variance is relatively large, as evidenced by the close proximity of the average and standard deviation values.

Table 1. Descriptive Statistics research data on BMI and Physical Fitness

	N	Minimum	Maximum	Mean	Std. Deviation
Age	61	14.00	18.00	16.1475	1.01384
Weight	61	34.00	120.00	59.9836	14.75296
Height	61	144.00	185.00	165.5246	6.88623
V Sit and Rest	61	.00	25.00	9.7066	5.76989
Sit Up	61	23.00	58.00	38.8197	7.92992
Squat Thrust	61	2.00	13.00	7.6885	2.04565
Pacer	61	5.00	56.00	31.1311	8.85715
Valid N (listwise)	61				

The above data description will be used to calculate BMI values with the following criteria:

Table 2. Nutrition Status

Indeks	nutritional status category	Threshold (Z-Score)
Age (BMI) of children aged 5 - 18 years	Undernutrition (thinness)	- 3 SD to < - 2 SD
	Good Nutrition (normal)	- 2 SD to + 1 SD
	Overnutrition (overweight)	1 SD to + 2 SD
	Obesity (obese)	+ 2 SD

From the results of calculating the BMI scores for students in classes X to XII at Baruna Sailing Vocational School, Pemalang, it can be described as follows:

Table 3. BMI values of Baruna Vocational School students

Indeks	Nutritional Status Category	Amount
Age (BMI) of children aged 5 - 18 years	Undernutrition (thinness)	11
	Good Nutrition (normal)	35
	Overnutrition (overweight)	11
	Obesity (obese)	4

The calculation of the fitness levels of SMK Baruna Pemalang students was conducted using V Sit and Reach, Sit Up, Squat Thrust, and Pacer tests, as described in Table 1. The V Sit and Reach data show a minimum score of 0 and a maximum of 25 with an average of 9.7066. This means the flexibility level of male students aged 14 to 18 years is categorized as moderate based on the criteria in the Nusantara Student Fitness Test guide, as indicated by the proximity of the average and minimum values. The standard deviation is 5.769, indicating that the data variation is relatively small due to the proximity of the average and standard deviation values.

The Sit Up data, performed for one minute, show a minimum result of 23 repetitions and a maximum of 58 repetitions, with an average of 38 repetitions. This indicates that the average Sit Up ability of SMK Baruna students falls into the low category according to the TKPN Sit Up Test Norms. The standard deviation is 7.929, indicating that the data variation is relatively large due to the

significant difference between the average and standard deviation values.

The Squat Thrust data, performed for 30 seconds, show a minimum result of 2 repetitions and a maximum of 13 repetitions, with an average of 7.688 repetitions. This places the Squat Thrust ability of the students in the low category. The standard deviation is 2.045, indicating that the data variation is relatively small due to the proximity of the average and standard deviation values.

The Pacer Test data, a 20-meter shuttle run, show a minimum result of 5 and a maximum of 56 with an average of 31.131. This indicates that the physical endurance of the students is categorized as very low. These results highlight the importance of improving students' physical abilities to perform the physical activities required in the maritime industry.

Based on the V Sit and Reach measurements and the results of the Sit Up, Squat Thrust, and Pacer tests, the criteria can be described as follows:

Tabel 4. Fitness calculation formula

Variable	Weight	Value	Value Proportion
Pacer	50	5	2,5
Squat thrust	20	5	1
Sit Up	20	5	1
V Sit and Reach	10	5	0,5
Total			**5**

Table 5. weight, value, value proportion

Fitness Calculation	Fitness Category	Amount
Indonesian students' fitness test	Very Good	0
	Good	0
	Enough	15
	Less	46
	Very Less	0

DISCUSSION

Body Mass Index (BMI) is a measure used to assess an individual's nutritional status based on weight and height. School children who are underweight or overweight/obese are vulnerable to adverse changes in physical fitness (Yip et al., 2024). The formula to calculate BMI is weight in kilograms divided by height in meters squared. median BMI is relatively low in early life and high at older ages, probably due to its method of construction (Cole & Lobstein, 2012). BMI categories are generally divided into four: underweight (<18.5), normal (18.5-24.9), overweight (25-29.9), and obese (≥30). At SMK Baruna Pemalang, data from 61 male students show that the average BMI falls into the normal nutrition category, but their average fitness level is categorized as low.

Although SMK Baruna Pemalang students have an average BMI within the normal nutrition category, their low physical fitness levels indicate the presence of other factors affecting fitness besides nutritional status. Insufficient or irregular physical activity, potentially unbalanced diets, poor sleep quality, and mental health issues are some factors that can impact fitness levels. Apart from the factors mentioned above, manipulative exercises can be used as an alternative to improve gross motor skills. The success of this may be influenced by several other factors that limit this research, such as social, cultural, and linguistic factors, as well as possibly genetic characteristics (Phytanza et al., 2023). A healthy BMI should ideally support optimal physical fitness, but in this case, these other factors appear to be more dominant in determining the students' fitness.

To improve the students' physical fitness, a comprehensive strategy is needed. One form of fitness testing that can be used is the application of the Naïve Bayes algorithm for classifying physical fitness levels, which can be used to predict VO2Max (Burhaein et al., 2024). Structured and regular exercise programs, including cardio, strength, flexibility, and endurance training, should be implemented. Another alternative for improving training, particularly reaction training, can be the use of audiovisual imagery training and visual imagery training (Burhaein & Riyan Jaya, 2024). Additionally, education on the importance of balanced and adequate nutrition is crucial, as well as providing meal plans that meet the students' nutritional needs optimally. Improving sleep quality and ensuring adequate rest is also important by educating students about the importance of sufficient and quality sleep and ensuring adequate rest periods.

A holistic approach is also needed to manage students' stress and mental health. Counseling, recreational activities, and psychological support can help students manage stress better. Creating an environment that supports a healthy and active lifestyle is also important to achieve optimal fitness levels. With a comprehensive approach and appropriate interventions, it is expected that the fitness levels of SMK Baruna Pemalang students can improve, enabling them to be more prepared for daily activities and intensive training.

Conclusion

The conclusion of this study indicates that the Body Mass Index (BMI) of students falls within the normal nutritional level for 35 students, while the average physical fitness level of students is categorized as poor, with 46 students in this category. These results suggest that there is room for improvement to enhance overall fitness levels. A limitation of this study is the limited sports facilities available at the school to support physical education. The researcher recommends conducting further studies to improve BMI and physical fitness levels at maritime schools.

Conflict of Interest

We declare that the article we wrote does not involve any specific conflicts of interest and adheres to the Helsinki Declaration.

Ethics Statement

This research was conducted in accordance with the Helsinki Declaration. Ethical approval for this study was obtained from the Ethics Committee of Universitas Negeri Semarang on November 1, 2023, with approval number 411/KEP/EC/2023.

Authors Contribution

Study Design, JY; Data Collection, SR, OWKH, and TH; Statistical Analysis, JY and SR; Data Interpretation, JY and OWKH; Manuscript Preparation, JY and SR; Literature Search, SR and TH. All authors have read and approved the final manuscript version for publication.

REFERENCES

Andrade-Lara, K. E., Latorre-Román, P. Á., Párraga-Montilla, J. A., Pincay-Lozada, J. L., Cabrera-Linares, J. C., & Mayanquer-Lara, A. (2024). Association between physical condition and weight status in primary school students. *Retos*, *51*, 888–894. [Crossref]

Appau, M. W., Attakora-Amaniampong, E., & Anugwo, I. C. (2024). Nature of student housing in Ghana: drivers of physical health condition effects on students living with disability (SWD) in Purpose-Built university housing. *Property Management*, *42*(4), 523–544. [Crossref]

Arleiny, A., & Prastyanti, R. A. (2019). Optimalisasi Fitness For Duty Pelaut Berdasarkan Peraturan Menteri Kesehatan Republik Indonesia Nomor 1 Tahun 2018 Tentang Pemeriksaan Kesehatan Pelaut. *Infokes: Jurnal Ilmiah Rekam Medis Dan …*, *9*(1), 50–56.

Ben Brahim, M., Sal-de-Rellán, A., Hernaiz-Sánchez, A., Yasin, H., & García-Valverde, A. (2023). The relationships between body mass index, reciprocal ponderal index, waist-to-height ratio, and fitness in young adult males. *Frontiers in Psychology*, *14*.1250913. [Crossref]

Boquete-Pumar, C., Álvarez-Salvago, F., Martínez-Amat, A., Molina-García, C., De Diego-Moreno, M., & Jiménez-García, J. D. (2023). Influence of Nutritional Status and Physical Fitness on Cognitive Domains among Older Adults: A Cross-Sectional Study. *Healthcare (Switzerland)*, *11*(22). [PubMed]

Burhaein, E., Fadjeri, A., & Widiyono, I. P. (2024). Application of Naive Bayes Algorithm for Physical Fitness Level Classification. *International Journal of Disabilities Sports and Health Sciences*, *7*(1). 178-187. [Crossref]

Burhaein, E., & Riyan Jaya, S. (2024). The Influence of Imagery and Agility Training on Athletes Futsal Goalkeeper Reaction Time Metro City Senior High School. *International Journal of Disabilities Sports and Health Sciences*, *7*(1). [CrossRef]

CDC. (2021). Body Mass Index (BMI), Healthy Weight, Nutrition, and Physical Activity. In *Centers for Disease Control and Prevention*.

Cole, T. J., & Lobstein, T. (2012). Extended international (IOTF) body mass index cut-offs for thinness, overweight and obesity. *Pediatric Obesity*, *7*(4), 284–294. [PubMed]

Di Maglie, A., Marsigliante, S., My, G., Colazzo, S., & Muscella, A. (2022). Effects of a physical activity intervention on schoolchildren fitness. *Physiological Reports*, *10*(2). [PubMed]

Guo, J., Wan, B., Zheng, S., Song, A., & Huang, W. (2022). A Teenager Physical Fitness Evaluation Model Based on 1D-CNN with LSTM and Wearable Running PPG Recordings. *Biosensors*, *12*(4). [PubMed]

Ha, A. S., Lonsdale, C., Lubans, D. R., & Ng, J. Y. Y. (2020). Increasing Students' Activity in Physical Education: Results of the Self-determined Exercise and Learning

Lv, W., Fu, J., Zhao, G., He, Z., Sun, S., Huang, T., Wang, R., Chen, D., & Chen, R. (2023). A cohort study of factors influencing the physical fitness of preschool children:

for FITness Trial. *Medicine and Science in Sports and Exercise*, *52*(3), 696–704. [PubMed]

Huang, Z., Li, S., Lu, F., Tian, K., & Peng, L. (2023). Current situation and factors influencing physical fitness among adolescents aged 12 ~ 15 in Shandong Province, China: A cross-sectional study. *Preventive Medicine Reports*, *36*. [PubMed]

Ilyas, M., Soemarko, D. S., Adi, N. P., Fitria, D. Y., Putra, M. I., & Kualasari, Y. (2021). Relatıonshıp between nutrıtıon ıntake and the fıtness of manufacturıng workers ın ındonesıa. *Indonesian Journal of Public Health*, *16*(1). [CrossRef]

Inaba, K., Hochi, Y., Iwaasa, T., & Mizuno, M. (2021). Relationships between the Psychological Safety, Job Resources, and Work Engagement of Fitness Club Employees. *Juntendo Medical Journal*, *67*(4).1-7. [CrossRef]

Indah, Y., Ansyar, D. I., Ibrahim, I. A., Suyuti, S., Hartini, D. A., & Dewi, N. U. (2021). Prediction model of balanced nutrition practices among university students in the covid-19 outbreak. *Open Access Macedonian Journal of Medical Sciences*, *9*, 1155–1160. [CrossRef]

Ksajikyan, N., Aghababyan, H., & Sargsyan, M. (2024). Assessment of reactıvıty to the body under condıtıons of physıcal actıvıty ın students aged 17-20 yeARS. *Georgian Medical News*, *347*(2), 54–58. [PubMed]

Kubiyeva, S., Botagariev, T., Akhmetova, A., Tissen, P., Zhetimekov, E., Bobyreva, M., Mambetov, N., & Aralbaev, A. (2019). Specificity of physical development and physical preparation of schoolchildren of orenburg and aktobe cities. *Journal of Human Sport and Exercise*, *14*(Proc5). [CrossRef]

Kwon, J., & Kwon, Y. T. (2024). Factors Influencing the Subjective Health and Physical Fitness Perceptions of Korean Adolescents. *Iranian Journal of Public Health*, *53*(4), 878–887. [CrossRef]

Li, S., Cao, H., Liu, H., Hu, Y., & Liu, J. (2023). Relationship between body mass index and physical fitness index in Chinese college students: Results from a cross-sectional survey. *American Journal of Human Biology*, *35*(5). [PubMed]

Liu, B., Liu, X., Wang, Q., Yan, W., & Hao, M. (2022). Nutritional status, food consumption, lifestyle, and physical fitness in rural and urban elementary school children in Northeast China. *Frontiers in Nutrition*, *9*. [PubMed]

López, I. M. R., Martín-Matillas, M., Delgado-Fernández, M., Delgado-Rico, E., Folgoso, C. C., & Verdejo-García, A. (2021). Effect of increased physical activity on physical fitness in an overweight and/or obese group of adolescents. *Sport TK*, *10*(1), 17–28. [CrossRef]

Lu, Z., Mao, C., Tan, Y., Zhang, X., Li, Z., Zhang, L., Zhu, W., & Sun, Y. (2022). Trends in Physical Fitness and Nutritional Status among School-Aged Children and Adolescents during the COVID-19 Pandemic in Shaanxi, China—A Cross-Sectional Study. *Nutrients*, *14*(15). [PubMed]

a decision tree analysis. *Frontiers in Public Health*, *11*. [PubMed]

Machado, E. A., Farinatti, P., Sicuro, F. L., Rodrigues, F., Bouskela, E., & Collett-Solberg, P. F. (2021). Daily

physical activity, cardiorespiratory fitness, nutritional status, endothelial function, and autonomic modulation in school-age adolescents: A principal component analysis. *Obesity Research and Clinical Practice*, *15*(3), 205–211. [PubMed]

Martin, J., Lobo, J., De Jesus, J., Santos, M., Baltazar, S., Baltazar, J., & Miller, J. (2023). Selected Physical Fitness Efficiency in the Improvement of Students' Body Mass Index in an Online Learning Environment. *International Journal of Human Movement and Sports Sciences*, *11*(4), 926–937. [CrossRef]

Mokmin, N. A. M., & Jamiat, N. (2021). The effectiveness of a virtual fitness trainer app in motivating and engaging students for fitness activity by applying motor learning theory. *Education and Information Technologies*, *26*(2), 1847–1864. [CrossRef]

Murphy, C., Takahashi, S., Bovaird, J., & Koehler, K. (2021). Relation of aerobic fitness, eating behavior and physical activity to body composition in college-age women: A path analysis. *Journal of American College Health*, *69*(1), 30–37. [PubMed]

Oukheda, M., Bouaouda, K., Mohtadi, K., Lebrazi, H., Derouiche, A., Kettani, A., Saile, R., & Taki, H. (2023). Association between nutritional status, body composition, and fitness level of adolescents in physical education in Casablanca, Morocco. *Frontiers in Nutrition*, *10*. [PubMed]

Özdemir, M. (2023). The Effect of School-Based Physical Activity on Body Composition and Body Mass Index as Indicators of Obesity. Int. J. Sports Eng. Biotech; 1(1): 25-28. [CrossRef]

Patel, A. V, Friedenreich, C. M., Moore, S. C., Hayes, S. C., Silver, J. K., Campbell, K. L., Winters-Stone, K., Gerber, L. H., George, S. M., & Fulton, J. E. (2019). American College of Sports Medicine roundtable report on physical activity, sedentary behavior, and cancer prevention and control. *Medicine and Science in Sports and Exercise*, *51*(11), 2391. [PubMed]

Phytanza, D. T. P., Burhaein, E., Lourenço, C. C. V., & Pavlovic, R. (2023). Physical activity based on manipulative exercise: how it affects the gross motor of children with autism for 12 years old? *International Journal of Disabilities Sports and Health Sciences*, *6*(2). [CrossRef]

Rajabi, H., Sabouri, M., & Hatami, E. (2021). Associations between physical activity levels with nutritional status, physical fitness and biochemical indicators in older adults. *Clinical Nutrition ESPEN*, *45*, 389–398. [PubMed]

Rusdiana, A., Wiriawan, O., & Ronald, H. (2022). Panduan Tes Kebugaran Pelajar Nusantara (TKPN). *Kementerian Pemuda Dan Olahraga Republik Indonesia*.

Saputra. (2022, September 9). *Haornas 2022; Angka Kebugaran Masyarakat Masih Rendah, jadi PR Bersama*.

Shanti, D. H. (2021). *Kebugaran Jasmani Pelajar Indonesia Rendah*. Antaranews.Com.

Sofianita, N. I., Khomsan, A., Setiawan, B., & Ekayanti, I. (2020). Identification of Balanced Nutrition in Indonesia Elementary School Curriculum. *Malaysian Journal of Medicine and Health Sciences*, *16*, 71–72.

Soon Kim, J., & Sung Lee, J. (2024). An Analysis of Influencing Factors of Regular Physical Activities between Fitness Participation Types: Focus on Bodybuilding and Yoga. *American Journal of Health Behavior*, *48*(1), 134–144. [CrossRef]

Syah, M. N. H., Asna, A. F., & Wahono, D. N. (2020). Nutrition balanced guideline: Irregular weight monitoring is associated with overweight-obesity in adolescents (high school students) at Bekasi. *Journal of Nutritional Science and Vitaminology*, *66*, S137–S140. [PubMed]

Thomas, E., Bianco, A., Tabacchi, G., da Silva, C. M., Loureiro, N., Basile, M., Giaccone, M., Sturm, D. J., Şahin, F. N., Güler, Ö., Gómez-López, M., Sánchez, G. F. L., Pajaujiene, S., Zuoziene, I. J., Rada, A., Alesi, M., & Palma, A. (2020). Effects of a physical activity intervention on physical fitness of schoolchildren: The enriched sport activity program. *International Journal of Environmental Research and Public Health*, *17*(5). [PubMed]

Tong, Z., Kong, Z., Jia, X., Yu, J., Sun, T., & Zhang, Y. (2023). Spatial Heterogeneity and Regional Clustering of Factors Influencing Chinese Adolescents' Physical Fitness. *International Journal of Environmental Research and Public Health*, *20*(5). [PubMed]

Wang, Q., Guo, H., Chen, S., Ma, J., & Kim, H. (2023). The Association of Body Mass Index and Fat Mass with Health-Related Physical Fitness among Chinese Schoolchildren: A Study Using a Predictive Model. *International Journal of Environmental Research and Public Health*, *20*(1). [PubMed]

World Health Organization (WHO). (2017). Mean Body Mass Index (BMI). *Who*.

Xie, Q., Xiong, J., Mao, C., Niu, Z., Zhou, J., Gong, L., & Jiang, J. (2023). Association between body mass index and physical fitness index among secondary school students in Jiangxi Province. *Chinese Journal of School Health*, *44*(8), 1216–1220. [CrossRef]

Yip, K. man, Wong, S. W. S., So, H. kwan, Tso, W. W. Y., Siu, P. M. F., Wong, I. C. K., Yam, J. C., Kwan, M. Y. W., Lum, T. Y. S., Louie, L. H. T., Lee, A., Wong, W. H. S., & Ip, P. (2024). Physical Fitness and Body Mass Index Status of Hong Kong Primary Schoolchildren across the COVID-19 Pandemic, before and after School Closure. *Journal of Pediatrics*, *264*. [PubMed]

Yoo, J. J., & Lee, S. E. (2022). Factors influencing life satisfaction: Role of physical fitness, body satisfaction, and shopping. *Family and Consumer Sciences Research Journal*, *51*(2), 90–102. [CrossRef]

Zalal, A., Nugraheni, W., & Saleh, M. (2023). Dampak Penghapusan Mata Pelajaran PJOK Terhadap Kebugaran Siswa Kelas XII SMK. *Jurnal Educatio FKIP UNMA*, *9*(4). [CrossRef]

Zhang, J., Gao, X., & Li, T. (2022). Comparison of physical fitness and physiological function of children and adolescents with different nutritional status in Beijing-Tianjin-Hebei Region. *Chinese Journal of School Health*, *43*(6), 894–897. [CrossRef]

Zhang, Y., Lai, Z., Qiu, A., Yu, H., Lin, J., Wei, W., & Chen, X. (2021). Association between nutritional status and indicators of physical fitness and physical capacity among primary and secondary school students in Xiamen/. *Chinese Journal of School Health*, *42*(8), 1212–1215. [CrossRef]

Zhang, Y., Xu, W. Y., Liu, R. Q., & Xu, S. J. (2021). Analysis of College Students' Cognition upon PE Study and Their Physical Conditions during the COVID-19 Pandemic Era. *2021 IEEE 3rd International Conference on Computer Science and Educational Informatization, CSEI 2021*, 89–93. [CrossRef]