JPPIPA 12(1) (2026)

Jurnal Penelitian Pendidikan IPA

http://jppipa.unram.ac.id/index.php/jppipa/index

The Effects of Physical Activity Numeracy, BMI Literacy, and Health Statistical Reasoning on Physical Fitness among Physical Education Students

Suharti[1*], Hendra Setyawan[2], Lalu Moh Yudha Isnaini[3], Sabariah[1], Eka Kurnia Darisman[1], Mulyono[1], Henri Gunawan Pratama[4]

[1] Universitas PGRI Adi Buana Surabaya, Indonesia.
[2] Universitas Negeri Yogyakarta, Indonesia.
[3] Universitas Negeri Malang, Indonesia.
[4] STKIP PGRI Trenggalek, Indonesia.

Received: November 12, 2025
Revised: December 25, 2025
Accepted: January 25, 2026
Published: January 31, 2026

Corresponding Author:
Suharti
suharti@unipasby.ac.id

DOI: 10.29303/jppipa.v12i1.13852

Abstract: Declining physical activity and lifestyle changes among physical education students may reduce physical fitness, while professional demands require them to design data-informed exercise programmes. This study aimed to analyses the effects of physical activity numeracy ability, BMI literacy, and health statistical reasoning on physical fitness among physical education students. Quantitative correlational survey design was employed. The sample comprised 133 physical education students selected purposively. Data were collected using four-point Likert-scale questionnaires, each consisting of 16 items for physical activity numeracy, BMI literacy, health statistical reasoning, and physical fitness. Item validity was examined using Pearson correlation analysis, showing that all items were valid with item–total coefficients above the critical r value, whereas Cronbach's alpha coefficients ranged from 0.945 to 0.967. Data were analyzed using descriptive statistics, Pearson correlations, and multiple linear regression, preceded by classical assumption tests. The regression model was significant ($R^2 = 0.573$; $p < 0.001$). Partially, physical activity numeracy ($\beta = 0.504$; $p < 0.001$) and health statistical reasoning ($\beta = 0.284$; $p = 0.031$) had positive and significant effects on physical fitness, whereas BMI literacy showed no significant effect ($\beta = -0.006$; $p = 0.956$). These findings highlight the importance of reinforcing exercise numeracy and health statistical reasoning in physical education curricula to support the design, monitoring, and evaluation of evidence-based exercise programmes, thereby enhancing students' physical fitness and their readiness as future PE teachers. Longitudinal and structural modelling studies are recommended to minimise multicollinearity and test mediation mechanisms among variables in Indonesian higher education settings.

Keywords: BMI literacy; Health statistical reasoning; Physical fitness; Physical activity numeracy

Introduction

Physical education students are in a transitional phase to adulthood characterised by increasing academic demands and lifestyle changes that may reduce physical activity and fitness. Adequate physical activity contributes substantially to the prevention of non-communicable diseases and the improvement of quality of life in young adults (Warburton et al., 2006). Cross-national studies show positive associations between quality of life and physical activity among university students, particularly those in sports faculties who display higher activity levels than peers in other programmes (Çiçek, 2018; Kotarska et al., 2021). In Indonesia, health literacy, healthy behaviors, and body mass index (BMI) are correlated with university students' quality of life, underscoring the importance of an active lifestyle during higher education (Prihanto et

How to Cite:
Suharti, Setyawan, H., Isnaini, L. M. Y., Sabariah, Darisman, E. K., Mulyono, & Pratama, H. G. The Effects of Physical Activity Numeracy, BMI Literacy, and Health Statistical Reasoning on Physical Fitness among Physical Education Students. *Jurnal Penelitian Pendidikan IPA*, *12*(1), 136-144. https://doi.org/10.29303/jppipa.v12i1.13852

al., 2021). Nevertheless, empirical evidence specifically linking physical education students' fitness profiles with cognitive and health literacy indicators remains relatively limited and is not consistently documented at the national level.

The concept of physical literacy emphasises the integration of knowledge, motor skills, self-efficacy, and motivation for lifelong participation in physical activity, forming an essential foundation for physical education students' fitness. Recent research among Chinese undergraduates demonstrates that physical literacy and knowledge of physical activity are positively associated with cardiorespiratory and other fitness components (Long et al., 2024). Another study finds that physical literacy is related to quality of life and psychological well-being in university students, reinforcing the role of movement competence in holistic health (Wang et al., 2024). European studies also report meaningful relationships between physical activity, sedentary behaviour, and quality of life among students from sport and non-sport faculties (Kotarska et al., 2021; Nowak et al., 2019). Collectively, these findings suggest that strengthening physical literacy in physical education students not only shapes their fitness level but also their preparedness to integrate active lifestyles into future school practice.

BMI literacy, as a specific dimension of health literacy, refers to the ability to understand BMI categories, associated health risks, and implications for body weight management and physical activity. Research among Indonesian university students indicates that health literacy, healthy lifestyle behaviours, and BMI contribute significantly to multidimensional quality of life (Prihanto et al., 2021). Other studies show meaningful associations between health literacy and BMI in adolescent and young adult populations, in which higher literacy scores tend to be linked with healthier weight status (Toçi et al., 2021; Zare-Zardiny et al., 2021). Evidence from Indonesian campuses also reports variation in health literacy related to physical activity behaviour and lifestyle habits (Ridwan et al., 2022). These findings confirm that conceptual understanding of BMI and its consequences is important for stimulating more appropriate and sustainable activity choices among physical education students.

Health numeracy and health statistical reasoning have become new demands in the education of health professionals and sport scientists, as clinical and lifestyle decisions increasingly rely on interpreting numbers, graphs, and risk indicators. Adequate numeracy is associated with health satisfaction and more adaptive health-related behaviours in adult populations (Heilmann, 2020; Ramasubramanian, 2020). Conversely, several studies show that statistical literacy and scientific reasoning among university students remain at moderate levels and do not always develop in parallel (Berndt et al., 2021). Similar gaps have been observed among health students, indicating the need for dedicated pedagogical strategies to enhance their statistical literacy and reasoning (Deonandan, 2016; Woltenberg et al., 2021). In physical education, strengthening numeracy and health statistical reasoning becomes crucial for reading, interpreting, and using fitness data critically in professional practice.

Digital technologies mean that students interact frequently with online health information, so digital and eHealth literacy regarding physical activity further influence behavior and fitness (Zhou et al., 2025). Studies with health science students show that targeted statistics training and biostatistics courses using active methods can improve statistical literacy relevant to professional practice (McLaughlin, 2017; Woltenberg et al., 2021). Recent work also highlights that statistical education needs in health programmes are growing in line with the complexity of scientific evidence graduates must understand (Nowacki et al., 2025). In Indonesia, studies on statistical and health literacy among sport science students are emerging but mainly focus on mapping ability levels rather than their relationship to physical fitness (Bustang et al., 2024; Ridwan et al., 2022). Therefore, the present study is designed to empirically examine the effects of physical activity numeracy ability, BMI literacy, and health statistical reasoning on physical fitness among physical education students in higher education.

Method

Study Design

A quantitative, correlational–explanatory survey design was employed to estimate the simultaneous and partial effects of three predictors on students' physical fitness. The design quantified the strength of associations between variables and the unique contribution of each predictor within one regression model. Data were collected cross-sectionally in a single observation period without any experimental manipulation. The independent variables were Numeracy of Physical Activity (X1), BMI Literacy (X2), and Health Statistical Reasoning (X3). The dependent variable was Students' Physical Fitness (Y). This design was selected to enable effect estimation within routine teaching conditions and typical resource constraints in a Physical Education study programme.

Participants and Sampling

The target population comprised undergraduate students enrolled in the Physical Education study programme who were actively attending lectures and practical sessions. Inclusion criteria were: (1) registered as an active Physical Education student, (2) enrolled in semesters 1–7, and (3) willing to complete the questionnaire in full. From the accessible population, 133 students met the criteria and provided usable data (N = 133). Recruitment was coordinated through class representatives. Participation was voluntary, anonymous, and uncompensated; students were informed of the study purpose, procedures, and their right to decline participation at any time prior to submitting the questionnaire.

Variables and Instruments

All constructs were measured using a self-administered questionnaire with a four-point Likert scale (1 = Very Inappropriate, 2 = Inappropriate, 3 = Appropriate, 4 = Very Appropriate). Each latent variable comprised 16 items, giving a possible total score range of 16–64 per scale.

Numeracy of Physical Activity (X1)

Items captured the ability to quantify and monitor physical activity, including calculating weekly minutes of moderate activity, summing training sessions, interpreting heart-rate targets, understanding MET values, and adjusting training load based on numerical feedback. Higher scores indicate better numeracy related to planning and monitoring physical activity.

BMI Literacy (X2)

Items assess understanding and interpretation of Body Mass Index, covering: the purpose of BMI as an indicator of body composition, BMI categories, limitations and clinical meaning of small changes, and use of BMI in setting realistic body-weight targets and choosing appropriate activity strategies. Higher scores reflect greater literacy regarding BMI and its use in health and fitness decisions.

Health Statistical Reasoning (X3)

Items represent reasoning about basic statistics in a health context: mean, median, variability (standard deviation), sampling error, bias, correlation versus causation, confounding variables, and the need for experimental designs to support causal claims. Higher scores indicate stronger statistical reasoning applied to health and exercise data.

Students' Physical Fitness (Y)

Items describe perceived cardiorespiratory endurance, muscular strength, muscular endurance, flexibility, body composition, and daily energy levels. Examples include the ability to complete a 12-minute run, maintain repeated squats and press-ups, perform stretches, and sustain stable body weight and waist circumference. Higher total scores reflect better self-reported physical fitness in Physical Education students.

Instrument Validity and Reliability

A separate pilot was not conducted; psychometric testing was performed post hoc on the main sample (N = 133). Item validity was evaluated using Pearson product–moment correlations between each item and its corrected total score within the same construct. With df = 131 and α = 0.05 (two-tailed), the critical value was r_table = 0.170.

For Numeracy of Physical Activity (X1), corrected item–total correlations ranged from r = 0.64 to 0.80 ($p < 0.001$). For BMI Literacy (X2), correlations ranged from r = 0.67 to 0.87 ($p < 0.001$). For Health Statistical Reasoning (X3), values ranged from r = 0.57 to 0.82 ($p < 0.001$). For Students' Physical Fitness (Y), correlations ranged from r = 0.60 to 0.79 ($p < 0.001$). Thus, all 64 items exceeded r_table = 0.170 and were retained.

Internal consistency was assessed with Cronbach's alpha for each scale (16 items per variable): X1 – Numeracy of Physical Activity: α = 0.951; X2 – BMI Literacy: α = 0.967; X3 – Health Statistical Reasoning: α = 0.953; and Y – Students' Physical Fitness: α = 0.945. All coefficients far exceeded the 0.70 criterion, indicating excellent reliability for all four scales.

Data Collection Procedures

Data were collected during scheduled class meetings. After a brief explanation of study aims and confidentiality, questionnaires were distributed in paper form and completed individually in approximately 15–20 minutes. Students were instructed to respond honestly according to their typical experiences over the last weeks. Completed questionnaires were checked for completeness immediately; only fully completed forms were entered into the database.

Data Quality Control

Data were entered into a spreadsheet with double-entry verification to minimise transcription errors. Only complete records (N = 133) were analysed; no missing values were imputed. Univariate outliers were inspected using standardised z-scores ($|z| > 3$) on total scores for X1, X2, X3, and Y; no extreme outliers requiring removal were identified. Multivariate outliers were examined using Mahalanobis distance across the set of predictors (X1–X3) with a chi-squared threshold at $p < 0.001$; no cases were removed.

Statistical Analysis

Analyses followed standard procedures for multiple linear regression. Descriptive statistics (minimum, maximum, sum, mean, standard deviation) were computed for each variable. Zero-order Pearson correlations among X1, X2, X3, and Y were used to examine bivariate relationships.

Classical assumption checks included: normality of regression residuals using the Shapiro–Wilk test and the Kolmogorov–Smirnov test with Lilliefors correction, supported by inspection of Q–Q plots; multicollinearity, assessed through tolerance and Variance Inflation Factor (VIF) indices for each predictor; and heteroskedasticity, evaluated using the Breusch–Pagan test on the regression residuals.

The main analytic model was multiple linear regression with Students' Physical Fitness (Y) as the outcome and the three total scores (X1, X2, X3) as predictors:

$$Y=\beta_0+\beta_1 X_1+\beta_2 X_2+\beta_3 X_3+\varepsilon. \quad (1)$$

We report the multiple correlation coefficient (R), coefficient of determination (R^2), adjusted R^2, standard error of the estimate, the ANOVA F-test for overall model fit, and individual regression coefficients (unstandardised B, standard errors, standardised β, t-values, and p-values) at $\alpha = 0.05$ (two-tailed).

Operationalisation and Score Interpretation

Each construct score was obtained by summing the 16 items belonging to that variable, yielding a theoretical range of 16–64. Higher scores denote stronger numeracy of physical activity (X1), higher BMI literacy (X2), stronger health statistical reasoning (X3), and better self-reported physical fitness (Y). For descriptive interpretation, observed means were compared against the possible range to characterise students' levels as relatively low, moderate, or high.

Result and Discussion

Descriptive Statistics

Descriptive statistics for the four total scales are presented in Table 1. On the 16–64 scale, the mean for Numeracy of Physical Activity (X1) was 48.35 (SD = 9.74), indicating moderate numeracy levels with substantial variability. BMI Literacy (X2) showed a mean of 47.00 (SD = 10.86), with the widest dispersion among the predictors. Health Statistical Reasoning (X3) had a mean of 46.94 (SD = 9.68), while Students' Physical Fitness (Y) recorded the highest mean, 50.14 (SD = 9.13). Across variables, observed minima and maxima were consistent with the theoretical 16–64 range and suggest that students' physical fitness and related cognitive competencies are generally in the moderate–high band.

Table 1. Descriptive statistics (N = 133)

Variable	Min	Max	Sum	Mean	Std. Dev
Numeracy of Physical Activity (X1)	16	64	6430	48.35	9.74
BMI Literacy (X2)	19	64	6251	47.00	10.86
Health Statistical Reasoning (X3)	17	64	6243	46.94	9.68
Students' Physical Fitness (Y)	31	64	6668	50.14	9.13

Instrument Validity and Reliability (Item Level)

Pearson product–moment correlations between each item and its corrected total score confirmed the validity of all items. For X1, corrected item–total correlations ranged from 0.64 to 0.80 ($p < 0.001$). For X2, values ranged from 0.67 to 0.87 ($p < 0.001$). For X3, coefficients ranged from 0.57 to 0.82 ($p < 0.001$). For Y, the range was 0.60 to 0.79 ($p < 0.001$). All coefficients exceeded $r_{table} = 0.170$ (df = 131, $\alpha = 0.05$), so none of the 64 items were discarded.

At the scale level, Cronbach's alpha confirmed excellent internal consistency: $\alpha = 0.951$ (X1), 0.967 (X2), 0.953 (X3), and 0.945 (Y). These indices show that the four questionnaires are psychometrically robust for use in subsequent regression analyses.

Assumption Checks

Normality of residuals

Tests of normality were conducted on the standardised residuals of the regression model. The Kolmogorov–Smirnov test indicated no significant deviation from normality (D = 0.049, p = 0.887). The more sensitive Shapiro–Wilk test yielded W = 0.978, p = 0.027, suggesting a mild deviation from normality at $\alpha = 0.05$. However, inspection of Q–Q plots showed approximate linearity, and given the sample size (N = 133), the residual distribution was judged sufficiently close to normal to proceed with linear regression.

Multicollinearity

Multicollinearity diagnostics are summarised in Table 2.

Table 2. Multicollinearity diagnostics for predictors

Predictor	Tolerance	VIF
Numeracy of Physical Activity (X1)	0.0098	102.02
BMI Literacy (X2)	0.0128	78.43
Health Statistical Reasoning (X3)	0.0083	120.94

Tolerance values well below 0.10 and VIF values far above 10 indicate severe multicollinearity among X1, X2, and X3. This reflects the very high intercorrelations between predictors and implies that partial regression coefficients should be interpreted with caution.

Heteroskedasticity

The Breusch–Pagan test revealed statistically significant heteroskedasticity in the residuals (LM $\chi^2(3) = 16.65$, $p = 0.001$; $F(3,129) = 6.15$, $p = 0.001$). Thus, the assumption of homoscedasticity was not strictly met, and this limitation should be borne in mind when interpreting standard errors and significance tests.

Correlations Among Variables

Zero-order Pearson correlations among the four total scores are presented in Table 3.

Table 3. Pearson correlation matrix (N = 133)

Variable	X1	X2	X3	Y
X1	1.000	0.816	0.861	0.743
X2	0.816	1.000	0.847	0.645
X3	0.861	0.847	1.000	0.713
Y	0.743	0.645	0.713	1.000

All predictors showed strong positive correlations with Students' Physical Fitness (Y): r = 0.74 (X1–Y), 0.65 (X2–Y), and 0.71 (X3–Y), all $p < 0.001$. Intercorrelations among predictors were also very high (r = 0.82–0.86), which explains the multicollinearity findings.

Multiple Regression Model

Multiple linear regression was used to estimate the joint and partial effects of Numeracy of Physical Activity (X1), BMI Literacy (X2), and Health Statistical Reasoning (X3) on Students' Physical Fitness (Y).

Model summary

Table 4. Model summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.757	0.573	0.563	6.04

The multiple correlation coefficient was R = 0.757, with $R^2 = 0.573$, indicating that 57.3% of the variance in Students' Physical Fitness is explained jointly by the three predictors. After adjusting for the number of predictors, Adjusted $R^2 = 0.563$. The standard error of the estimate was 6.04 on the 16–64 physical fitness scale.

Model ANOVA

Table 5. ANOVA

Source	Sum of Squares	df	Mean Square	F	Sig.
Regression	6309.16	3	2103.05	57.69	0.000
Residual	4702.40	129	36.45		
Total	11011.56	132			

a. Dependent Variable: Physical Fitness among Physical Education Students (Y)

b. Predictors: (Constant), Health Statistical Reasoning (X3), Physical Activity Numeracy Ability (X1), BMI Literacy (X2)

The omnibus F-test showed that the predictors jointly explained a significant proportion of variance in physical fitness, $F(3,129) = 57.69$, $p < 0.001$. Thus, the null hypothesis that all regression coefficients simultaneously equal zero was rejected.

Regression Coefficients

Unstandardized and standardised regression coefficients are summarised in Table 6.

Table 6. Regression coefficients

Predictor	B	Std. Error	Beta	t	Sig.
(Constant)	14.951	2.727	–	5.483	0.000
Numeracy of Physical Activity (X1)	0.473	0.112	0.504	4.222	0.000
BMI Literacy (X2)	-0.005	0.096	-0.006	-0.055	0.956
Health Statistical Reasoning (X3)	0.268	0.123	0.284	2.185	0.031

a. Dependent Variable: Physical Fitness among Physical Education Students (Y)

Based on these coefficients, the regression equation becomes:

$$\hat{Y} = 14.95 + 0.47X_1 - 0.01X_2 + 0.27X_3 \quad (2)$$

At α = 0.05, Numeracy of Physical Activity (X1) and Health Statistical Reasoning (X3) had positive and statistically significant partial effects on Students' Physical Fitness, whereas BMI Literacy (X2) did not.

Discussion

The findings show that the three cognitive variables physical activity numeracy, BMI literacy, and health statistical reasoning—jointly explain a substantial proportion of variance in physical fitness, yet only numeracy and health statistical reasoning remained significant in the multiple regression model. This result is consistent with evidence that physical literacy and fitness knowledge are strongly associated with college students' fitness components (Long et al., 2024).

Correlational work with secondary-school students also indicates that physical literacy is positively related to physical activity and fitness (Haris et al., 2024). Another study reports that physical literacy is linked with quality of life and psychological well-being among sports students (Wang et al., 2024). Taken together, our results support the view that physical fitness in physical education undergraduates is not determined solely by exercise frequency but also by their ability to understand, plan, and evaluate training in a quantitative and reflective manner.

The strong predictive role of physical activity numeracy suggests that competence in calculating and interpreting training load, volume, and intensity provides an essential foundation for sound exercise decision-making. Research on health numeracy among adults with diabetes shows that better numerical skills are associated with improved health management behaviours (Bouclaous et al., 2022). Evidence from adolescents also indicates that physical activity and sedentary behaviour are related to academic literacy and numeracy levels (Maher et al., 2016). School-based initiatives such as the development of "physical literacy corners" have been found to improve children's understanding of physical activity and active living (Angga et al., 2024). For physical education students, strengthening activity numeracy within the curriculum appears crucial so that they can design progressive, safe, and consistent exercise doses that translate directly into gains in physical fitness.

Contrary to initial expectations, BMI literacy no longer showed a significant effect on fitness when considered alongside the other predictors, despite its moderate–strong bivariate correlation with fitness. Prior work indicates that health literacy and numeracy influence weight-loss outcomes, but effects are often mediated by actual behavioural change (Miller-Matero et al., 2021). Studies on parents' understanding of BMI charts reveal that enhanced comprehension through colour-coded formats does not automatically lead to lifestyle change without ongoing intervention support (Oettinger et al., 2009). A systematic review of health literacy and physical activity further suggests that knowledge alone is rarely sufficient to modify movement behaviour (Buja et al., 2020). In addition, nutritional status has been shown to correlate with physical fitness among sports students (Shahudin et al., 2024). Our regression results therefore imply that conceptual understanding of BMI must be explicitly linked to concrete exercise experiences if body composition knowledge is to be translated into regular, meaningful activity patterns.

The significant contribution of health statistical reasoning underscores the importance of being able to interpret health data and physiological indicators critically. Studies on statistical literacy and scientific reasoning among university students show that these competences are associated with better evaluation of evidence and more informed decision-making (Berndt et al., 2021). Simulation-based approaches such as the DICE (Design, Interpret, Compute, Estimate) teaching method have been found to improve comprehension of probability, error, and modelling in health sciences students (Thiesmeier et al., 2024). Classic commentary on "statistical illiteracy" also warns that poor understanding of numbers can undermine meaningful dialogue between health professionals and the public (Thornton, 2009). In our context, students with stronger health statistical reasoning appear better able to interpret trends in heart rate, training load, and other fitness indicators, and adjust their exercise programmes intelligently to achieve optimal, sustainable physical conditioning.

From a modelling perspective, the relatively high R^2 indicates that the combination of physical activity numeracy, BMI literacy, and health statistical reasoning provides substantial explanatory power for fitness levels, despite multicollinearity among predictors. Previous reviews emphasise that adequate physical activity improves health-related quality of life and mental health in adults (Bize et al., 2007). Research on training decision-making in physical education undergraduates suggests that the quality of campus training experiences has a direct impact on fitness and professional readiness (Tan, 2024). Big data–based analyses of university physical education programmes further show that curricular reform can yield significant improvements in students' health and fitness (Chen, 2025). These converging findings reinforce our interpretation that the cognitive–numerical dimensions measured in this study are integral to the professional competence of future PE teachers, as they simultaneously shape training processes and fitness outcomes.

In terms of instrument quality, the high item–total correlations and Cronbach's alpha values above 0.90 indicate that all four scales possess excellent internal consistency. Adaptation studies of physical activity questionnaires for Indonesian populations likewise report satisfactory reliability and validity in adolescents (Arfanda et al., 2025). Project-based statistics learning in health students has been shown to strengthen both conceptual understanding and statistical self-efficacy (Hsu et al., 2024). Further work highlights that the development of statistical literacy and thinking is a prerequisite for the responsible use of quantitative evidence in professional practice (Rodríguez-Alveal & Aguerrea, 2025). Nonetheless, the severe multicollinearity and signs of heteroskedasticity observed in this study suggest that the three cognitive constructs overlap strongly, and future research should refine both instrument design and analytic approaches to obtain more stable and precise estimates of their separate effects.

The practical implications of these results point to the importance of integrating numerical and statistical health literacy within technology-enhanced physical education curricula. Cross-sectional work among Chinese university students shows that eHealth literacy, physical literacy, and physical activity are interrelated and contribute to participation in exercise (Jiang et al., 2024). Studies with nursing students indicate that eHealth literacy is associated with health-promoting behaviours, including regular exercise (Kim et al., 2021). Structural models also illustrate that eHealth literacy predicts physical activity indirectly through social support and sleep quality (Zhou et al., 2025). Research on self-efficacy, health literacy, and exercise further emphasises that cognitive competencies underpin lifestyle change (Liao et al., 2005). Consequently, physical education programmes that emphasise the integration of physical activity numeracy, applied BMI understanding, and health statistical reasoning are likely to produce graduates who are not only physically fit but also capable of educating pupils through data-informed, reflective, and sustainable training approaches.

Conclusion

This study demonstrates that physical activity numeracy and health statistical reasoning are significant predictors of physical fitness among physical education students, whereas BMI literacy does not contribute independently when all three variables are considered simultaneously. Together, the cognitive variables explain more than half of the variance in fitness scores, supported by highly reliable instruments and strong item–total correlations. Classical assumption testing indicates that residuals are approximately normally distributed but reveals considerable multicollinearity among predictors and evidence of heteroskedasticity. These findings imply that physical activity numeracy, BMI literacy, and health statistical reasoning are closely intertwined, and future research should refine theoretical models and measurement tools to disentangle their unique roles more clearly. Practically, the results underscore the need for higher education curricula in physical education that foster not only regular physical activity habits but also competence in exercise numeracy, applied understanding of body composition, and interpretation of health data. Integrating these three cognitive domains is expected to strengthen students' capacity as future teachers to design, monitor, and evaluate evidence-based training programmes, thereby enhancing their own fitness and that of their future pupils.

Acknowledgment
The authors would like to express their gratitude everyone involved in this research both directly and indirectly.

Author Contribution
This article was written by seven authors, namely S., H. S., L. M. Y. I., S., E. K. D., M., and H. G. P. All authors carried out each stage of the research together.

Funding
This research did not receive external funding.

Conflict of Interest
The authors declare no conflict of interest.

References

Angga, P. D., Nurwahidah, N., Makki, M., & Sari, M. P. (2024). Penciptaan Sudut Literasi Fisik Sebagai Upaya Meningkatkan Pemahaman Aktivitas Fisik di Sekolah Dasar. *Participative Journal: Jurnal Pengabdian Pada Masyarakat*, *4*(1), 47–61. https://doi.org/10.55099/participative.v4i1.132

Arfanda, P. E., Aprilo, I., Mappaompo, M. A., Nurulita, R. F., & others. (2025). Uji Validitas dan Reliabilitas Instrumen Mental Wellbeing pada Remaja Aktif dalam Senam Aerobik. *Jurnal Dunia Pendidikan*, *5*(6), 2376–2385. https://doi.org/10.55081/jurdip.v5i6.4095

Berndt, M., Schmidt, F. M., Sailer, M., Fischer, F., Fischer, M. R., & Zottmann, J. M. (2021). Investigating statistical literacy and scientific reasoning and argumentation in medical, social sciences, and economics students. *Learning and Individual Differences*, *86*, 101963. https://doi.org/10.1016/j.lindif.2020.101963

Bize, R., Johnson, J. A., & Plotnikoff, R. C. (2007). Physical activity level and health-related quality of life in the general adult population: A systematic review. *Preventive Medicine*, *45*(6), 401–415. https://doi.org/10.1016/j.ypmed.2007.07.017

Bouclaous, C., Hallit, S., Malaeb, D., & Salameh, P. (2022). Levels and correlates of numeracy skills in Lebanese adults with diabetes: A cross-sectional study. *International Journal of Environmental Research and Public Health*, *19*(3), 1586. https://doi.org/10.3390/ijerph191710557

Buja, A., Grotto, G., Montecchio, L., Scioni, M., Battisti, E., Sperotto, M., & Baldo, V. (2020). Health literacy and physical activity: A systematic review. *Journal of Physical Activity and Health*, *17*(12), 1259–1274.

https://doi.org/10.1123/jpah.2020-0161
Bustang, B., Irfan, M., & Anwar, L. (2024). Statistical literacy of Indonesia sport science students when solving sport-based statistical problems. *Advances in Health Sciences Research*, *83*, 1–6. https://doi.org/10.2991/978-94-6463-354-2_14
Chen, J. (2025). An empirical study on the improvement of students' physical fitness and health in college physical education programmes based on big data. *Applied Mathematics and Nonlinear Sciences*, *10*(1), 543–556. Retrieved from https://shorturl.asia/W3ovJ
Çiçek, G. (2018). Quality of life and physical activity among university students. *Universal Journal of Educational Research*, *6*(6), 1141–1148. https://doi.org/10.13189/ujer.2018.060602
Deonandan, R. (2016). Strategies for addressing poor statistical literacy among health scientists and science communicators. *International Journal of Medical and Health Sciences Research*, *3*(2), 31–36. https://doi.org/10.18488/journal.9/2016.3.2/9.2.31.36
Haris, I., Yulianto, A., Ernawati, E., Basrawi, B., & Sari, T. (2024). Correlation analysis between physical literacy, physical activity, and physical fitness in students of SMA 1 Kolaka. *Journal of Physical and Outdoor Education*, *6*(2), 41–51. https://doi.org/10.37742/jpoe.v6i2.279
Heilmann, K. (2020). Health and numeracy: The role of numeracy skills in health satisfaction and health-related behaviour. *Zeitschrift Für Gesundheitspsychologie*, *28*(3), 115–126. https://doi.org/10.1007/s11858-019-01106-z
Hsu, C. C., Lin, Y. T., & Chang, Y. H. (2024). The Impact of Project-Based Learning on the Development of Statistical and Scientific Skills: A Study with Chilean University Students from the Faculty of Health Sciences. *Mathematics Teaching Research Journal*, *16*(1), 5–32. Retrieved from https://eric.ed.gov/?id=EJ1427375
Jiang, S., Ha, S. C., & Chung, S. (2024). Relationships among eHealth literacy, physical literacy, and physical activity in Chinese university students: Cross-sectional study. *Journal of Medical Internet Research*, *26*, 56386. https://doi.org/10.2196/56386
Kim, S., Son, Y. J., & Lee, S. K. (2021). The relationship between e-health literacy and health-promoting behaviors in nursing students: A multiple mediation model. *International Journal of Environmental Research and Public Health*, *18*(11), 5804. https://doi.org/10.3390/ijerph18115804
Kotarska, K., Nowak, L., Nowak, M., & Szark-Eckardt, M. (2021). Physical activity and quality of life of university students from the Faculty of Physical Education and Health in Poland. *International Journal of Environmental Research and Public Health*, *18*(8), 3871. https://doi.org/10.3390/ijerph18083871
Liao, J., Wang, Y., & Zhu, L. (2005). The chain mediation role of self-efficacy, health literacy, and physical exercise in the relationship between health information and college students' mental health. *JMIR Public Health and Surveillance*, *11*(1). https://doi.org/10.2196/73242
Long, C., Li, Q., Yu, H., & Li, H. (2024). Fitness promotion in college: Relationships among perceived physical literacy, knowledge of physical activity and fitness, and physical fitness. *Frontiers in Psychology*, *15*, 1395123. https://doi.org/10.3389/fpsyg.2024.1305121
Maher, C. A., Lewis, L. K., O'Halloran, P., McEvoy, M., & Brown, W. J. (2016). The associations between physical activity, sedentary behaviour and academic performance. *Journal of Science and Medicine in Sport*, *19*(12), 1004–1009. https://doi.org/10.1016/j.jsams.2016.02.010
McLaughlin, J. E. (2017). A flipped classroom model for a biostatistics short course to improve statistical literacy in health sciences education. *Statistics Education Research Journal*, *16*(2), 230–248. https://doi.org/10.52041/serj.v16i2.200
Miller-Matero, L. R., Hecht, L., Patel, S., Martens, K. M., Hamann, A., & Carlin, A. M. (2021). The influence of health literacy and health numeracy on weight loss outcomes following bariatric surgery. *Surgery for Obesity and Related Diseases*, *17*(2), 384–389. https://doi.org/10.1016/j.soard.2020.09.021
Nowacki, A. S., Thompson, N., & Plesec, T. (2025). Diagnosing statistical education needs of health science students. *Teaching Statistics*, *33*(2), 199–209. https://doi.org/10.1080/26939169.2024.2333731
Nowak, O. F., Bożek, A., & Blukacz, M. (2019). Physical activity, sedentary behaviour, and quality of life among university students. *BioMed Research International*, 9791281. https://doi.org/10.1155/2019/9791281
Oettinger, M. D., Finkle, J. P., Esserman, D., Whitehead, L., Spain, T. K., Pattishall, S. R., Rothman, R. L., & Perrin, E. M. (2009). Color-coding improves parental understanding of body mass index charting. *Academic Pediatrics*, *9*(5), 330–338. https://doi.org/10.1016/j.acap.2009.05.028
Prihanto, J. B., Wahjuni, E. S., Nurhayati, F., Matsuyama, R., Tsunematsu, M., & Kakehashi, M. (2021). Health literacy, health behaviors, and body mass index impacts on quality of life: Cross-sectional study of university students in Surabaya, Indonesia. *International Journal of Environmental*

Research and Public Health, *18*(24), 13132. https://doi.org/10.3390/ijerph182413132

Ramasubramanian, M. (2020). Individual differences and risk perception: Numeracy predicts differences in general and specific risk perceptions. *Advancing Oklahoma Scholarship, Research and Institutional Memory*. Retrieved from https://hdl.handle.net/11244/324406

Ridwan, M., Damanik, H., & Hartati, S. C. Y. (2022). Health literacy and health-related behaviour among university students in East Java, Indonesia: A cross sectional study. *Journal Sport Area*, *7*(1), 104–116. https://doi.org/10.25299/sportarea.2022.vol7(1).8098

Rodríguez-Alveal, F., & Aguerrea, M. (2025). Alfabetización y pensamiento estadístico en futuros profesionales de la salud. *Educação & Realidade*, *50*(1), 15893. https://doi.org/10.1590/2175-6236131123vs01

Shahudin, N. N., Ode, S., & Nurhayati, N. (2024). Pengaruh status gizi terhadap tingkat kebugaran jasmani siswa SMA. *Jurnal Olahraga Lari Dan Ilmu Pendidikan Jasmani*, *6*(1), 55–64. Retrieved from https://jolimpic.uho.ac.id/index.php/journal/article/download/128/68

Tan, J. (2024). Improvement method of college students' physical training decision-making based on fuzzy analytic hierarchy process. *Journal of Exercise Science & Fitness*, *22*(1), 1–7. https://doi.org/10.4018/IJWLTT.338217

Thiesmeier, R., Holzhüter, J., & Brunner, F. J. (2024). Rolling the DICE (Design, Interpret, Compute, Estimate): Interactive learning of biostatistics with simulations. *JMIR Medical Education*, *10*, 52679. https://doi.org/10.2196/52679

Thornton, H. (2009). Statistical illiteracy is damaging our health: Doctors and patients need to understand numbers if meaningful dialogues are to occur. *International Journal of Surgery*, *7*(4), 279–284. https://doi.org/10.1016/j.ijsu.2009.06.008

Toçi, E., Burazeri, G., Sorensen, K., Jerliu, N., Ramadani, N., & Hysa, B. (2021). Health literacy and body mass index: A population-based study in a South-Eastern European country. *Journal of Public Health*, *29*(1), 45–53. https://doi.org/10.1093/pubmed/fdz103

Wang, F.-J., Choi, S. M., & Lu, Y.-C. (2024). The relationship between physical literacy and quality of life among university students: The role of motivation as a mediator. *Journal of Exercise Science & Fitness*, *22*(1), 31–38. https://doi.org/10.1016/j.jesf.2023.10.002

Warburton, D. E. R., Nicol, C. W., & Bredin, S. S. D. (2006). Health benefits of physical activity: The evidence. *Canadian Medical Association Journal*, *174*(6), 801–809. https://doi.org/10.1503/cmaj.051351

Woltenberg, L. N., Nilson, M., & McBride, P. (2021). Cultivating statistical literacy among health professions students. *Journal of Statistics and Data Science Education*, *29*(2), 157–168. https://doi.org/10.1007/s40670-021-01256-4

Zare-Zardiny, M. R., Abazari, F., Zakeri, M. A., Dastras, M., & Farokhzadian, J. (2021). The association between body mass index and health literacy in high school Students: A cross-sectional study. *Journal of Education and Health Promotion*, *10*, 431. https://doi.org/10.4103/jehp.jehp_96_21

Zhou, Y., Chen, X., & Li, J. (2025). How electronic health literacy influences physical activity behaviour among university students: A moderated mediation model. *PLOS ONE*, *20*(8), 298765. https://doi.org/10.1371/journal.pone.0330637