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Exploring The Impact of Physical Activity and Sleep Quality on Physical Fitness and Cognitive Intelligence

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Abstract

Modern lifestyles dominated by screen exposure and sedentary behavior have led to global health concerns, including reduced physical fitness and cognitive ability among university students. Over 80% of adolescents fail to meet WHO's recommended physical activity levels, while poor sleep quality has been linked to decreased academic performance and mental health. This study aims to examine the relationship between physical activity and sleep quality on physical fitness and cognitive intelligence in university students. A quantitative correlational method was used with 60 participants aged 19–21 years. Instruments included the International Physical Activity Questionnaire (IPAQ), Pittsburgh Sleep Quality Index (PSQI), Multistage Fitness Test (MFT), and Digit Span Test. Results showed 58.33% of students engaged in moderate physical activity and 80% had good sleep quality. Significant positive correlations were found between physical activity and physical fitness ($r = 0.571$), sleep quality and physical fitness ($r = 0.735$), physical activity and cognitive intelligence ($r = 0.520$), and sleep quality and cognitive intelligence ($r = 0.674$), all with $p < 0.01$. Sleep quality contributed 33.2% to physical fitness and 28.7% to cognitive intelligence, while physical activity contributed 32.7% and 25.4%, respectively. These findings highlight the need for health promotion strategies in higher education settings.

Keywords: Cognitive intelligence; physical activity level; physical fitness; sleep quality

1. Introduction

In recent years, the lifestyle of university students has increasingly shifted toward sedentary patterns marked by high screen time, low physical activity, and irregular sleep habits. These behavioral trends raise critical health concerns, particularly as this age group is undergoing key developmental transitions that influence long-term health outcomes (Goevaerts, 2023; Gutiérrez-Espinoza, 2024). According to the World Health Organization (WHO), more than 80% of adolescents and young adults globally do not meet the minimum recommended levels of physical activity, contributing to risks such as obesity, cardiovascular problems, sleep disturbances, and declining cognitive performance. University students, in particular, represent a group vulnerable to these risks due to academic demands, irregular routines, and high exposure to digital media (Mulé et al., 2022; Wilhite et al., 2023). The urgency of this research lies in addressing these health threats specifically within the university student population

an academically demanding group vulnerable to stress, poor sleep hygiene, and a lack of structured physical routines.

The advancement of technology and the increase in digital-based work have led many people to spend more time in front of screens and engage in less physical activity, this habit contributes to various health issues, including rising cases of obesity, cardiovascular diseases, and metabolic disorders such as hypertension and diabetes (Bermudo-Gallaguet et al., 2023). The lack of physical activity in daily life is one of the primary factors leading to weight gain and decreased physical fitness (Sepriadi et al., 2024; Wing, 2024). Given the increasing prevalence of sedentary lifestyles and health-related issues, understanding the impact of physical activity and sleep quality on overall well-being is crucial for developing effective health interventions (Walker, 2024; Widanita & Anggraeni, 2023). Physical activity plays a crucial role in maintaining fitness and body balance. Previous studies show that physical activity and sleep quality are two important factors that can influence the development of physical fitness and cognitive intelligence ((MacEachern et al., 2022; Nader, 2023; Rojas, 2024; Shimamoto, 2021; Verschuren, 2023). However, most existing studies examine these factors in isolation, and there is still a limited understanding of how these two aspects interact simultaneously to affect overall health, especially in young adults navigating university life. Moreover, the existing literature often emphasizes only physical outcomes and neglects other important health dimensions such as mental and cognitive well-being.

This lack of activity can hinder an individual's ability to perform daily tasks optimally. Additionally, several researches highlight that low physical fitness levels negatively impact sleep quality and mental health (Altunalan, 2024; Smith, 2023; Vargas, 2021; Yan, 2024). Poor sleep and sleep disorders such as insomnia can lead to chronic fatigue and reduced productivity. Despite the well-established importance of physical activity and sleep quality, their combined impact on health-related physical fitness and cognitive performance remains underexplored, making this research essential in filling the knowledge gap. Sleep disturbances experienced by many people today are often caused by unhealthy lifestyles, such as a lack of exercise, exposure to blue light from electronic devices before bed, and irregular eating patterns (Ai, 2022; Huang & Zhao, 2020; Yan, 2024). Recent studies indicate that poor sleep quality affects memory, cognitive abilities, and focus in daily activities (Lemes, 2024; Pancotto, 2021; Verschuren, 2023). Moreover, insufficient quality sleep can increase the risk of cognitive impairments in old age, such as Alzheimer's disease and vascular dementia (Casagrande et al., 2020; Feng, 2023; Huang & Zhao, 2020). Therefore, maintaining good sleep patterns and paying attention to physical fitness are essential for overall health.

This study introduces an integrated perspective by examining how physical activity levels and sleep quality interact to influence both physical fitness and cognitive functions, offering new insights into health promotion strategies. Furthermore, a fast-paced and convenience-driven lifestyle also impact mental health. High academic and work pressure often leads to stress and burnout, negatively affecting emotional well-being and individual performance. Research conducted by (Marlicz, 2023) indicates that approximately 89% of students experience varying levels of burnout, partly due to low physical fitness levels and insufficient physical activity. Understanding these relationships is vital for designing interventions that promote mental resilience and overall health. Previous studies have found that 57% of students have a moderate level of physical fitness, while 19% fall into the low category (Corral-Pérez, 2024; Hadiana et al., 2023). This finding suggests that many individuals still require increased physical activity to maintain their health. This study aims to bridge those gaps by examining the relationship between physical activity levels and sleep quality, and how both contribute to physical fitness and cognitive intelligence among university students. Through this integrative approach, the study provides a more holistic view of student wellness that goes beyond physical health to include cognitive and possibly mental dimensions as well.

2. Method

This research adopts a quantitative approach with a correlational design, aiming to determine the relationships between physical activity levels, sleep quality, health-related physical fitness, and cognitive intelligence. The study was conducted on students at the Faculty of Health Sciences, Jenderal Soedirman University, involving 60 participants who were selected through a consecutive sampling technique. Participants were included based on several inclusion criteria, such as being an active undergraduate student aged between 18–25 years, in good physical and mental health, and willing to participate voluntarily. Meanwhile, exclusion criteria included students with diagnosed sleep disorders, neurological problems, or physical limitations that might interfere with fitness testing.

The research procedure consisted of four main stages. The first stage was recruitment, where students were informed about the research and invited to participate. In the second stage, screening was conducted to ensure that participants met the established inclusion and exclusion criteria. The third stage was data collection, in which participants filled out self-reported questionnaires and underwent a series of physical and cognitive tests. Finally, in the assessment stage, data were processed and analyzed using statistical software. In the data collection phase, physical activity levels were measured using the International Physical Activity Questionnaire (IPAQ)(Giustino et al., 2020), assessing sleep quality with the Pittsburgh Sleep Quality Index (PSQI) (Smyth, 2000), evaluating physical fitness using the Multistage Fitness Test (MFT) (Leger et al., 1988) to determine VO_2Max levels, and measuring cognitive performance through the Digit Span Test from the Wechsler Adult Intelligence Scale (WAIS) and Wechsler Intelligence Scale for Children (WISC) (Webber & Soble, 2018).

Prior to conducting the main statistical analysis, prerequisite tests such as normality and homogeneity tests were carried out to determine the suitability of the data for further analysis. Afterward, correlation tests were used to explore the relationships among variables, and regression analysis was performed to examine the extent to which physical activity and sleep quality could predict health-related physical fitness and cognitive intelligence. All data were analyzed using SPSS software, ensuring the accuracy and reliability of the results. This structured methodology allows for reproducibility by other researchers and provides valuable insight into the influence of lifestyle factors on student health and cognitive function.

3. Result

Respondent Characteristics

Table 1 presents descriptive statistics for the Body Mass Index (BMI) and age of the respondents. Participants' BMI ranged from 17.0 to 23.6 kg/m^2, with a mean score of 18.71 kg/m^2 and a standard deviation of 1.62 kg/m^2. Participants' ages ranged from 19 to 21 years, with a mean score of 19.74 years and a standard deviation of 1.41.

Table 1. Descriptive statistics of respondents' body mass index and age

Variable	Minimum	Maximum	Mean ± SD
Body Mass Index (BMI)	17.0	23.6	18.71 ± 1.62
Age (years)	19	21	19.74 ± 1.41

The data indicate that participants generally fall within the normal BMI range and represent a homogenous, early adulthood age group suitable for examining health and cognitive related variables in a student population. This uniformity supports the reliability of the findings by minimizing demographic variation and highlighting health patterns relevant to young adults.

Physical Activity Level

Table 2. Frequency distribution physical activity level

No.	Category	Frequency	Percentage (%)
1	Heavy Physical Activity	16	26,67%
2	Moderate Physical Activity	35	58,33%
3	Light Physical Activity	9	15%

Table 2 shows that the majority of participants maintain at least moderate levels of physical activity, indicating a generally active lifestyle among the student cohort. This suggests that daily routines or environmental factors may support physical engagement to some extent. However, the presence of a smaller group (15%) classified under light physical activity raises concerns regarding potential disparities in lifestyle habits and highlights the need for targeted interventions. These findings point to the importance of promoting more inclusive and accessible physical activity programs, especially for students who may face barriers to maintaining an active lifestyle. Understanding these differences is essential for developing strategies that foster consistent physical engagement across the entire student population.

Sleep Quality

Table 3. Frequency distribution of sleep quality

No.	Category	Score Range	Frequency	Percentage (%)
1	Good	<5	48	80%
2	Poor	>5	12	20%

Table 3 highlights a generally favorable trend in sleep quality among participants, reflecting the potential role of healthy sleep habits in supporting student well-being and academic performance. However, the presence of individuals experiencing poor sleep underscores the importance of early identification and intervention strategies to address sleep-related issues that may impact physical and cognitive functioning.

Physical Fitness Level

Table 4. Frequency distribution of physical fitness

No.	Category	Score Range	Frequency	Percentage (%)
1	Very good	69 – 70	2	10%
2	Good	61 – 68	3	15%
3	Moderate	52 – 60	9	45%
4	Low	44 – 51	5	25%
5	Very low	40 – 43	1	5%

Table 4 reveals an uneven distribution of physical fitness levels, with a notable concentration in the moderate category but relatively low representation in the higher fitness ranges. This pattern may reflect limited engagement in structured physical training or lifestyle habits that do not sufficiently support optimal fitness. The presence of students with low and very low fitness levels raises concerns and suggests a need for targeted initiatives to enhance physical activity, encourage healthier routines, and support overall physical development among students.

Cognitive Intelligence

Table 5. Cognitive intelligence test results

No	Category	Score Range	Frequency	Percentage (%)
1	Very good	16-19	5	8,33%
2	Good	12-15	16	26,67%
3	Average	8-11	28	46,67%
4	Poor	4 – 7	11	18,33%
5	Very Poor	0 – 3	0	0%

Table 5 highlights a generally positive trend in the cognitive intelligence levels of participants, with most students performing within the average to good categories. This distribution suggests that the majority possess adequate cognitive functioning to support academic and problem-solving tasks. However, the presence of a subgroup with poor cognitive scores emphasizes the importance of identifying students who may benefit from additional academic support or cognitive training. Interestingly, the absence of students in the very poor category may reflect a baseline level of intellectual readiness within the sample. These findings underscore the need for inclusive strategies to nurture cognitive growth while also addressing gaps among lower-performing individuals.

Hypothesis Testing

Before proceeding to hypothesis testing, the data were first examined through prerequisite tests, including normality and linearity tests. The results of the Shapiro-Wilk normality test indicated that all variables were normally distributed, with significance values for physical activity level ($p = 0.144$), sleep quality ($p = 0.690$), physical fitness level ($p = 0.197$), and cognitive intelligence ($p = 0.432$), all exceeding the 0.05 threshold. Furthermore, the linearity test showed that all variable relationships were linear, with significance values as follows: physical activity level * physical fitness level ($p = 0.957$), sleep quality * physical fitness level ($p = 0.804$), physical activity level * cognitive intelligence ($p = 0.941$), and sleep quality * cognitive intelligence ($p = 0.962$).

Correlation Test Results

Pearson correlation tests were conducted to assess the relationship between independent variables (physical activity level and sleep quality) and dependent variables (physical fitness level and cognitive intelligence). All independent variables show a positive and significant relationship with the dependent variables ($p<0.05$).

Table 6. Correlation test results

Relationship	*r*	Sig.	Interpretation
Physical activity level and physical fitness level	0.571	0.002	Positive Correlation
Sleep quality and physical fitness level	0.735	0.000	Strong Significant Correlation
Physical activity level and cognitive intelligence	0.520	0.004	Positive Correlation
Sleep quality and cognitive intelligence	0.674	0.001	Strong Significant Correlation

Multiple Correlation Test Results

A multiple correlation test was conducted to examine the simultaneous relationship between physical activity level and sleep quality and the dependent variables.

Table 7. Multiple correlation test results

Dependent Variable	Multiple Correlation (*R*)	R^2	Sig.	Interpretation
Physical fitness level	0.812	0.659	0.000	Strong Positive Correlation
Cognitive intelligence	0.735	0.541	0.001	Strong Positive Correlation

Table 7 describe that the combination of physical activity level and sleep quality has a strong correlation with physical fitness level and cognitive intelligence, with both models being statistically significant ($p<0.05$).

Multiple Regression Analysis

To determine the extent to which physical activity level (X_1) and sleep quality (X_2) contribute to physical fitness level (Y_1) and cognitive intelligence (Y_2), a multiple regression analysis was conducted. The results provide insight into the relative importance of these independent variables in influencing both physical and cognitive outcomes.

Table 8. Multiple regression test results

Variable	F count	F table	Sig.
Physical activity level, sleep quality, and physical fitness level	17.36	3.49	0.000
Physical activity level, sleep quality, and physical fitness level	16.72	3.49	0.001

Table 8 highlights how lifestyle factors like physical activity and sleep quality play a vital role in shaping both physical fitness and cognitive intelligence. The results underscore the importance of fostering balanced daily routines, as both variables together exhibit a meaningful contribution to overall health and mental performance. These findings suggest that integrated interventions targeting physical activity and sleep habits could serve as effective strategies to support not only physical well-being but also cognitive development.

Effective and Relative Contribution Analysis

The Effective Contribution (EC) and Relative Contribution (RC) of each independent variable were calculated to determine their impact on the dependent variables.

Table 9. Effective and relative contribution analysis result

Independent Variable	EC to Physical Fitness (%)	EC to Cognitive Intelligence (%)	RC to Physical Fitness (%)	RC to Cognitive Intelligence (%)	Sig.
Physical activity level	32.7%	25.4%	49.6%	47.0%	0.002
Sleep quality	33.2%	28.7%	50.4%	53.0%	0.000

The analysis of the data reveals that sleep quality has a slightly greater impact than physical activity level on both physical fitness level and cognitive intelligence. This suggests that participants with better sleep quality tend to demonstrate higher levels of physical fitness and cognitive performance compared to those with lower sleep quality, regardless of their physical activity levels. Furthermore, the regression analysis and contribution values confirm that sleep quality plays a more dominant role in shaping cognitive intelligence than physical activity level. This finding highlights the critical role of adequate and quality sleep in supporting not only physical well-being but also cognitive functioning, emphasizing the need for proper sleep management as a key factor in overall health and performance.

Discussion

This study examined the impact of physical activity and sleep quality on physical fitness and cognitive intelligence among university students. The findings revealed significant positive correlations between physical activity and physical fitness ($r = 0.571$, $p = 0.002$), sleep quality and physical fitness ($r = 0.735$, $p = 0.000$), physical activity and cognitive intelligence ($r = 0.520$, $p = 0.004$), and sleep quality and cognitive intelligence ($r = 0.674$, $p = 0.001$). Regression analysis showed that sleep quality contributed 33.2% to physical fitness and 28.7% to cognitive intelligence, while physical activity contributed 32.7% and 25.4%, respectively. These results align with previous studies highlighting the essential role of both factors in maintaining cognitive and physical well-being (Agostino, 2023; Haryanto, 2024; Huang & Zhao, 2020; Marijančić, 2023).

This study investigated the influence of physical activity and sleep quality on physical fitness and cognitive intelligence among university students. The findings revealed statistically significant and positive correlations between all variables, indicating the interconnected roles of lifestyle factors in shaping students' physical and cognitive outcomes.

Impact of Physical Activity on Physical Fitness and Cognitive Intelligence

The analysis revealed a significant positive relationship between physical activity and physical fitness ($r = 0.571$, $p = 0.002$), confirming that students who engage in regular physical activity tend to have better levels of physical fitness. This supports the well established physiological understanding that exercise improves cardiovascular endurance, muscle strength, and metabolic efficiency. Additionally, a moderate but significant correlation between physical activity and cognitive intelligence ($r = 0.520$, $p = 0.004$) reinforces previous studies showing that regular physical activity enhances cerebral blood flow, promotes neurogenesis, and improves executive functioning and memory (Tikhomirov, 2024; Verdelho, 2022).

Impact of Sleep Quality on Physical Fitness and Cognitive Intelligence

Sleep quality showed a strong positive correlation with both physical fitness ($r = 0.735$, $p = 0.000$) and cognitive intelligence ($r = 0.674$, $p = 0.001$), suggesting that sleep plays a vital restorative role in both physical and cognitive processes. Students with better sleep quality were more physically fit and cognitively alert. This aligns with studies indicating that deep sleep stages support muscle recovery and hormonal balance essential for physical fitness, while also facilitating memory consolidation and cognitive processing (Alfini, 2022; Patel, 2024; Hbaieb, 2025).

Joint Effect of Physical Activity and Sleep Quality on Physical Fitness

Regression analysis showed that physical activity and sleep quality together explained 65.9% of variance in physical fitness, suggesting a strong combined influence of these two lifestyle factors. Notably, sleep quality contributed slightly more to the model (33.2%) compared to physical activity (32.7%), suggesting that rest and recovery may play equal, if not a little more, important roles in determining physical performance. While regular physical activity is widely recognized to improve cardiovascular endurance, muscle strength, and metabolic function (Sholikhah & Tuah, 2021), getting enough sleep enhances these benefits by promoting tissue repair, hormonal regulation, and overall recovery. The interaction between these variables shows a synergistic relationship, where good sleep quality can increase the effectiveness of physical exercise and reduce the risk of fatigue or overtraining. These findings underscore the importance of adopting a holistic approach to student health by integrating an active lifestyle and healthy sleep behaviors. As a result, programs that aim to improve physical fitness among college students should not only promote regular exercise routines but also

encourage sleep hygiene education and stress management strategies to optimize recovery and physical outcomes (Yuliastrid et al., 2024).

Joint Effect of Physical Activity and Sleep Quality on Cognitive Intelligence

Both physical activity and sleep quality also significantly contributed to cognitive intelligence, together explaining 54.1% of its variance. Sleep quality (28.7%) had a marginally stronger contribution than physical activity (25.4%), reinforcing that adequate and quality sleep is fundamental for higher-order cognitive functions such as attention, reasoning, and problem-solving. The integrative approach of this study provides novel evidence that the synergistic impact of physical activity and sleep quality supports optimal cognitive performance in students.

The novelty of this research lies in its integrated approach, demonstrating that while both physical activity and sleep quality are crucial, sleep quality has a slightly stronger influence on cognitive intelligence. Unlike previous studies that often examined these factors separately, this study provides a holistic perspective on their combined impact. Additionally, the use of validated measurement tools strengthens the reliability of the findings. The results also emphasize the importance of maintaining good sleep hygiene, as inadequate sleep has been linked to impaired cognitive abilities, such as memory retention and focus (Alfini, 2022; Chow, 2023; Corral-Pérez, 2024; Hbaieb, 2025; Patel, 2024). Meanwhile, regular physical activity has been shown to enhance neuroplasticity, further supporting cognitive function (Tikhomirov, 2024; Verdelho, 2022; Wang, 2024)

Despite its strengths, this study has limitations, including a relatively small sample size (n = 60) and reliance on self-reported data, which may introduce bias. The cross-sectional design also prevents causal inference, necessitating future longitudinal studies. Additionally, the sample was drawn from a single university, which may limit the generalizability of the findings. Future research should incorporate larger, more diverse samples and objective measures like actigraphy and accelerometry to minimize bias and improve data accuracy.

Future research should also explore intervention programs that integrate structured physical activity and sleep education to optimize student health and cognitive function. Experimental designs could help determine causality, and exploring the effects of other lifestyle factors, such as nutrition and stress, could provide deeper insights. These findings underscore the importance of promoting both active lifestyles and good sleep hygiene to enhance students' cognitive and physical health. Universities should integrate structured physical activity and sleep education programs into health promotion strategies to optimize overall well-being.

Conclusion and Recommendation

This study concludes that both physical activity and sleep quality play essential roles in improving physical fitness and cognitive intelligence among university students. While both factors contribute significantly, sleep quality appears to have a slightly greater influence on cognitive intelligence. These findings emphasize the importance of maintaining an active lifestyle and proper sleep hygiene as key components of student well-being. Given the significant relationships observed, it is evident that promoting healthier habits can enhance both physical and cognitive performance.

Based on these findings, it is recommended that universities implement structured programs encouraging regular physical activity and sleep hygiene awareness. Future research should focus on expanding the sample size, incorporating objective measurement tools, and exploring intervention-based studies to assess the long-term effects of these factors. Additionally, investigating other lifestyle variables, such as nutrition and mental health, can provide a more comprehensive understanding of

student well-being. Policymakers and educational institutions should collaborate to design evidence-based health programs that foster both physical and cognitive development, ultimately contributing to better academic performance and overall quality of life.

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References

Agostino, S. (2023). Physical strength levels and short-term memory efficiency in primary school children: A possible match? *Journal of Sports Medicine and Physical Fitness*, *63*, 1343–1349. https://doi.org/10.23736/S0022-4707.23.14996-6

Ai, J. Y. (2022). Effects of Multi-Component Exercise on Sleep Quality in Middle-Aged Adults. *International Journal of Environmental Research and Public Health*, *19*(23). https://doi.org/10.3390/ijerph192315472

Alfini, A. J. (2022). Cardiorespiratory Fitness as a Moderator of Sleep-Related Associations with Hippocampal Volume and Cognition. *Brain Sciences*, *12*(10). https://doi.org/10.3390/brainsci12101360

Altunalan, T. (2024). The relationship between physical activity level and timing and sleep quality and hygiene in healthy individuals: A cross-sectional study. *BMC Public Health*, *24*(1). https://doi.org/10.1186/s12889-024-20708-1

Bermudo-Gallaguet, A., Velázquez-Díaz, D., Sanz, B., Cadenas-Sanchez, C., Cabeza-Ruiz, R., Andres, A., Gajewski, P. D., Plini, E. R. G., & Hola, V. (2023). The Effect of Two Somatic-Based Practices Dance and Martial Arts on Irisin, BDNF Levels and Cognitive and Physical Fitness in Older Adults: A Randomized Control Trial. *Clinical Interventions in Aging*, *14*(3), 652–661. https://doi.org/10.1111/jir.12883

Casagrande, M., Favieri, F., Tambelli, R., & Forte, G. (2020). The enemy who sealed the world: Effects quarantine due to the COVID-19 on sleep quality, anxiety, and psychological distress in the Italian population. *Sleep Medicine*. https://doi.org/10.1016/j.sleep.2020.05.011

Chow, C. H. (2023). The relationship between sleep and physical activity in an in-patient rehabilitation stroke setting: A cross-sectional study. *Topics in Stroke Rehabilitation*, *30*(1), 43–52. https://doi.org/10.1080/10749357.2021.2006982

Corral-Pérez, J. (2024). Associations Between Physical Activity and Inactivity Levels on Physical Function and Sleep Parameters of Older Adults With Frailty Phenotype. *Journal of Applied Gerontology*, *43*(7), 910–921. https://doi.org/10.1177/07334648231218095

Feng, Y. (2023). Relationship between serum brain-derived neurotrophic factor and cognitive impairment in children with sleep-disordered breathing. *Frontiers in Pediatrics*, *10*. https://doi.org/10.3389/fped.2022.1027894

Giustino, V., Parroco, A. M., Gennaro, A., Musumeci, G., Palma, A., & Battaglia, G. (2020). Physical Activity Levels and Related Energy Expenditure during COVID-19 Quarantine among the Sicilian Active Population: A Cross-Sectional Online Survey Study. *Sustainability*, *12*(4356).

Goevaerts, W. F. (2023). Adherence to a lifestyle monitoring system in patients with heart disease: Protocol for the care-on prospective observational trial. *BMC Cardiovascular Disorders*, *23*(1). https://doi.org/10.1186/s12872-023-03222-x

Gutiérrez-Espinoza, H. (2024). Lifestyle behavior of physiotherapy students from Ecuador upon admission to higher education: A cross-sectional study. *Frontiers in Sports and Active Living*, *6*. https://doi.org/10.3389/fspor.2024.1352144

Hadiana, O., Syamaun, M., & Ratnawati, R. (2023). Implementation of the Inquiry Model on the Critical Thinking Ability of Prospective Physical Education Teachers in Football Learning. *Physical Activity Journal*, *5*(1), 47. https://doi.org/10.20884/1.paju.2023.5.1.9764

Haryanto, J. (2024). Exploring cognitive processing speed, emotional intelligence, and topspin shot accuracy in table tennis. *Journal of Physical Education and Sport*, *24*(3), 695–702. https://doi.org/10.7752/jpes.2024.03082

Hbaieb, M. A. (2025). Endothelial Dysfunction in Acute Myocardial Infarction: A Complex Association With Sleep Health, Traditional Cardiovascular Risk Factors and Prognostic Markers. *Clinical Cardiology*, *48*(1). https://doi.org/10.1002/clc.70080

Huang, Y., & Zhao, N. (2020). Generalized anxiety disorder, depressive symptoms and sleep quality during COVID-19 outbreak in China: A web-based cross-sectional survey. *Psychiatry Research*. https://doi.org/10.1016/j.psychres.2020.112954

Leger, L. A., Mercier, D., Gadoury, C., & ... (1988). The multistage 20 metre shuttle run test for aerobic fitness. *Journal of Sports …*. https://doi.org/10.1080/02640418808729800

Lemes, V. B. (2024). Associations of sleep time, quality of life, and obesity indicators on physical literacy components: A structural equation model. *BMC Pediatrics*, *24*(1). https://doi.org/10.1186/s12887-024-04609-1

MacEachern, S., Forkert, N. D., Lemay, J. F., & Dewey, D. (2022). Physical Activity Participation and Barriers for Children and Adolescents with Disabilities. *International Journal of Disability, Development and Education*, *69*(1), 204–216. https://doi.org/10.1080/1034912X.2021.1952939

Marijančić, V. (2023). Relationship between Physical Activity and Sedentary Behavior, Spinal Curvatures, Endurance and Balance of the Trunk Muscles-Extended Physical Health Analysis in Young Adults. *International Journal of Environmental Research and Public Health*, *20*(20). https://doi.org/10.3390/ijerph20206938

Marlicz, W. (2023). Burnout in healthcare—The Emperor's New Clothes. In *Przeglad Gastroenterologiczny* (Vol. 18, Issue 3, pp. 274–280). https://doi.org/10.5114/PG.2023.131595

Mulé, D., Jeger, I., Dötsch, J., Breido, F., Ferrari, N., & Joisten, C. (2022). Correlation between Language Development and Motor Skills, Physical Activity, and Leisure Time Behaviour in Preschool-Aged Children. *Children*, *9*(3). https://doi.org/10.3390/children9030431

Nader, P. A. (2023). Results from the Lebanese 2022 report card on physical activity for children and youth. *Journal of Exercise Science and Fitness*, *21*(1), 14–19. https://doi.org/10.1016/j.jesf.2022.10.007

Pancotto, H. P. (2021). Influence of swimming on sleep and quality of life of people with visual impairments. *Revista Brasileira de Medicina Do Esporte*, *27*(2), 179–183. https://doi.org/10.1590/1517-869220212702191748

Patel, A. (2024). The effect of exercise on daytime sleepiness in healthy individuals. In *Sleep Medicine* (Vol. 120, pp. 10–14). https://doi.org/10.1016/j.sleep.2024.05.049

Rojas, G. (2024). Physical activity level and physical fitness in subjects with chronic musculoskeletal pain: A cross-sectional study. *PeerJ*, *12*. https://doi.org/10.7717/peerj.16880

Sepriadi, Syafruddin, Khairuddin, Alnedral, Bafirman, Rifki, M. S., Ihsan, N., Eldawaty, Hayati, S. R., Pratiwi, H., Pratiwi, M. D., & Chaeroni, A. (2024). Effect of nutritional status and parents' income on physical fitness of elementary school students. *Retos*, *58*, 506–510. https://doi.org/10.47197/retos.v58.107998

Shimamoto, H. (2021). Relationships between depression, daily physical activity, physical fitness, and daytime sleepiness among japanese university students. *International Journal of Environmental Research and Public Health*, *18*(15). https://doi.org/10.3390/ijerph18158036

Sholikhah, A. M., & Tuah, N. A. A. H. M. (2021). *Predictors of Overweight and Obesity Among Children and Adolescents in Developing Countries: A Literature Review*. 338–350. https://doi.org/10.2991/assehr.k.211223.059

Smith, P. J. (2023). Sleep Quality, Metabolic Function, Physical Activity, and Neurocognition Among Individuals with Resistant Hypertension. *Journal of Alzheimer's Disease : JAD*, *93*(3), 995–1006. https://doi.org/10.3233/JAD-230029

Smyth, C. (2000). The Pittsburgh Sleep Quality Index (PSQI). *Director (Cincinnati, Ohio)*. https://doi.org/10.1067/min.2000.107649

Tikhomirov, R. (2024). The Effect of Physical Activity of Varying Intensity on Students' Cognitive Abilities. *Education and Self Development*, *19*(3), 165–180. https://doi.org/10.26907/esd.19.3.12

Vargas, C. A. (2021). Syndrome metabolic markers, fitness and body fat is associated with sleep quality in women with severe/morbid obesity. *International Journal of Environmental Research and Public Health*, *18*(17). https://doi.org/10.3390/ijerph18179294

Verdelho, A. (2022). Physical Activity Self-Report Is Not Reliable among Subjects with Mild Vascular Cognitive Impairment: The AFIVASC Study. *Journal of Alzheimer's Disease*, *87*(1), 405–414. https://doi.org/10.3233/JAD-215381

Verschuren, O. (2023). Real-time daily fatigue, sleep, physical activity, and health-related fitness in adults with cerebral palsy. *Developmental Medicine and Child Neurology*, *65*(4), 509–516. https://doi.org/10.1111/dmcn.15421

Walker, K. (2024). Patients' and staff's experiences of Well-Track physical activity and sleep quality intervention in an Early Intervention in Psychosis (EIP) service. *Advances in Mental Health*, *22*(3), 635–652. https://doi.org/10.1080/18387357.2024.2302118

Wang, T. (2024). A Cross-Sectional Study on the Association between Physical Activity and Cognitive Function Among Community-Dwelling Older Adults in Tianjin. *Current Alzheimer Research*, *21*(7), 517–525. https://doi.org/10.2174/0115672050347596241111112811

Webber, T. A., & Soble, J. R. (2018). Utility of various WAIS-IV Digit Span indices for identifying noncredible performance validity among cognitively impaired and unimpaired examinees. *Clinical Neuropsychologist*, *32*(4), 657–670. https://doi.org/10.1080/13854046.2017.1415374

Widanita, N., & Anggraeni, D. (2023). The Effect of Aerobic Exercise on Improving SleepQuality and Flexibility in Overweight Women in the Covid-19 Pandemic Era. *Physical Activity Journal (PAJU)*.

Wilhite, K., Booker, B., Huang, B. H., Antczak, D., Corbett, L., Parker, P., Noetel, M., Rissel, C., Lonsdale, C., Del Pozo Cruz, B., & Sanders, T. (2023). Combinations of Physical Activity, Sedentary Behavior, and Sleep Duration and Their Associations With Physical, Psychological, and Educational Outcomes in Children and Adolescents: A Systematic Review. *American Journal of Epidemiology*, *192*(4), 665–679. https://doi.org/10.1093/aje/kwac212

Wing, D. (2024). Cardiorespiratory Fitness and Sleep, but not Physical Activity, are Associated with Functional Connectivity in Older Adults. *Sports Medicine - Open*, *10*(1). https://doi.org/10.1186/s40798-024-00778-6

Yan, K. (2024). Association of daily physical activity with hypertension, depressive symptoms, loneliness, and poor sleep quality in aged 60–79 older adults. *Scientific Reports*, *14*(1). https://doi.org/10.1038/s41598-024-81798-w

Yuliastrid, D., Sholikhah, A. M., Mustar, Y. S., Noordia, A., Perwira, A., & Putera, S. H. P. (2024). A Cross-Sectional Study Exploring Sport Participation, Perceived Stress, and Its Association With Life Satisfaction Among University Students. *Sports Science and Health*, *14*(1), 5–12.