https://e-journal.hamzanwadi.ac.id/index.php/porkes
Vol. 8, No. 2, Hal 782-798 Agustus 2025
Doi: 10.29408/porkes.v8i2.30303

The Relationship of Physical Activity Intensity with Cardiorespiratory Fitness and Sleep Duration of Sport Education Students

Abdi Mulyawan*, Januar Abdilah Santoso, Jeane Betty Kurnia Jusuf

Sports Education Study Program, Faculty of Teacher Training and Education, Muhammadiyah University of East Kalimantan, Indonesia

*Correspondence: jas970@umkt.ac.id

Abstract

The relationship between physical activity intensity, cardiorespiratory fitness and sleep duration has become a vital health issue among students. The aim of this research is to analyze the relationship between physical activity intensity, cardiorespiratory fitness and sleep time in sports students at Universitas Muhammadiyah Kalimantan Timur. Using a cross-sectional design, this research was conducted on a sample of 102 students (68 men, 34 women) aged 18 to 25 years, who were selected using stratified random sampling. Data were collected using the International Physical Activity Questionnaire (IPAQ) to assess the intensity of physical activity, the Multistage Fitness Test (MFT) to assess cardiorespiratory fitness, and the Pittsburgh Sleep Quality Index (PSQI) to assess sleep duration. Pearson correlation and multiple linear regression were used in data analysis. The results showed that there was a significant positive correlation between physical activity intensity and cardiorespiratory fitness ($r = 0.642$, $p < 0.001$), a moderate positive correlation between physical activity intensity and sleep duration ($r = 0.468$, $p < 0.001$), and a significant correlation between cardiorespiratory fitness and sleep duration ($r = 0.537$, $p < 0.001$). This study confirms that maintaining adequate physical activity levels plays an important role in improving cardiorespiratory fitness and increasing optimal sleep duration in college students.

Keyword: Physical activity intensity; cardiorespiratory fitness; sleep duration; college students; physical education

Received: 14 Mey 2025 | Revised: 28 Mey, 9, 10 June 2025
Accepted: 13 June 2025 | Published: -15 June 2025

Introduction

Physical activity and cardiovascular disease allow an optimal balance between exercise time and health necessary to protect them because they are dissatisfied with physical performance and physical capacity (Romero-Blanco et al., 2020). Current company data (risk data) for 2023, the next 18-24 days in the US is 8.7% among students (Ministry of Education Culture & Technology, 2023). The reason is that people who are struggling with work do not take their work seriously, ignore it, and overcome the dangers of sedentary work (Sousa et al., 2021). Several recent studies have shown that there is a trend of decreasing physical activity among students, resulting in a 15-20% decline in cardiorespiratory fitness over the last decade (Lavie et al., 2019).

This decline was due to various factors, including an increase in sedentary lifestyles, gadget addiction, intense lecture hours, and time-consuming academic activities (Chastin et al., 2021). Additionally, changes in sleep behavior are also a major concern for students, with approximately 60% of students in Indonesia reporting insufficient sleep duration < 7 hours per day and poor sleep quality (Syamsoedin et al., 2021). The World Health Organization (WHO) recommends that young adults, including students, engage in at least 150-300 minutes per week of moderate-intensity physical activity or 75-150 minutes per week of vigorous-intensity physical activity to achieve optimal health benefits, including increased cardiorespiratory fitness (World Health Organization, 2020).

Nevertheless, implementing simple rezdrowiesi remains a major challenge for students, including students majoring in physical education who should have a higher awareness of the importance of physical activity (Romero-Blanco et al., 2020). Sports Education students are unique only because they undergo a curriculum that integrates theoretical components into the practice of physical activity. At least physical activity and cardiovascular disease do not stop over time (Wibowo et al., 2022). However, this means that students can only rely on the fact that Karena had a short academic career. The relationship between physical activity, cardiorespiratory fitness, and sleep duration is becoming increasingly important in research, considering that these three variables interact to influence students' health and academic performance.

(Dolezal et al., 2017) found that students with sufficient physical activity tended to have better cardiorespiratory fitness and more optimal sleep duration. On the other hand, students with low levels of physical activity are at risk of experiencing decreased cardiorespiratory fitness and sleep disorders (Sampasa-Kanyinga et al., 2020). Problems related to the relationship between physical activity, cardiorespiratory fitness and sleep duration in physical education students in Indonesia still require more comprehensive research. There is still mixed evidence regarding how the intensity of physical activity affects the cardiorespiratory fitness and sleep duration of Indonesian students, especially in courses that are directly related to physical activity such as Sports Education.

Previous research by (Wibowo et al., 2022) examined the relationship between sleep quality and cardiorespiratory fitness in students, but did not specifically analyze the role of physical activity intensity as a variable that can influence these two parameters. Muhammadiyah University of East Kalimantan (UMKT), as one of the universities that

organizes the Sports Science study program, is an ideal place to study it. Based on the first research, it can be concluded that UMKT Sports Education students have difficulty maintaining the correct level of physical activity, even though they take classes that are directly related to physical activity and sports. This likely affects their breathing, heart rate and sleep patterns.

Based on the definition above, this study aims to determine the relationship between physical activity intensity and cardiovascular fitness and sleep duration in undergraduate students of Sports Education at Muhammadiyah University, East Kalimantan. We hope that the results of this research can provide scientific support for developing strategies to improve students' cardiorespiratory fitness and sleep quality through targeted and measurable increases in physical activity. Diverse strategies have been suggested to tackle the issues of inadequate physical activity, suboptimal cardiorespiratory fitness, and poor sleep quality among university students.

Comprehensive strategies, such as curricular alterations to extend sports practice hours, the introduction of campus wellness initiatives, and teaching on healthy lifestyles, have been implemented at several colleges with differing outcomes (Fletcher & Landolfo, (2021). Technology-driven methods utilizing mobile applications for tracking physical activity and sleep have been beneficial in enhancing student awareness regarding the significance of physical activity (Feter et al., 2021; Maselli et al., 2018). Nonetheless, these methodologies have not explicitly examined the concurrent link among physical activity intensity, cardiorespiratory fitness, and sleep length within Indonesian sport education student cohorts.

This research provides a solution using a cross-sectional analytical method that concurrently assesses the link among these three variables to discern patterns that can inform the development of more targeted therapies. This project aims to utilize validated instruments such as IPAQ, MFT, and PSQI to deliver a thorough assessment of UMKT sport education students' conditions and establish a scientific foundation for the development of more effective and quantifiable student health enhancement initiatives. Moreover, the results of this study will enhance the existing information about the interrelation of physical activity, fitness, and sleep among Asian university populations, a subject that is currently underrepresented in the literature (Pengpid & Peltzer, 2019).

Method

This research uses an analytical and cross-sectional observational research design where variables are measured simultaneously. This approach was chosen to analyze the relationship between physical activity intensity (independent variable) with cardiorespiratory fitness and sleep duration (dependent variable) in the absence of intervention. This popular researcher is known for his participation in the Bachelor of Sports Education Study Program at Universitas Muhammadiyah Kalimantan Timur for 138 students. The sample size used in Slovenia is 5% and the error rate is at least 102%. The stratified random sampling method allows you to determine the results and increase the population density.

The criteria include: (1) actively studying the undergraduate program for up to 18 months, (2) 18 to 25 days, (3) safe training, and (4) influencing the results of measurements of cardiovascular, respiratory and musculoskeletal training. Selection criteria: (1) intensive

drug training, (2) required activity restrictions, and (3) maintenance and care. Instruments that can be used in this research include:

1. Physical Activity Intensity Measurement: The intensity of physical activity was assessed using the validated Indonesian version of the International Physical Activity Questionnaire (IPAQ), with a validity coefficient of r = 0.72 and a Cronbach's alpha reliability of 0.78. The IPAQ categorizes physical activity intensity into three levels: low < 600 MET-minutes/week, moderate 600-2999 MET-minutes/week, and high ≥ 3000 MET-minutes/week. This questionnaire evaluates physical activity across the domains of employment, transportation, domestic tasks, and recreation. The assessment standards for the IPAQ pertain to the Guidelines for Data Processing and Analysis established by the International Physical Activity Questionnaire (IPAQ Research Committee, 2005), which includes classification. Category 1 (poor) = fails to satisfy the criteria for categories 2 or 3; Category 2 (moderate) entails engaging in vigorous activity for a minimum of 20 minutes on three or more days per week, or participating in moderate activity/walking for at least 30 minutes on five or more days per week, or a combination of activities that collectively reach at least 600 MET-minutes per week. Category 3 (high) requires vigorous activity on at least three days achieving 1500 MET-minutes per week, or any combination of activities over seven days that totals at least 3000 MET-minutes per week (Craig et al., 2003; Hagströmer et al., 2006).
2. Cardiorespiratory Fitness Measurement: Cardiorespiratory fitness was assessed with the Multi-Stage Fitness Test (MFT), which estimates vo_2max in ml/kg/minute. The test exhibits a validity coefficient of r = 0.84 and a reliability coefficient of r = 0.92. vo_2max evaluation guidelines, as delineated by the American College of Sports Medicine (ACSM, 2022), categorize males as follows: very poor < 35 ml/kg/min, poor (35-38 ml/kg/min), fair 39-42 ml/kg/min, good 43-46 ml/kg/min, and very good > 46 ml/kg/min. For females with adjusted values: very bad < 28 ml/kg/min, poor 28-31 ml/kg/min, fair (32-35 ml/kg/min, good 36-39 ml/kg/min, and very good > 39 ml/kg/min. These standards have been modified for Asian populations according to the research conducted by (Tomkinson et al., 2017) and validated for Indonesian university students by (Prasetyo et al., 2020).
3. Sleep Duration Measurement: The sleep length was assessed utilizing the sleep duration component of the Indonesian adaptation of the Pittsburgh Sleep Quality Index (PSQI), which has a validity coefficient of r = 0.79 and a Cronbach's alpha reliability of 0.83. Sleep length evaluation guidelines are based on the National Sleep Foundation recommendations (Hirshkowitz et al., 2015), which classify sleep duration as insufficient < 7 hours/night, optimal 7-9 hours/night, and excessive > 9 hours/night. This categorization has been modified to align with World Health Organization (World Health Organization, 2020) guidelines for young adults in the Asia-Pacific region and has been validated for Indonesian populations by (Syamsoedin et al., 2021).

This research was developed in three main phases. The preparation phase includes obtaining approval from the UMKT Health Research Ethics Committee, preparing research instruments, and briefings for research assistants. Next, the implementation phase begins with filling out the consent information, followed by completing the IPAQ and PSQI questionnaires, taking several cardiorespiratory fitness measurements and anthropometric

measurements in the form of height and weight. The final phase consists of data analysis, economic analysis and interpretation of results to draw research conclusions, where the team processes the measurement results. Data were analyzed using IBM SPSS Statistics version 26 in the following steps:

1. Descriptive analysis It is used to describe the characteristics of the sample and the distribution of given research variables (mean, median, standard deviation, minimum and maximum values).
2. Test of normality and homogeneity The normality of the data was tested using the Kolmogorov-Smirnov test, and the homogeneity was tested using the Levene test. Data are considered normal if $p > 0.05$.
3. Correlation analysis Pearson correlation is used to analyze the relationship between physical activity intensity, cardiorespiratory fitness and sleep duration when the data are normally distributed. If the data are not normally distributed, Spearman's correlation is used.
4. Regression analysis Multiple linear regression was used to analyze the simultaneous relationship between physical activity intensity, cardiorespiratory fitness and sleep time, and the contribution of each variable was determined.
5. Significance test The results of the analysis are considered significant if the p-value is < 0.05 with a confidence interval of 95%.

This study received ethical approval from the Health Research Ethics Committee of Universitas Muhammadiyah Kalimantan Timur under the number 025/KEPK-UMKT/I/2025. All respondents participating in the study provided consent through informed consent.

Result

Table 1 shows the demographic characteristics of the 102 respondents who participated in this study. The majority of respondents (66.7%) were males between 18 and 25 years old with a mean age of 20.4 ± 1.6 years. The distribution of respondents by year group was relatively even, with the largest proportion coming from the class of 2023 (28.4%). The majority of respondents (58.8%) had a normal body mass index (BMI), with 23.5% considered overweight and 17.7% considered obese.

Table 1. Demographic characteristics of respondents (n=102)

Characteristics	Frequency (n)	Percentage (%)
Gender		
Male	68	66.7
Female	34	33.3
Age (years)		
18-19	29	28.4
20-21	43	42.2
22-25	30	29.4
Year of Admission		
2021	25	24.5
2022	27	26.5
2023	29	28.4
2024	21	20.6

Body Mass Index		
Underweight (<18.5)	0	0
Normal (18.5-22.9)	60	58.8
Overweight (23.0-24.9)	24	23.5
Obese (≥25.0)	18	17.7

Table 2 shows the distribution of respondents according to the intensity of physical activity, cardiovascular and respiratory health status, and sleep duration. The majority of respondents (55.9%) were characterized by a moderate intensity of physical activity, 30.4% described it as high and 13.7% as low. In terms of cardiorespiratory fitness, most of the respondents were in the fair (29.4%) and good (32.4%) categories, but still 19.6% of the respondents had poor cardiorespiratory fitness and 6.9% had very poor cardiorespiratory fitness. Regarding sleep duration, 58.8% of respondents had optimal sleep time (7-9 hours/night), while 41.2% had insufficient sleep time < 7 hours/night.

Table 2. Distribution of respondents according to the intensity of physical activity, cardiovascular status and sleep duration (n=102)

Variables	Frequency (n)	Percentage (%)
Physical Activity Intensity		
Low (<600 MET-minutes/week)	14	13.7
Moderate (600-2999 MET-minutes/week)	57	55.9
High (≥3000 MET-minutes/week)	31	30.4
Cardiorespiratory Fitness (VO_2Max)		
Very Poor	7	6.9
Poor	20	19.6
Fair	30	29.4
Good	33	32.4
Very Good	12	11.8
Sleep Duration		
Insufficient (<7 hours/night)	42	41.2
Optimal (7-9 hours/night)	60	58.8
Excessive (>9 hours/night)	0	0

Table 3 shows the descriptive statistics of the study variables. The mean intensity of physical activity of the respondents was 2217.5 ± 1256.8 MET-minutes/week, falling into the medium category. The average value of vo_2max as an indicator of cardiorespiratory fitness is 41.2 ± 6.4 ml/kg/min and is considered sufficient. Meanwhile, the average sleep time of respondents was 6.8 ± 1.1 hours/day, slightly below the recommended minimum sleep time (7 hours/day).

Table 3. Descriptive statistics of research variables (n=102)

Variables	Mean ± SD	Min	Max
Physical Activity Intensity (MET-minutes/week)	2217.5 ± 1256.8	480.0	4560.0
Cardiorespiratory Fitness (VO_2Max, ml/kg/min)	41.2 ± 6.4	28.5	55.8

https://e-journal.hamzanwadi.ac.id/index.php/porkes
Vol. 8, No. 2, Hal 782-798 Agustus 2025
Doi: 10.29408/porkes.v8i2.30303

Variables	Mean ± SD	Min	Max
Sleep Duration (hours/night)	6.8 ± 1.1	4.5	8.7

The results of the Pearson correlation analysis showed that there is a significant positive relationship between the intensity of physical activity and cardiorespiratory fitness $r = 0.642$, $p < 0.001$. This suggests that the greater the intensity of physical activity, the better the respondent's cardiorespiratory fitness. In Figure 1 you can see a visualization of the relationship between two variables. Simple linear regression analysis showed that physical activity intensity contributed 41.2% to the variability of cardiorespiratory fitness $R^2 = 0.412$, $F = 70.45$, $p < 0.001$. The resulting regression equation is: $vo_2max = 31.08 + 0.0046 \times$ physical activity intensity.

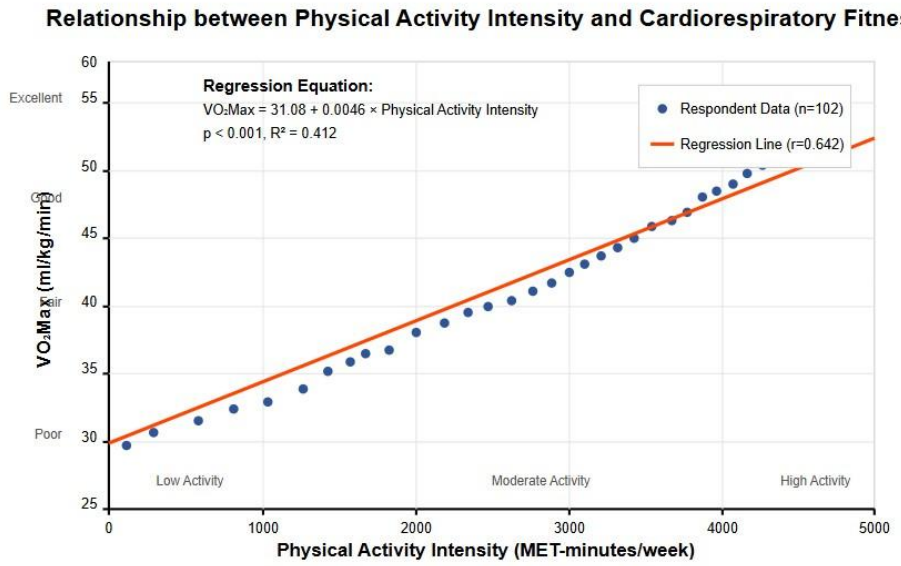

Figure 1. The relationship between the intensity of physical activity and cardiorespiratory fitness

There is a moderate and significant positive correlation between the intensity of physical activity and sleep duration $r = 0.468$, $p < 0.001$. These results indicate that students with greater intensity of physical activity tend to sleep longer. Regression analysis showed that the intensity of physical activity contributed 21.9% to the change in sleep duration $R^2 = 0.219$, $F = 28.10$, $p < 0.001$. The resulting regression equation is as follows: Sleep time = $5.77 + 0.00046 \times$ Physical activity intensity. The results of the Pearson correlation analysis showed that there was a significant positive relationship between cardiorespiratory fitness and sleep duration $r = 0.537$, $p < 0.001$.

This means that students with better cardiorespiratory fitness tend to have more optimal sleep times. Regression analysis showed that cardiorespiratory fitness contributed 28.8% to the change in sleep duration $R^2 = 0.288$, $F = 40.56$, $p < 0.001$. The resulting regression equation is: Sleep duration = $4.12 + 0.065 \times vo_2max$. Multiple linear regression analysis was carried out to determine the simultaneous relationship between physical activity intensity with cardiorespiratory fitness and sleep duration. The results of the analysis (Table 4) show

that these two independent variables together contributed 32.3% to the variability in sleep duration $R^2 = 0.323$, $F = 23.65$, $p < 0.001$.

Table 4. Results of linear regression analysis with sleep duration as the dependent variable.

Independent Variables	B	SE	β	t	p-value
Constant	4.026	0.348	-	11.569	<0.001
Physical Activity Intensity	0.00023	0.0001	0.262	2.364	0.020
Cardiorespiratory Fitness (VO_2Max)	0.048	0.014	0.380	3.429	0.001

$R^2 = 0.323$; $F = 23.65$; $p < 0.001$

Based on the results of the multiple regression analysis, the regression equation was obtained: Sleep time = 4.026 + 0.00023 × Physical activity intensity + 0.048 × vo_2max. These results indicate that both physical activity intensity and cardiorespiratory fitness significantly influence sleep duration, with cardiorespiratory fitness having a greater effect (β=0.380) than physical activity intensity (β=0.262). Additional analyzes were conducted to compare means of study variables by gender, school year, and BMI category. The results of the independent t-test showed that men had higher physical activity intensity (2466.3 ± 1298.5 vs. 1720.4 ± 1023.6 MET-minutes/week, $p < 0.001$) and cardiorespiratory fitness (44.2 ± 5.8 vs. 35.3 ± 3.2 ml/kg/min, $p < 0.001$) than Women. However, there were no significant differences in sleep duration depending on gender ($p = 0.217$).

The ANOVA results showed that there were no significant differences in the intensity of physical activity ($p = 0.358$) and sleep duration ($p = 0.462$) depending on the year of teaching. However, there were significant differences in cardiorespiratory fitness by class year ($p = 0.042$), with students in the Class of 2021 having the highest vo_2max values. According to BMI categories, ANOVA results showed significant differences in cardiorespiratory fitness ($p < 0.001$), with the normal BMI group having the highest vo_2max value compared to the overweight and obese groups. However, no significant differences were found in physical activity intensity ($p = 0.074$) and sleep duration ($p = 0.128$) depending on BMI category.

Discussion

This research investigated the correlation among physical activity intensity, cardiorespiratory fitness, and sleep length in students of sports education. The findings indicate substantial positive correlations among these three variables, validating the interrelation of physical activity, fitness, and sleep habits with student health. These findings respond to the research hypotheses outlined in the introduction about the impact of physical activity intensity on cardiorespiratory fitness and sleep duration among sport education students.

The findings indicated a robust positive association between the intensity of physical activity and cardiorespiratory fitness $r = 0.642$, $p < 0.001$, aligning with prior research by (Hamlin et al., 2021), which documented a significant correlation ($r = 0.71$) between both

variables among college students. The contribution of physical activity intensity to cardiorespiratory fitness (41.2%) underscores its significance in determining cardiorespiratory fitness, as corroborated by (Oliveira-Silva et al., 2022), who found that engaging in regular physical activity at least three times weekly for 30 minutes markedly enhanced vo_2max.

An intriguing discovery is that, despite being sport education students engaged in practical courses, 13.7% of respondents exhibited low physical activity intensity, and 26.5% demonstrated poor or very poor cardiorespiratory fitness. This suggests that being a student-athlete does not inherently ensure appropriate physical activity and fitness levels. This data corresponds with the results of (Andriani et al., 2023), which indicated that 21.4% of physical education students in Indonesia participated in minimal physical activity outside of practical exercises.

These findings theoretically endorse the physiological adaptation theory, which posits that heightened physical activity intensity will induce adaptations in the cardiorespiratory system via enhanced stroke volume, cardiac output, and oxygen consumption efficiency (Joyner & Casey, 2021). The fundamental mechanisms include augmented mitochondrial biogenesis, enhanced capillarization, and elevated cardiac contractility (Lin et al., 2022). This research is unusual in its confirmation of this link among Indonesian sport education students, a group hitherto underrepresented in studies, and in identifying persistent inequalities between academic level and physical activity engagement.

Factors contributing to diminished physical activity among certain students may encompass substantial academic demands, involvement in non-physical pursuits like student groups, and heightened sedentary behaviors, including device usage and social media engagement (Delello et al., 2025). Research conducted by (Yoon et al., 2021) indicated that students who engaged with screens for over 4 hours daily generally exhibited less physical activity and inferior cardiorespiratory fitness, irrespective of their academic discipline. This indicates that modern lifestyle circumstances may diminish the anticipated advantages of participation in a sports program.

Relationship Between Physical Activity Intensity and Sleep Duration

This study identified a moderate positive association between the intensity of physical activity and sleep duration $r = 0.468$, $p < 0.001$, suggesting that students engaging in higher levels of physical exercise generally have more favorable sleep duration. This study aligns with the results of (Kovacevic et al., 2022), which indicated that average sleep duration improved by 42 minutes in persons who consistently participated in moderate to intense physical exercise compared to those with low levels of physical activity.

The neurobiological and chronobiological views elucidate the mechanisms that connect physical exercise and sleep length. Physical exercise enhances adenosine synthesis, a neurotransmitter that regulates sleep-wake cycles, and influences circadian rhythms affecting sleep quality and length (Murray et al., 2021). Moreover, physical activity elevates core body temperature, and the ensuing cooling process post-exercise induces drowsiness and accelerates sleep onset (Dolezal et al., 2022). The release of endorphins and the decrease in cortisol levels generated by exercise also enhance sleep quality and duration (Kredlow et al., 2015).

The contribution of physical activity intensity to sleep duration (21.9%) signifies that, although physical activity is significant, additional factors such as academic stress, caffeine intake, pre-bedtime device usage, sleep environment, and class schedules also affect student sleep duration (Almojali et al., 2017; Buysse, 2014). This discovery introduces originality within the Indonesian student context, where cultural and academic elements may exert distinct influences relative to Western populations that have been well examined.

Relationship Between Cardiorespiratory Fitness and Sleep Duration

The findings indicated a substantial positive association between cardiorespiratory fitness and sleep length $r = 0.537$, $p < 0.001$, aligning with the results of (Zhang et al., 2022), which demonstrated that students with elevated vo_2max generally experienced improved sleep duration and quality. Cardiorespiratory fitness accounted for 28.8% of the variability in sleep duration, underscoring the significant influence of physical fitness on maintaining good sleep patterns.

The association between cardiorespiratory fitness and sleep length is reciprocal. On one side, optimal cardiorespiratory fitness enhances sleep quality by improving the efficiency of the circulatory and respiratory systems, regulating metabolism, and modulating neurotransmitters associated with sleep regulation, such as serotonin and melatonin (Wang & Boros, 2021). Improved cardiorespiratory fitness correlates with superior autonomic nervous system equilibrium, marked by heightened parasympathetic activity during rest, hence aiding in the start and maintenance of sleep (Zieglеret al., 2025).

Conversely, adequate sleep duration facilitates physiological recovery, hormonal modulation, and cardiovascular system adaptability, hence enhancing cardiorespiratory fitness (Franklin et al., 2022). Sleep deprivation impairs exercise performance and diminishes the efficacy of training adaptations (Fullagar et al., 2015). The reciprocal nature of this link underscores the significance of targeting both fitness and sleep in health promotion initiatives.

Multiple regression analysis indicated that cardiorespiratory fitness exerted a more significant effect ($\beta=0.380$) on sleep duration than physical activity intensity ($\beta=0.262$). This suggests that enhancing cardiorespiratory fitness, irrespective of the method employed, significantly influences sleep length. This conclusion is corroborated by research conducted by (Moraes et al., 2025) which indicated that those with elevated vo_2max levels experienced superior sleep duration and quality, even when accounting for physical activity levels.

Theoretical and Practical Implications

This research theoretically endorses the biobehavioral theory, which posits that optimal health arises from intricate connections among biological factors (cardiorespiratory fitness), behavioral factors (physical activity), and physiological aspects (sleep patterns). The findings validate an integrative model demonstrating that these three variables mutually influence one another within a comprehensive system, hence endorsing the principle of lifestyle medicine (Rippe, 2019).

The results indicating substantial disparities based on gender, academic year, and BMI category offer further insights for formulating targeted interventions. Gender disparities can be elucidated through physiological characteristics, like muscle mass composition, lung capacity, and hemoglobin levels, alongside sociocultural aspects that vary between males and

females (Guthold et al., 2020). These disparities indicate the necessity for gender-sensitive methodologies in the formulation of physical activity and health promotion initiatives.

The study identified variations in cardiorespiratory fitness over academic years, revealing that senior students (class of 2021) exhibited the greatest vo_2max values. This may result from accumulating experience and physiological adaptations throughout the study period, together with an enhanced understanding of the significance of sustaining physical fitness as prospective physical education instructors (Rodriguez-Ayllon et al., 2021) This finding raises doubts regarding the efficacy of current curricula in fostering sustained physical exercise throughout the academic program.

Novel Contributions and Comparisons with Previous Research

This study offers multiple original contributions to the current literature. This study explicitly investigates the correlation among physical activity intensity, cardiorespiratory fitness, and sleep length among Indonesian sport education students, a demographic that has been inadequately represented in global research. The study indicates that enrollment in a sport-related curriculum does not inherently provide ideal physical activity levels or fitness, hence questioning prevailing beliefs regarding sport education students.

The discovery that cardiorespiratory fitness exerts a greater impact on sleep duration than the level of physical exercise offers novel perspectives for intervention formulation. This indicates that programs aimed at enhancing fitness results may be more efficacious for sleep enhancement than those exclusively concentrated on augmenting activity levels. The study offers culture-specific data for Indonesian communities, highlighting the significant variations in physical activity patterns and sleep routines among different cultures (Pengpid & Peltzer, 2019).

This research identified analogous association patterns to Western studies, although exhibited distinct absolute values for physical activity levels and sleep length, indicating that cultural and environmental factors may affect these connections. This study reveals a prevalence of insufficient sleep at 41.2%, beyond the 25-30% recorded in comparable Western groups, suggesting a more significant sleep issue among Indonesian university students (Syamsoedin et al., 2021).

Limitations and Future Research Directions

This research has multiple limitations, including a cross-sectional design that precludes the establishment of causal relationships, reliance on self-report measures for certain variables that may introduce response bias, concentration on a single institution that restricts generalizability to the wider Indonesian student population, and insufficient control for confounding variables such as academic stress, caffeine consumption, and socioeconomic factors that may affect the three primary variables.

Future research should investigate targeted interventions that concurrently enhance these three variables within higher education settings, employ longitudinal designs to establish causal relationships, incorporate multiple institutions to enhance generalizability across Indonesia, explore potential mediators and moderators in the interactions between physical activity, cardiorespiratory fitness, and sleep duration, and assess the efficacy of technology-based interventions for improving these health behaviors among Indonesian university students.

Future research should integrate objective assessments of physical activity (accelerometry) and sleep (actigraphy) to mitigate measurement bias, examine the influence of cultural and environmental factors pertinent to Indonesian contexts, and analyze the long-term health and academic outcomes linked to these relationships. Investigating the cost-effectiveness of various intervention strategies would be beneficial for policy formulation.

Conclution

This study effectively addresses the research topics by establishing strong positive correlations among physical activity intensity, cardiorespiratory fitness, and sleep duration in students of sport education. Increased intensity of physical exercise correlates with enhanced cardiorespiratory fitness and extended sleep duration. Although respondents were students in a major linked to physical activity, a significant proportion still had low physical activity intensity, inadequate cardiorespiratory fitness, and insufficient sleep length, highlighting a disparity between theoretical understanding and actual application. This research reveals that cardiorespiratory fitness significantly impacts sleep length more than the level of physical exercise, underscoring the necessity of enhancing cardiorespiratory fitness to promote good sleep patterns.

Notable disparities in physical activity intensity and cardiorespiratory fitness by gender, and variations in cardiorespiratory fitness related to academic year and BMI category, offer more insights for the creation of more individualized and focused programs. This research underscores the necessity of incorporating structured physical activity into higher education curricula, formulating strategies to enhance student cardiorespiratory fitness, and executing holistic approaches that promote physical activity, improve physical fitness, and educate on sleep hygiene. The findings of this research can provide a basis for creating more efficient and evidence-based campus wellness programs.

Moreover, the results enhance the worldwide comprehension of health habits among university students, especially within underrepresented Asian demographics. The research limitations encompass a cross-sectional design that precludes the establishment of causal relationships, reliance on self-report measures for certain variables that may introduce response bias, concentration on a single institution that restricts generalizability to the wider Indonesian student population, and the omission of confounding variables such as academic stress, caffeine intake, and socioeconomic factors that could affect the three primary variables. The sample size, although sufficient for correlation analysis, may possess limited power for identifying smaller effect sizes in subgroup analyses.

Future research is required to investigate targeted interventions that can concurrently strengthen these three characteristics in higher education settings, utilize longitudinal designs to validate causal links, and incorporate different institutions to improve the generalizability of findings throughout Indonesia. Furthermore, research ought to analyze the mediating and moderating elements within these associations, assess the long-term health and academic results linked to these variables, and evaluate the cost-effectiveness of various intervention strategies for policy formulation. The incorporation of objective assessment instruments and

the acknowledgment of culturally distinctive elements in Indonesian contexts will enhance future inquiries in this critical domain of student health research.

Author's Statement

The author declares that this article has never been published in any other journal. I thank the Institute of Research and Community Service, Muhammadiyah University, East Kalimantan for their support in conducting this study, as well as all respondents and the research team who contributed to data collection and analysis.

Reference

Almojali, A. I., Almalki, S. A., Alothman, A. S., Masuadi, E. M., & Alaqeel, M. K. (2017). The Prevalence and Association of Stress with Sleep Quality Among Medical Students. *Journal of Epidemiology and Global Health*. 7(3). 169–174. https://doi.org/10.1016/j.jegh.2017.04.005

Andriani, R., Rusdiana, A., & Sultoni, K. (2023). Profil Aktivitas Fisik Mahasiswa Pendidikan Jasmani di Indonesia: Studi Cross-Sectional. *Jurnal Pendidikan Jasmani dan Olahraga*. 8(1), 78–87. https://doi.org/10.17509/jpjo.v8i1.48327

Buysse, D. J. (2014). Sleep Health: Can We Define It? Does It Matter?. National Library of Medicine. 37(1), 9–17. https://doi.org/10.5665/sleep.3298

Chastin, S. F. M., Abaraogu, U., Bourgois, J. G., Dall, P. M., Darnborough, J., Duncan, E., Dumortier, J., Jiménez Pavón, D., McParland, J., Roberts, N. J., & Hamer, M. (2021). Effects of Regular Physical Activity on the Immune System, Vaccination and Risk of Community-Acquired Infectious Disease in the General Population: Systematic Review and Meta-Analysis. *Sports Medicine*. 51(1), 1673–1686. https://link.springer.com/article/10.1007/s40279-021-01466-1

Craig, C. L., Marshall, A. L., Sjöström, M., Bauman, A. E., Booth, M. L., Ainsworth, B. E., Pratt, M., Ekelund, U., Yngve, A., Sallis, J. F., & Oja, P. (2003). International Physical Activity Questionnaire: 12-country reliability and validity. *Medicine & Science in Sports & Exercise.* 35(8), 1381–1395. https://doi.org/10.1249/01.MSS.0000078924.61453.FB

Delello, J., McWhorter, R., Yoo, S., Roberts, P., & Adele, B. (2025). The Impact of Esports on the Habits, Health, and Wellness of the Collegiate Player. *Journal of Intercollegiate Sport.* 18(1). 1-10. https://doi.org/10.17161/jis.v18i1.21714

Dolezal, B. A., Neufeld, E. V, Boland, D. M., Martin, J. L., & Cooper, C. B. (2022). Interrelationship Between Sleep and Exercise: A Systematic Review. *National Library of Medicine*. 2022, Article 5645624. https://pubmed.ncbi.nlm.nih.gov/28458924/

Dolezal, A. B., Neufeld, E. V., Boland, D. M., Martin, J. L., & Cooper, C. B. (2017). Interrelationship Between Sleep and Exercise: A Systematic Review. *Journal Advances in Priventive Medicine*. 26(1). 105. https://doi.org/10.1155/2017/1364387

Feter, N., Dos Santos, T. S., Caputo, E. L., & da Silva, M. C. (2021). What is the Role of Smartphones on Physical Activity Promotion? A Systematic Review and Meta-

Analysis. *International Journal of Public Health*. 66, 679–690. https://pubmed.ncbi.nlm.nih.gov/30758514/

Fullagar, H. H., Skorski, S., Duffield, R., Hammes, D., Coutts, A. J., & Meyer, T. (2015). Sleep and Athletic Performance: The Effects of Sleep Loss on Exercise Performance, and Physiological and Cognitive Responses to Exercise. *Sports Medicine*. 45(2). 161–186. https://doi.org/10.1007/s40279-014-0260-0

Fletcher, F. G., & Landolfo, C. (2021). Promoting Physical Activity and Exercise: JACC Health Promotion Series. *Journal of the American College of Cardiology*. 72(14), 1622-1639. https://www.sciencedirect.com/science/article/pii/S0735109718381695

Franklin, A. B., Eijsvogels, M. H. T., Pandey, A., Quindry, J., & Toth, P. P. (2022). Physical Activity, Cardiorespiratory Fitness, and Cardiovascular Health: A Clinical Practice Statement of the ASPC Part I: Bioenergetics, Contemporary Physical Activity Recommendations, Benefits, Risks, Extreme Exercise Regimens, Potential Maladaptations. *American Journal of Preventive Cardiology*.12(1). 1-13. https://doi.org/10.1016/j.ajpc.2022.100424

Guthold, R., Stevens, G. A., Riley, L. M., & Bull, F. C. (2020). Global Trends in Insufficient Physical Activity Among Adolescents: A Pooled Analysis of 298 Population-Based Surveys With 1·6 Million Participants. *The Lancet Child & Adolescent Health*. 4(1), 23–35. https://doi.org/10.1016/S2352-4642(19)30323-2

Hagströmer, M., Oja, P., & Sjöström, M. (2006). The International Physical Activity Questionnaire (IPAQ): A study of concurrent and construct validity. *Public Health Nutrition*, 9(6), 755–762. https://doi.org/10.1079/PHN2005898

Hamlin, M. J., Deuchrass, R. W., Olsen, P. D., Choukri, M. A., Marshall, H. C., Lizamore, C. A., Leong, C., & Elliot, C. A. (2021). The Effect of Sleep Quality and Quantity on Student-Athlete Performance, Well-Being and Recovery. *Journal Sports.* 9(8), 106. https://doi.org/10.3389/fspor.2021.705650

Hirshkowitz, M., Whiton, K., Albert, S. M., Alessi, C., Bruni, O., DonCarlos, L., Hazen, N., Herman, J., Katz, E. S., Kheirandish-Gozal, L., Neubauer, D. N., O'Donnell, A. E., Ohayon, M., Peever, J., Rawding, R., Sachdeva, R. C., Setters, B., Vitiello, M. V, Ware, J. C., & Adams Hillard, P. J. (2015). National Sleep Foundation's Sleep Time Duration Recommendations: Methodology and Results Summary. *Sleep Health*. 1(1), 40–43. https://doi.org/10.1016/j.sleh.2014.12.010

IPAQ Research Committee. (2005). Guidelines for Data Processing and Analysis of the International Physical Activity Questionnaire (IPAQ)-Short and Long Forms. https://www.ipaq.ki.se/scoring.pdf

Joyner, M. J., & Casey, D. P. (2021). Regulation of Increased Blood Flow (Hyperemia) to Muscles During Exercise: A Hierarchy of Competing Physiological Needs. *National Library of Medicine*. 101(1), 273–334. https://pubmed.ncbi.nlm.nih.gov/25834232/

Kovacevic, A., Mavros, Y., Heisz, J. J., & Fiatarone Singh, M. A. (2022). The Effect of Resistance Exercise on Sleep: A Systematic Review of Randomized Controlled Trials. *Sleep Medicine Reviews*, 59, 101535. https://doi.org/10.1016/j.smrv.2021.101535

Kredlow, M. A., Capozzoli, M. C., Hearon, B. A., Calkins, A. W., & Otto, M. W. (2015). The Effects of Physical Activity on Sleep: A Meta-Analytic Review. Journal of Behavioral Medicine, 38(3), 427–449. https://doi.org/10.1007/s10865-015-9617-6

Lavie, C. J., Ozemek, C., Carbone, S., Katzmarzyk, P. T., & Blair, S. N. (2019). Sedentary Behavior, Exercise, and Cardiovascular Health. *Circulation Research*. 124(5). 799–815. https://doi.org/10.1161/CIRCRESAHA.118.312669

Lee, J., & Kim, J. (2019). Associations of Physical Activity with Sedentary Behavior, Stress, and Academic Performance Among Korean Adolescents. *Health Promotion International*, 34(6), 1191–1200. https://doi.org/10.1093/heapro/day063

Lin, X., Zhang, X., Guo, J., Roberts, C. K., McKenzie, S., Wu, W. C., Liu, S., & Song, Y. (2022). Effects of Exercise Training on Cardiorespiratory Fitness and Biomarkers of Cardiometabolic Health: A Systematic Review and Meta-Analysis of Randomized Controlled Trials. *Journal of the American Heart Association*, 11(13), e024598. https://www.ahajournals.org/doi/full/10.1161/JAHA.115.002014

Ministry of Education Culture, R., & Technology. (2023). Implementation guide for Indonesian children's gymnastics excellence.

Murray, K., Godbole, S., Natarajan, L., Full, K., Hipp, J. A., Glanz, K., Mitchell, J., Laden, F., James, P., Quante, M., & Kerr, J. (2021). The Relations Between Sleep, Time of Physical Activity, and Time Outdoors Among Adult Women. *National Library of Medicine*. 16(1), e0245924. https://pubmed.ncbi.nlm.nih.gov/28877192/

Maselli, M., Ward, B. P., & Carraro, A., (2018). Promoting Physical Activity Among University Students: A Systematic Review of Controlled Trials. *American Journal of Health Promotion*. 32(7). 1-10. https://doi.org/10.1177/0890117117753798

Moraes, G. M., Soares, N. V., Netto, R. C. D. T., & Verardi, L. E. C. (2025). Ejercicio Físico y Síntomas de Depresión y Ansiedad en Estudiantes Universitarios: una Revisión Sistemática con Metaanálisis. *Journal Retos*. 67(1). 1-12. https://doi.org/10.47197/retos.v67.111276

Oliveira-Silva, I., Leicht, A. S., Moraes, M. R., Sim\~oes, H. G., Del Rosso, S., Córdova, C., & Boullosa, D. A. (2022). Heart Rate Variability and Cardiorespiratory Fitness in Physically Active and Inactive Adults: A Systematic Review and Meta-Analysis. *International Journal of Environmental Research and Public Health*, 19(4), 2185. https://doi.org/10.3390/ijerph19042185

Pengpid, S., & Peltzer, K. (2019). Physical Activity, Sedentary Behavior, and Health-Related Quality of Life Among University Students in 24 Countries. *International Journal of Environmental Research and Public Health*. 16(13), 2394. https://doi.org/10.3390/ijerph16122084

Prasetyo, Y., Wiriawan, O., Tartibian, B., Kusnanik, N. W., & Wahjuni, E. S. (2020). Cardiorespiratory Fitness Normative Data and Cardiovascular Disease Risk Among Indonesian University Students. *Pedagogy of Physical Culture and Sports*, 24(4), 162–168. https://doi.org/10.15561/26649837.2020.0402

Rippe, J. M. (2019). Lifestyle medicine: The Health Promoting Power of Daily Habits and Practices. *American Journal of Lifestyle Medicine*, 13(6), 499–512. https://doi.org/10.1177/1559827618785554

Rodriguez-Ayllon, M., Cadenas-Sánchez, C., Estévez-López, F., Muñoz, N. E., Mora-Gonzalez, J., Migueles, J. H., Molina-García, P., Henriksson, H., Mena-Molina, A., Martínez-Vizcaíno, V., Catena, A., Löf, M., Erickson, K. I., Lubans, D. R., Ortega, F. B., & Esteban-Cornejo, I. (2021). Role of Physical Activity and Sedentary Behavior in the Mental Health of Preschoolers, Children and Adolescents: A Systematic Review and Meta-Analysis. *Sports Medicine*, 51(2), 339–361. https://link.springer.com/article/10.1007/s40279-019-01099-5?platform=hootsuite&error=cookies_not_supported&code=8f0a66b7-1741-4d9f-a0f1-6039fe87639a

Romero-Blanco, C., Rodríguez-Almagro, J., Onieva-Zafra, M. D., Parra-Fernández, M. L., Prado-Laguna, M. D., & Hernández-Martínez, A. (2020). Physical Activity and Sedentary Lifestyle in University Students: Changes During Confinement due to the Covid-19 Pandemic. *International Journal of Environmental Research and Public Health*. 17(18). 6567. https://doi.org/10.3390/ijerph17186567

Sampasa-Kanyinga, H., Colman, I., Goldfield, G. S., Janssen, I., Wang, J., Podinic, I., Tremblay, M. S., Saunders, T. J., Sampson, M., & Chaput, J. P. (2020). Combinations of Physical Activity, Sedentary Time, and Sleep Duration and Their Associations With Depressive Symptoms and Other Mental Health Problems in Children and Adolescents: A Systematic Review. *International Journal of Behavioral Nutrition and Physical Activity*. 17(1), 72. https://doi.org/10.1186/s12966-020-00976-x

Sousa, G. R., Tavares, A. P. L., Silva, J. D. C., Silva, F. F., Pesquero, A. A. A., & Silva, M. G. (2021). Relationship between physical activity level and quality of sleep in Brazilian university students. *Revista de Atención Primaria*. 53(5). 101974. https://doi.org/10.1016/j.aprim.2021.101974

Syamsoedin, W. K. P., Kurnia, A. D., Indriyawati, N., & Nurmala, I. (2021). Poor Sleep Quality, Excessive Daytime Sleepiness and Their Associated Factors Among University Students in Indonesia: A Cross-Sectional Study. *Journal of Public Health Research*, 10(2), 2202. https://doi.org/10.4081/jphr.2021.2202

Tomkinson, G. R., Lang, J. J., Blanchard, J., Léger, L. A., & Tremblay, M. S. (2017). The 20-m Shuttle Run: Assessment and Interpretation of Data in Relation to Youth Aerobic Fitness and Health. *Pediatric Exercise Science*, 29(4), 441–460. https://pubmed.ncbi.nlm.nih.gov/30885058/

Wang, F., & Boros, S. (2021). The effect of physical activity on sleep quality: A systematic review. *European Journal of Physiotherapy*, 23(1), 11–18. https://doi.org/10.1080/21679169.2019.1623314

Wibowo, D. S., Permadi, A. W., & Yasa, I. M. A. (2022). Hubungan Kualitas Tidur Dengan Kebugaran Kardiorespirasi pada Mahasiswa Fisioterapi Universitas Dhyana Pura. *Jurnal Kesehatan, Sains, dan Teknologi (Jakasakti)*. 1(1), 157–164. https://doi.org/10.36002/js.v1i1.1962

World Health Organization. (2020). WHO Guidelines on Physical Activity and Sedentary Behaviour.

Yoon, S., Kim, S., Park, H., & Kim, J. (2021). Relationship Between Physical Activity Levels, Screen Time, and Self-Perceived Physical Fitness Among Korean University

Students: A Cross-Sectional Study. *International Journal of Environmental Research and Public Health*, 18(10), 5491. https://doi.org/10.3390/ijerph18105491

Zhang, Y., Liu, J., Zhang, Y., Ke, L., & Liu, R. (2022). Interactive Compensation Effects of Physical Activity and Sleep on Mental Health: A Longitudinal Panel Study among Chinese College Students during the COVID-19 Pandemic. *International Journal of Environmental Research and Public Health*. 19(19). https://doi.org/10.3390/ijerph191912323

Ziegler, A. K., Engelhardt, S., McAlpine, S. C., Guzik , J. T., Dimmeler, S., & Swirski, K. F. (2025). Neural Mechanisms in Cardiovascular Health and Disease. *Ahaiasa Journals*. 136(11). 1-10. https://doi.org/10.1161/CIRCRESAHA.125.325580