Majalah Ilmiah Fisioterapi Indonesia
Indonesian Scientific Journal of Physiotherapy

Original Research Articles
ISSN (Print): 2303-1921
ISSN (Online): 2722-0443
Volume 14, Number 1, Pages 29-34 (2026)
DOI: https://doi.org/10.24843/mifi.000001037

Physical Activity and Sleep Quality in Relation to Blood Pressure Among Young Adults: A Cross-Sectional Study

Farah Riskananda[1], Wahyu Tri Sudaryanto[2]

[1,2]Faculty of Health Sciences, Universitas Muhammadiyah Surakarta, Indonesia

Corresponding author:
Name: Wahyu Tri Sudaryanto
E-mail: wts831@ums.ac.id

Received 2 December 2025; Revised 16 December 2025; Accepted 17 December 2025; Published 2 January 2026

Abstract

Introduction: Blood pressure is a key indicator of cardiovascular health and is strongly influenced by lifestyle-related factors, particularly physical activity and sleep quality. Insufficient physical activity and poor sleep quality have been associated with impaired blood pressure regulation through neurohormonal and metabolic mechanisms; however, empirical evidence examining these relationships among young adults, especially university students, remains limited.
Objective: This study aimed to examine the relationship between physical activity, sleep quality, and blood pressure among young adult students at the Faculty of Health Sciences, Universitas Muhammadiyah Surakarta.
Methods: A quantitative observational study with a cross-sectional design was conducted involving 100 students aged 18–40 years. Physical activity was assessed using the International Physical Activity Questionnaire, sleep quality was measured using the Pittsburgh Sleep Quality Index, and blood pressure was measured using a digital sphygmomanometer. Data were analyzed using Spearman correlation, with systolic blood pressure as the primary outcome.
Results: The findings demonstrated a significant negative correlation between physical activity and systolic blood pressure ($r = -0.481$; $p < 0.001$). Sleep quality also showed a significant negative correlation with systolic blood pressure ($r = -0.257$; $p = 0.010$).
Conclusion: Higher levels of physical activity and better sleep quality were associated with lower and more controlled blood pressure among university students. These results highlight the importance of promoting active lifestyles and healthy sleep habits as early preventive strategies for cardiovascular risk in young adult populations.

Keywords
Young Adult; Blood Pressure; Hypertension; Physical Activity; Sleep Quality; Lifestyle.

Introduction

Blood pressure is a fundamental indicator of cardiovascular health, and its dysregulation plays a central role in the development of non-communicable diseases worldwide. Persistently elevated blood pressure substantially increases the risk of cardiovascular morbidity and mortality, including coronary heart disease, stroke, and heart failure.[1] Global data reported by the World Health Organization indicate that hypertension remains a major public health challenge, with high prevalence rates and low levels of awareness, treatment, and control, particularly in low- and middle-income countries.[2] These findings emphasize the importance of early preventive strategies targeting modifiable lifestyle factors before the onset of clinically overt cardiovascular disease.

Young adulthood represents a critical transitional period during which lifestyle behaviors are established and may persist into later life. University students, in particular, often experience changes in daily routines, academic stress, irregular sleep patterns, and reduced levels of structured physical activity. Although hypertension is more commonly diagnosed in older adults, evidence suggests that elevated blood pressure and prehypertensive states can already be observed in young adults and are associated with increased long-term cardiovascular risk. Early identification of lifestyle-related determinants of blood pressure among university students is therefore essential to support primordial and primary prevention efforts.

Physical activity has been consistently recognized as one of the most effective non-pharmacological strategies for blood pressure regulation. Regular physical activity contributes to reductions in systolic and diastolic blood pressure through several physiological mechanisms, including improved endothelial function, reduced peripheral vascular resistance, enhanced arterial compliance, and modulation of autonomic nervous system activity.[3] Additionally, physical activity promotes favorable metabolic adaptations such as improved insulin sensitivity, weight control, and reductions in systemic inflammation, all of which are closely linked to blood pressure homeostasis. Conversely, physical inactivity has been associated with an increased risk of hypertension and adverse cardiovascular outcomes across diverse populations.[4]

Sleep quality is another important behavioral factor that has gained increasing attention in cardiovascular research. Adequate and restorative sleep plays a vital role in maintaining circadian regulation of blood pressure, particularly the normal nocturnal dipping pattern. Disturbances in sleep quality or duration may lead to sustained sympathetic activation, dysregulation of the hypothalamic–pituitary–adrenal axis, and increased secretion of stress hormones such as cortisol, ultimately contributing to elevated blood pressure.[5] Meta-analytic evidence has demonstrated that individuals with poor subjective sleep quality are at higher risk of hypertension compared with those who report good sleep quality.[6]

Recent studies have suggested that physical activity and sleep quality may exert both independent and interactive effects on blood pressure regulation. Observational studies and meta-analyses have reported that low levels of physical activity combined with poor sleep quality are associated with greater cardiovascular risk, including higher blood pressure levels.[4] However, much of the existing literature has focused on middle-aged and older adult populations, while evidence among young adults remains relatively limited. Furthermore, studies examining these associations within student populations, particularly in developing countries, are scarce.

In Indonesia, research exploring the relationship between physical activity, sleep quality, and blood pressure among university students is still limited, especially within faculties of health sciences. This population is of particular interest because health sciences students are expected to possess higher health literacy and to serve as future healthcare professionals and advocates for healthy lifestyles. Understanding the extent to which physical activity and sleep quality are associated with blood pressure in this group may provide valuable insights for targeted health promotion strategies within academic institutions.

Given the increasing prevalence of sedentary behavior and sleep disturbances among university students, there is a clear need for empirical evidence examining their potential impact on cardiovascular health indicators such as blood pressure. Therefore, the present study aimed to analyze the relationship between physical activity and sleep quality with systolic blood pressure among young adult students at the Faculty of Health Sciences, Universitas Muhammadiyah Surakarta. It was hypothesized that higher levels of physical activity and better sleep quality would be significantly associated with lower systolic blood pressure in this population.

Methods

This study employed an analytical observational design with a cross-sectional approach to examine the relationship between physical activity, sleep quality, and blood pressure among young adults. The research was conducted between September and October 2025 at the Faculty of Health Sciences, Universitas Muhammadiyah Surakarta, Indonesia. A cross-sectional design was selected to provide an initial overview of associations between lifestyle-related factors and blood pressure within a university student population, where early cardiovascular risk factors may already be present but remain underexplored.

The study population comprised all registered students at the Faculty of Health Sciences, Universitas Muhammadiyah Surakarta, totaling 2,595 individuals. The required sample size was calculated using Slovin's formula with a margin of error of 10%, resulting in a minimum sample size of 100 participants. This sample size was considered sufficient to detect meaningful correlations between physical activity, sleep quality, and blood pressure within the study population.

Participants were selected using random sampling to minimize selection bias. A sampling frame was constructed from the official student registry of the Faculty of Health Sciences, and eligible participants were randomly selected using a random number table. Inclusion criteria were age between 18 and 40 years, active enrollment as a student at the Faculty of Health Sciences, willingness to participate in the study, and absence of self-reported acute or chronic health conditions. Exclusion criteria included diagnosed mental disorders, current use of sleep medications or sedatives, pregnancy, known cardiovascular disease, high stress levels at the time of data collection, acute illness or fatigue, and inability to comply with study procedures. Participants who did not complete all required measurements or provided incomplete data were excluded from the final analysis.

The independent variables in this study were physical activity and sleep quality, while the dependent variable was blood pressure, with systolic blood pressure designated as the primary outcome. Physical activity was assessed using the Indonesian version of the International Physical Activity Questionnaire, which has been widely used and validated in adult populations.[7] The questionnaire evaluates physical activity performed over the preceding seven days across three intensity levels—walking, moderate-intensity activity, and vigorous-intensity activity—and generates a total physical activity score expressed in metabolic equivalent of task minutes per week (MET-min/week). Physical activity levels were categorized as low (<600 MET-min/week), moderate (600–3000 MET-min/week), or high (>3000 MET-min/week).

Sleep quality was measured using the Indonesian version of the Pittsburgh Sleep Quality Index, a standardized instrument consisting of seven components that assess subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleep medication, and daytime dysfunction.[8] The total PSQI score ranges from 0 to 21, with lower scores indicating better sleep quality. In this study, a total score of less than 5 was classified as good sleep quality, while a score of 5 or greater indicated poor sleep quality, in accordance with established cut-off values in the literature.

Blood pressure was measured using a calibrated digital sphygmomanometer. Measurements were performed by the researcher following standardized procedures. Participants were seated comfortably with back support and feet flat on the floor after a rest period of approximately five minutes. Blood pressure was measured twice on the same arm with an interval of one to two minutes between measurements, and the average of the two readings was used for analysis. Blood pressure categories were defined according to the European Society of Cardiology and European Society of Hypertension guidelines.[9]

Data collection commenced with an explanation of the study objectives and procedures, followed by the provision of written informed consent. Participants then completed the International Physical Activity Questionnaire and the Pittsburgh Sleep Quality Index under the supervision of the researcher to ensure standardized administration and to minimize misunderstanding of questionnaire items. Blood pressure measurements were subsequently conducted in a quiet environment to reduce measurement variability. All collected data were reviewed for completeness and consistency prior to statistical analysis.

Several strategies were implemented to minimize potential sources of bias. To reduce information bias, all participants received identical instructions regarding questionnaire completion, and standardized measurement protocols were applied consistently throughout the study. Random sampling was used to limit selection bias. Data quality checks were conducted to identify incomplete or inconsistent responses. Participants with missing data or those who failed to complete all study procedures were excluded from the analysis, and no imputation was performed for missing values.

Data analysis was performed using Statistical Package for the Social Sciences (SPSS) version 25. Descriptive statistics were calculated to summarize participant characteristics and main study variables. Continuous variables were expressed as means and standard deviations, while categorical variables were presented as frequencies and percentages. Normality of data distribution was assessed using the Kolmogorov–Smirnov test. As the primary variables were not normally distributed, non-parametric statistical methods were applied.

The association between physical activity, sleep quality, and systolic blood pressure was analyzed using Spearman rank correlation. Systolic blood pressure was selected as the primary outcome because it is considered a sensitive indicator of cardiovascular risk in young adult populations. Diastolic blood pressure was analyzed descriptively but was not included in inferential correlation analyses. The strength of correlation coefficients was interpreted according to Cohen's criteria, with values of 0.10–0.29 indicating weak correlation, 0.30–0.49 indicating moderate correlation, and values of 0.50 or greater indicating strong correlation.[10] All statistical tests were two-tailed, and a p-value of less than 0.05 was considered statistically significant.

This study received ethical approval from the Ethics Committee of the Faculty of Health Sciences, Universitas Muhammadiyah Surakarta (No. 1585/KEPK-FIK/X/2025). All participants provided written informed consent prior to participation, and confidentiality of participant data was strictly maintained throughout the research process.

Results

A total of 120 students from the Faculty of Health Sciences, Universitas Muhammadiyah Surakarta, were initially screened for eligibility in this study. Of these, 110 students met the predefined inclusion criteria. Ten students were excluded during the screening process due to acute illness, consumption of certain medications, or failure to complete the required questionnaires. After data verification and completeness checks, a final sample of 100 participants was included in the statistical analysis. The participant recruitment and selection process is illustrated in the STROBE flow diagram (Figure 1).

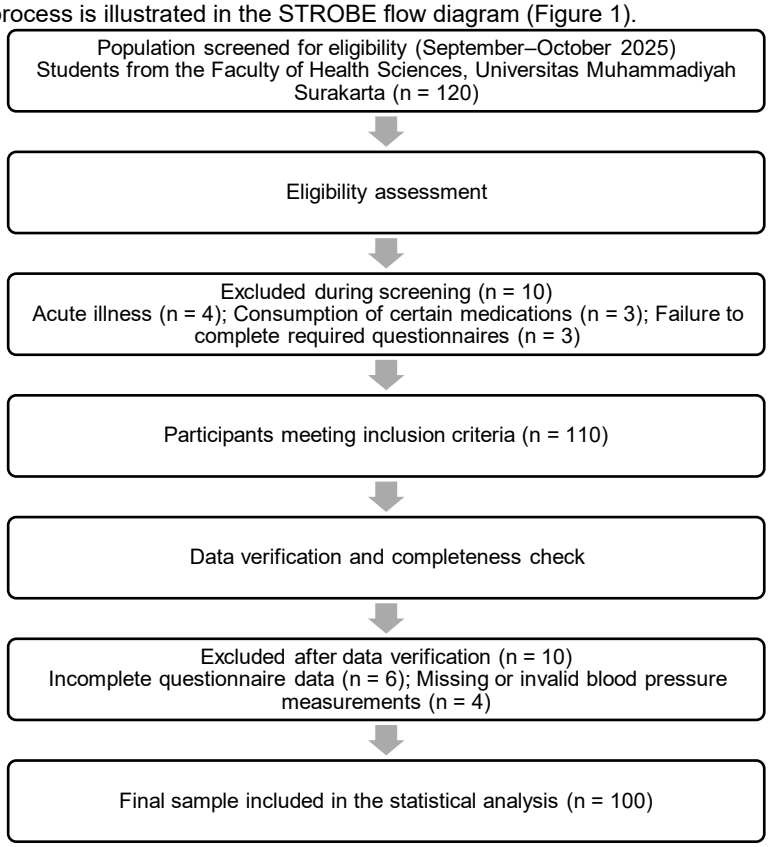

Figure 1. STROBE flow diagram of participant selection.

The demographic and baseline characteristics of the participants are presented in Table 1. The mean age of the respondents was 21.6 ± 2.4 years. Female participants accounted for 67% of the sample, while male participants comprised 33%. Regarding physical activity levels assessed using the International Physical Activity Questionnaire, 36% of participants were classified as having low physical activity, 55% had moderate physical activity, and 9% had high physical activity levels. In terms of sleep quality measured using the Pittsburgh Sleep Quality Index, 38% of participants demonstrated good sleep quality, whereas 62% were categorized as having poor sleep quality.

Table 1. Participant Characteristics (n = 100)

Variable	n (%) / Mean ± SD
Sex	
Female	67 (67%)
Male	33 (33%)
Age (years)	21.6 ± 2.4
Physical Activity Level (IPAQ)	
Low	36 (36%)
Moderate	55 (55%)
High	9 (9%)
Sleep Quality (PSQI)	
Good	38 (38%)
Poor	62 (62%)

Abbreviations: IPAQ = International Physical Activity Questionnaire; PSQI = Pittsburgh Sleep Quality Index.

The distribution of blood pressure categories among participants based on the European Society of Hypertension guidelines is shown in Table 2. A total of 24% of participants were classified as having normal blood pressure, while the majority of participants (57%) were categorized as having high-normal blood pressure. Additionally, 19% of participants met the criteria for stage 1 hypertension. No participants were classified as having stage 2 or stage 3 hypertension.

Table 2. Blood Pressure Categories Based on ESH Guidelines

Category	n (%)
Optimal	0 (0%)
Normal	24 (24%)
High-normal	57 (57%)
Hypertension stage 1	19 (19%)
Hypertension stage 2	0 (0%)
Hypertension stage 3	0 (0%)

Blood pressure classification based on the European Society of Hypertension guidelines.

Descriptive statistics for the main study variables are summarized in Table 3. The mean systolic blood pressure among participants was 118.37 ± 10.04 mmHg, with values ranging from 90 to 142 mmHg. The mean diastolic blood pressure was 80.30 ± 8.14 mmHg, with a minimum value of 60 mmHg. Physical activity levels demonstrated a mean total energy expenditure of 1199.91 ± 1014.32 MET-min/week, with values ranging from 80 to 3930 MET-min/week. The mean Pittsburgh Sleep Quality Index score was 3.39 ± 2.31, with scores ranging from 0 to 10.

Table 3. Descriptive Statistics of Main Study Variables

Variable	Mean ± SD	Minimum	Maximum
Systolic Blood Pressure (mmHg)	118.37 ± 10.04	90	142
Diastolic Blood Pressure (mmHg)	80.30 ± 8.14	60	118
Physical Activity (MET-min/week)	1199.91 ± 1014.32	80	3930
Sleep Quality (PSQI score)	3.39 ± 2.31	0	10

Abbreviations: MET = metabolic equivalent of task; PSQI = Pittsburgh Sleep Quality Index.

Normality testing using the Kolmogorov–Smirnov test indicated that all primary variables were not normally distributed. Specifically, systolic blood pressure, diastolic blood pressure, physical activity, and sleep quality all yielded p-values below 0.05, as presented in Table 4. Based on these results, non-parametric statistical analyses were deemed appropriate for examining associations between variables.

Table 4. Normality Test of Study Variables (Kolmogorov–Smirnov Test)

Variable	p-value	Distribution
Systolic Blood Pressure	0.001	Not normal
Diastolic Blood Pressure	<0.001	Not normal
Physical Activity	<0.001	Not normal
Sleep Quality	<0.001	Not normal

The results of the Spearman correlation analysis examining the associations between physical activity, sleep quality, and systolic blood pressure are presented in Table 5. A statistically significant negative correlation was observed between physical activity and systolic blood pressure ($r = –0.481$; $p < 0.001$). This finding indicates that higher levels of physical activity were associated with lower systolic blood pressure values among participants. According to Cohen's criteria, this correlation reflects a weak-to-moderate association.

Table 5. Spearman Correlation Between Physical Activity, Sleep Quality, and Systolic Blood Pressure

Variable	r	p-value
Physical Activity (IPAQ)	–0.481	<0.001
Sleep Quality (PSQI)	–0.257	0.010

Spearman rank correlation analysis; significance level set at $p < 0.05$.

Sleep quality also demonstrated a statistically significant negative correlation with systolic blood pressure ($r = –0.257$; $p = 0.010$). Higher Pittsburgh Sleep Quality Index scores, indicating poorer sleep quality, were associated with higher systolic blood pressure values, whereas lower scores, reflecting better sleep quality, were associated with lower systolic blood pressure. Based on established thresholds, this correlation represents a weak association.

Consistent with the predefined analytical plan, diastolic blood pressure was analyzed descriptively and was not included in inferential correlation testing. All statistical analyses were conducted using a two-tailed significance level of 0.05.

Discussion

This study examined the relationship between physical activity, sleep quality, and blood pressure among young adult students at the Faculty of Health Sciences, Universitas Muhammadiyah Surakarta. The findings demonstrated that both physical activity and sleep quality were significantly associated with systolic blood pressure, with negative correlation directions. These results indicate that higher levels of physical activity and better sleep quality are linked to lower systolic blood pressure among university students, highlighting the relevance of lifestyle behaviors in early cardiovascular risk modulation.

The observed negative association between physical activity and systolic blood pressure is consistent with a substantial body of evidence indicating that regular physical activity plays a critical role in blood pressure regulation. Previous studies have shown that increased physical activity contributes to reductions in systolic blood pressure through improvements in endothelial function, reductions in peripheral vascular resistance, and enhanced arterial compliance.[3] Regular physical activity also improves autonomic balance by decreasing sympathetic nervous system activity and increasing parasympathetic tone, thereby facilitating more effective cardiovascular regulation.[11] The moderate magnitude of correlation observed in this study suggests that even within a relatively young and generally healthy population, variations in physical activity levels may meaningfully influence blood pressure profiles.

These findings are further supported by recent large-scale observational and genetic studies. For example, a Mendelian randomization analysis demonstrated a potential causal relationship between low physical activity levels and increased risk of hypertension, reinforcing the biological plausibility of physical inactivity as a determinant of elevated blood pressure. The present study extends this evidence by demonstrating that such associations are already detectable in young adults, underscoring the importance of promoting physical activity early in the life course rather than delaying intervention until hypertension becomes clinically apparent.

In addition to physical activity, sleep quality was found to be significantly associated with systolic blood pressure, although the strength of this relationship was weaker than that observed for physical activity. Participants with poorer sleep quality, as indicated by higher Pittsburgh Sleep Quality Index scores, tended to exhibit higher systolic blood pressure values. This finding aligns with previous research reporting that inadequate or disturbed sleep is associated with impaired blood pressure regulation and increased cardiovascular risk.[5,6] Poor sleep quality has been linked to sustained sympathetic activation, disruption of circadian rhythms, and dysregulation of the hypothalamic–pituitary–adrenal axis, leading to elevated cortisol levels and adverse cardiovascular effects.

The relatively weaker correlation between sleep quality and systolic blood pressure observed in this study may be partly explained by the young age of the participants, who may not yet exhibit pronounced physiological consequences of chronic sleep disturbances. Nonetheless, the presence of a significant association suggests that sleep quality remains a relevant factor in blood

pressure regulation even among young adults. These findings emphasize the importance of considering sleep hygiene as a component of comprehensive cardiovascular health promotion strategies within university settings.[12]

Taken together, the results of this study suggest that physical activity and sleep quality may exert independent yet complementary influences on blood pressure regulation. University students often experience lifestyle patterns characterized by prolonged sedentary behavior, academic stress, and irregular sleep schedules, all of which may contribute cumulatively to early elevations in blood pressure. Interventions targeting both increased physical activity and improved sleep quality may therefore offer synergistic benefits in maintaining optimal cardiovascular health during young adulthood.

Several limitations of this study should be acknowledged when interpreting the findings. First, the cross-sectional design precludes causal inference, as the temporal relationship between physical activity, sleep quality, and blood pressure cannot be established. Second, the analysis was limited to bivariate correlations and did not control for potential confounding variables such as body mass index, dietary patterns, caffeine intake, smoking status, psychological stress, or medication use, all of which may influence blood pressure. The decision to employ bivariate analysis was intended to provide an initial exploration of associations within this population.

Third, physical activity and sleep quality were assessed using self-reported questionnaires, which may be subject to recall bias and social desirability bias. Although the International Physical Activity Questionnaire and the Pittsburgh Sleep Quality Index are widely used and validated instruments, objective measurements such as accelerometry or actigraphy could provide more precise assessments. Additionally, the study was conducted within a single faculty at one university, which may limit the generalizability of the findings to broader student populations.

Despite these limitations, the study offers several important strengths. It focuses on a relatively understudied population of young adult health sciences students and employs standardized, validated instruments for assessing physical activity and sleep quality. The findings contribute to the growing body of evidence supporting the role of modifiable lifestyle factors in early cardiovascular health and provide a foundation for future research and intervention development.

From a practical perspective, the results of this study have important implications for health promotion within academic institutions. Universities, particularly faculties of health sciences, are well positioned to implement programs that encourage regular physical activity, promote healthy sleep behaviors, and facilitate routine blood pressure monitoring. Such initiatives may not only benefit students' immediate well-being but also contribute to long-term cardiovascular disease prevention.

Future research should consider employing longitudinal or experimental designs to clarify causal relationships between physical activity, sleep quality, and blood pressure. Incorporating multivariate analytical approaches and objective measurement tools would further strengthen the evidence base. Expanding the scope of research to include diverse student populations and additional lifestyle factors may also provide a more comprehensive understanding of cardiovascular risk determinants in young adulthood.

Conclusion

This study demonstrated that physical activity and sleep quality are significantly associated with systolic blood pressure among young adult students at the Faculty of Health Sciences, Universitas Muhammadiyah Surakarta. Higher levels of physical activity were moderately associated with lower systolic blood pressure, while better sleep quality was weakly but significantly associated with more favorable blood pressure profiles. These findings suggest that even in a relatively young and generally healthy population, variations in lifestyle behaviors may meaningfully influence early cardiovascular risk indicators.

The negative association between physical activity and systolic blood pressure underscores the importance of maintaining adequate levels of physical activity as a non-pharmacological strategy for blood pressure regulation. Similarly, the observed relationship between sleep quality and blood pressure highlights the role of restorative sleep in supporting autonomic and cardiovascular homeostasis. Together, these results reinforce the concept that cardiovascular risk prevention should begin early in adulthood, before the onset of clinically diagnosed hypertension.

From a public health and educational perspective, the findings of this study have practical relevance for university settings. Academic institutions, particularly faculties of health sciences, may serve as strategic environments for implementing health promotion programs that encourage regular physical activity, improve sleep hygiene, and increase awareness of blood pressure monitoring. Such initiatives have the potential to foster healthy lifestyle habits that persist beyond the university years and contribute to long-term cardiovascular health.

Although causal relationships cannot be established due to the cross-sectional design, this study provides important preliminary evidence supporting the role of modifiable lifestyle factors in blood pressure regulation among university students. Future studies employing longitudinal or experimental designs, controlling for relevant confounding variables, and incorporating objective measures of physical activity and sleep are warranted to further elucidate these relationships. Overall, promoting active lifestyles and healthy sleep behaviors may represent an effective and feasible approach to early cardiovascular disease prevention in young adult populations.

Author Contribution

Conceptualization was performed by Wahyu Tri Sudaryanto. Methodology, investigation, data curation, formal analysis, visualization, and writing of the original draft were carried out by Farah Riskananda. Writing, review, and editing of the manuscript were conducted by Farah Riskananda under the supervision of Wahyu Tri Sudaryanto. Supervision and overall project oversight were provided by Wahyu Tri Sudaryanto. All authors have read and approved the final version of the manuscript.

Acknowledgments

The authors would like to express their sincere gratitude to Universitas Muhammadiyah Surakarta, particularly the Faculty of Health Sciences, for providing academic support and facilities throughout the research process. Appreciation is also extended to the academic supervisor, Wahyu Tri Sudaryanto, for his guidance, constructive feedback, and continuous support during the conduct of this study. The authors further thank all students of the Faculty of Health Sciences who willingly participated as respondents and contributed valuable data to this research.

Conflict of Interest Statement

The authors declare that there is no conflict of interest associated with this study.

Funding Sources

This study did not receive any external funding and was conducted independently as part of an academic research requirement.

Ethics Statement

This study was approved by the Ethics Committee of the Faculty of Health Sciences, Universitas Muhammadiyah Surakarta (No. 1585/KEPK-FIK/X/2025), and all participants provided written informed consent prior to participation.

References

1. Benjamin EJ, Al-Khatib SM. Research priorities in atrial fibrillation screening: a report from a National Heart, Lung, and Blood Institute virtual workshop. Circulation. 2021;143(4):372–388.
2. World Health Organization. Hypertension. Geneva: World Health Organization; 2025.
3. World Health Organization. Global recommendations on physical activity for health. Geneva: World Health Organization; 2017.
4. Zhang C, Chen S, Song W. Physical activity lowers hypertension risk: a 2-sample Mendelian randomization study. Med (Baltimore). 2025;104(41):e45054.
5. Lo K, Woo B, Wong M, Tam W. Subjective sleep quality, blood pressure, and hypertension: a meta-analysis. J Clin Hypertens (Greenwich). 2018;20(3):592–605.
6. Saraspuri NPE, Kusuma NN. The relationships between physical activity, sleep duration, alcohol consumption, and hypertension in adults: meta-analysis. J Epidemiol Public Health. 2022;7(1):1–16.
7. Balboa-Castillo T, Muñoz S, Serón P, Andrade-Mayorga O, Lavados-Romo P, Aguilar-Farias N. Validity and reliability of the International Physical Activity Questionnaire short form in Chilean adults. PLoS One. 2023;18(10):e0291604.
8. Setyowati A, Chung MH. Validity and reliability of the Indonesian version of the Pittsburgh Sleep Quality Index in adolescents. Int J Nurs Pract. 2021;27(5):e12856.
9. Williams B, Mancia G, Spiering W, Agabiti Rosei E, Azizi M, Burnier M, et al. 2018 ESC/ESH guidelines for the management of arterial hypertension. Eur Heart J. 2018;39(33):3021–3104.
10. Cohen J. Statistical power analysis for the behavioral sciences. 2nd ed. Hillsdale, NJ: Lawrence Erlbaum Associates; 1988.
11. Monfared V, Hashemi M, Kiani F, Javid R, Yousefi M, Hasani M, et al. The effect of physical activity intervention on blood pressure in 18 low and middle-income countries: a systematic review and meta-analysis of randomized controlled trials. Clin Hypertens. 2024;30(1):22.
12. Sukor ANA, Juliana N, Abdul Hamid N, Teng NIMF, Ithnin M, Azmani S, Kasim SS. A systematic review of literature on the association among sleep, cortisol level and cardiovascular health within the healthcare shift worker population. Biomedicines. 2025;13(10):2539.