Jurnal Berkala Kesehatan

Journal Home Page:
https://ppjp.ulm.ac.id/journal/index.php/berkala-kesehatan

Vol. 12 No.1
DOI: 10.20527/jbk.v12i1.25835
ISSN: 2477-3190 | e-ISSN: 2541-6472

Systematic Review

The Modulation of Sleep Quality by Aerobic Exercise and Caffeine: A Systematic Review

ABSTRACT

Sleep quality disturbance is a common health problem affecting young adults, and is associated with impaired cognitive function and daily performance. Lifestyle factors such as caffeine consumption and low physical activity are known to influence sleep quality, yet their combined effects remain underexplored. We aimed to evaluate the impact of coffee consumption and aerobic exercise on sleep quality among young adults. A systematic review was conducted on relevant studies published within the last ten years. Sleep quality was primarily assessed using the Pittsburgh Sleep Quality Index (PSQI). Higher caffeine intake was consistently associated with poorer sleep quality, prolonged sleep latency, and reduced sleep duration. Conversely, regular aerobic exercise was shown to improve sleep quality through physiological regulation, including hormonal balance and stress reduction. The combination of high caffeine consumption and insufficient aerobic exercise may exacerbate sleep disturbances. In conclusion, both caffeine intake and aerobic exercise are significant modifiable factors affecting sleep quality, highlighting the importance of lifestyle interventions to improve overall health and well-being in young adults.

©2026 Jurnal Berkala Kesehatan. Published by Universitas Lambung Mangkurat

Khalisa Salsabila Hadisurya[1*)], **Vita Murniati Tarawan**[1], **Yuni Susanti Pratiwi**[1]

[1]Faculty of Medicine, Padjadjaran University

Correspondent email:
khalisa23001@mail.unpad.ac.id

Article Info

Submitted	:	07 April 2026
In reviewed	:	14 April 2026
Accepted	:	09 June 2026
Available Online	:	26 June 2026

Keywords:

Sleep quality;
Coffee consumption;
Aerobic exercise;
Young adults;

How to Cite:
Hadisurya KS, Tarawan VM, Pratiwi YS. The Modulation of Sleep Quality by Aerobic Exercise and Caffeine: A Systematic Review. Jurnal Berkala Kesehatan. 2026;12(1):34-43.

INTRODUCTION

Sleep disturbances have become a significant global health concern due to their impact on quality of life, mental health, and productivity. According to the World Health Organization, more than one-third of the global population experiences sleep-related problems, particularly among individuals in the productive age group.[1] In Indonesia, sleep disturbances are also prevalent among young adults and university students, as reported in the national health profile.[2] Sleep disturbances are characterized by difficulties in initiating or maintaining sleep, early awakening, or non-restorative sleep, all of which may impair cognitive function, mood, and academic performance.[3] Among university students, poor sleep quality is commonly associated with academic workload, psychological stress, and unhealthy lifestyle habits.[4] One lifestyle factor frequently linked to sleep disturbances is caffeine consumption, particularly from coffee.

Caffeine acts as an adenosine receptor antagonist, reducing sleep pressure and increasing alertness. While this effect is beneficial for maintaining concentration, especially during academic activities, it may negatively affect sleep quality when consumed close to bedtime. Studies have shown that

caffeine intake within 1–3 hours before sleep can significantly increase sleep latency and reduce sleep efficiency.[5] In Indonesia, coffee consumption is high, with many reporting improved alertness and reduced drowsiness after consumption.[6] However, excessive or late consumption is associated with poor sleep quality, with a high proportion of young adults experiencing sleep disturbances after nighttime intake.[7]

A study reported that higher caffeine intake was significantly associated with poorer sleep quality, shorter sleep duration, and increased daytime dysfunction among university students.[8] Excessive caffeine consumption was also linked to higher levels of stress, anxiety, and emotional exhaustion, suggesting that caffeine may not only affect physiological sleep mechanisms but also mental well-being and academic functioning.[9] These findings reinforce the concern that caffeine consumption has become a common but potentially maladaptive coping strategy in student populations facing academic pressure.

Furthermore, emerging evidence suggests that the relationship between caffeine and sleep quality may be influenced by lifestyle behaviors such as physical activity and daily habits. Recent studies demonstrated that individuals with lower levels of physical activity and irregular sleep schedules were more likely to experience poor sleep quality when combined with frequent caffeine consumption.[10] Sedentary behavior may reduce the beneficial effects of sleep homeostasis and circadian regulation, thereby amplifying the negative impact of caffeine on sleep initiation and maintenance. This highlights the importance of evaluating caffeine consumption together with physical activity patterns to better understand behavioral factors contributing to sleep disturbances among young adults.[10] In addition to caffeine consumption, physical activity plays an important role in sleep regulation. Regular aerobic exercise has been shown to improve sleep quality by reducing stress, regulating circadian rhythms, and enhancing physiological sleep pressure.[11] However, many young adults tend to adopt sedentary lifestyles, which are associated with poorer sleep outcomes.[12] The imbalance between high caffeine consumption and low physical activity may further exacerbate sleep disturbances in this population.

Young adults, particularly university students, are vulnerable to lifestyle-related sleep problems due to academic demands, increased independence, and stress.[13,14] In this context, coffee consumption often increases as a coping strategy to maintain productivity, while physical activity tends to decrease. Although previous studies have examined the relationship between caffeine intake, physical activity, and sleep quality separately, findings remain inconsistent, and limited research has explored their combined effects.[15,16] Therefore, this study aims to evaluate the relationship between coffee consumption and sleep quality among young adults, with consideration of aerobic physical activity as a moderating lifestyle factor. Understanding this interaction is essential to provide a more comprehensive perspective on behavioral factors influencing sleep quality and to support the development of targeted lifestyle interventions.

METHODS

This study was conducted using a systematic review design to identify, evaluate, and synthesize existing scientific evidence regarding the effects of coffee or caffeine consumption and aerobic exercise on sleep quality among young adults. The study was carried out between February and April 2025. Data were obtained from secondary sources through a structured literature search in electronic databases, including PubMed, Google Scholar, ScienceDirect, and Cochrane Library. The search strategy utilized combinations of keywords such as “coffee,” “caffeine,” “aerobic exercise,” “sleep quality,” “PSQI,” and “students,” in both English and Indonesian, with publication limits set from January 1, 2016 onwards. Articles were screened based on title and abstract relevance, followed by full-text assessment according to predefined inclusion and exclusion criteria. Eligible studies included experimental, cohort, case-control, and cross-sectional designs, published in English or Indonesian, involving participants aged ≥18 years, particularly students, and using the Pittsburgh Sleep Quality Index (PSQI) as a measure of sleep quality. Studies were excluded if they were not methodologically relevant, had a high risk of bias, or had inaccessible full texts. The articles were selected in accordance with the PRISMA 2020 guidelines.[17]

Risk of bias is measured using JBI Critical Appraisal Tools for Analytical Cross-sectional Studies[18], Quasi-Experimental Studies[19], and Randomized Controlled Trials.[20] The selection process was guided by the Population, Intervention, Comparison, and Outcomes (PICO) framework to ensure consistency and reproducibility. The population included healthy young adults without chronic or sleep-related disorders. Interventions consisted of clearly defined caffeine or coffee consumption with the source of caffeine, dosage, and consumption frequency, and/or aerobic exercise with specified parameters such as type, frequency, intensity, and duration. Comparisons were based on PSQI scores across different exposure levels or intervention groups. The primary outcome was sleep quality assessed using total and subdomain PSQI scores, including sleep latency, duration, efficiency, disturbances, use of medication, and daytime

dysfunction. Data from included studies were extracted using a standardized table containing author, publication year, study design, sample size, intervention characteristics, and key findings. The extracted data were then synthesized descriptively to identify patterns and relationships between caffeine consumption, aerobic exercise, and sleep quality.

RESULT AND DISCUSSION

A total of 537 articles were identified during the initial search. After screening titles and abstracts, 438 articles were excluded, leaving 99 articles for full-text assessment. Of these 99 articles, 5 articles were excluded due to inaccessibility of the full text, 70 articles were excluded due to data not meeting the inclusion criteria, and 70 articles were excluded due to incompatible study methodologies. In total, 29 articles were included for the final analysis. The article selection process is illustrated in Figure 1. We included experimental studies, prospective cohort studies, retrospective cohort studies, cross-sectional surveys, and case-control studies in our analysis. All included articles were published after January 1, 2016. The inclusion criteria consisted of articles published in Indonesian or English, containing the keywords (caffeine, aerobic, exercise, sleep, quality, PSQI, medical, students), and using the Pittsburgh Sleep Quality Index (PSQI) as a measurement of sleep quality. Additionally, only articles with experimental, prospective cohort, retrospective cohort, cross-sectional survey, or case-control study designs were included.

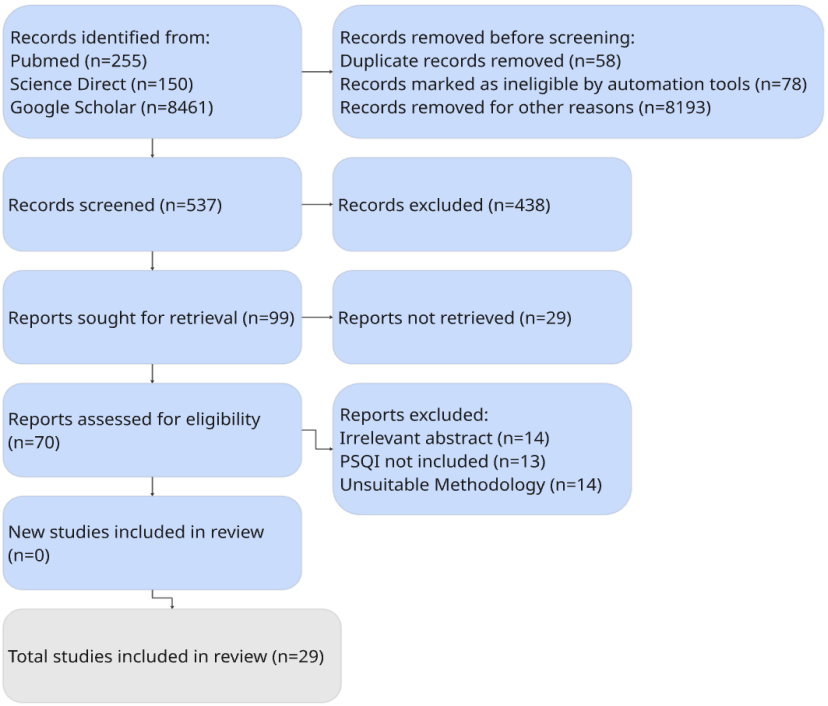

Figure 1. Results of the literature search and elimination

The exclusion criteria consisted of articles that contained the search keywords but had content or methodologies not aligned with the objectives of this study, articles with a high risk of bias, and articles with inaccessible full texts. A total of 18 articles exploring the effects of caffeine on sleep quality were included in the review (Table 1). There was a significant variability in the study designs, sizes, and methodology. The majority of studies were cross-sectional studies involving healthy young adults in different settings. The smallest study involved 40 subjects, and the largest involved 2413 subjects.

There was a significant variability in the measurement of caffeine intake, with some studies measuring the exact caffeine dosage to the milligram, while others measured caffeine intake qualitatively. All the reviewed studies reported a negative relationship between caffeine intake and sleep quality, as demonstrated with an increase of PSQI score in subjects consuming caffeine, or a higher baseline PSQI in subjects who consumed coffee regularly.

DOI: 10.20527/jbk.v11i1.20982 2026; 12(1): 34-43

Table 1. Summary of Caffeine Intake and Its Effects on Sleep Quality

Author	Year	N	Key Findings
H. Shihadeh et al.	2025	853	Mixed caffeine sources (coffee, tea, energy drinks), intake up to 3555 mg/week, higher intake significantly associated with poor sleep (PSQI >5).
Sedat. Arslan et al.	2025	82	Caffeine mainly from tea and coffee, high consumption more common in females, mean PSQI 6.3, indicating poor sleep quality.
E.J. Watson et al.	2016	80	Mean intake ~165 mg/day, poor sleepers consumed ~62 mg more caffeine/day, significantly associated with higher PSQI.
D.R. Young et al.	2019	462	Energy drinks and high-calorie coffee linked to increased PSQI (+1 point), worse sleep quality with frequent intake.
G.M. Nasir et al.	2022	83	Dose-dependent relationship (58–351 mg/day), higher caffeine correlated with higher PSQI
R.A.R. Bautista et al.	2022	199	Various caffeine sources, mean PSQI 7.54, moderate to poor sleep quality observed across participants.
EA. Claydon et al.	2023	400	Mean intake ~192 mg/day, total caffeine positively associated with PSQI (β=0.003), soda showed strongest effect.
Y. Veronica et al.	2023	40	Low vs high intake (>32 mg/day), no significant correlation between caffeine and PSQI (p>0.05).
M.A.J. Hermanoche et al.	2023	192	Median intake ~160 mg/day, majority moderate intake, no significant association with PSQI.
R. Alshuramni et al.	2023	260	Multiple caffeine sources, ~75% poor sleepers, higher intake linked to poorer sleep.
S. Turner et al.	2023	216	Median intake ~68 mg/day, higher caffeine linked to symptoms including sleep disturbance (41.4%).
E.H.K. Ikram et al.	2024	300	Mean intake ~194 mg/day, higher caffeine significantly associated with poorer sleep (p<0.01).
B.N. Aljafen et al.	2024	2413	Large sample, mean PSQI 8.4, caffeine intake identified as significant predictor of poor sleep.
S. Tresnawulan et al.	2024	60	Coffee (Arabica, Robusta, Liberica), strong correlation with poor sleep (r=0.439, p<0.001).
J. Schlichtiger et al.	2025	40	240 mg caffeine before sleep increased sleep latency, effect not statistically significant but trend observed.
A. Raju et al.	2025	195	Intake up to 525 mg/day, higher caffeine associated with poor sleep (r=0.510) and daytime sleepiness; OR 3.15.
M.A. Almalki et al.	2026	1564	Frequent intake (>3 cups/day) increased PSQI by ~1.08 points, consistent negative impact on sleep.
A.M. Afizi et al.	2024	224	Median intake ~225 mg/day, significant positive correlation with PSQI (r=0.188, p=0.005).

source: primary data

8 studies on the effects of aerobic exercise on sleep quality were included (Table 2). Most of the studies included in the review were small in size, ranging from 18 to 84 subjects. 6 of these studies were randomized controlled trials or randomized crossover trials. Exercise regimens range from walking, jogging, resistance training, and other types of aerobic exercises. Exercise intensities were reported qualitatively (light, moderate, or heavy) or quantitatively (by percentage VO_2max). Most studies reported a positive relationship between aerobic exercise and sleep quality.

Table 2. Summary of Exercise and Its Effects on Sleep Quality

Author	Year	N	Key Findings
T Kianian et al.	2017	31	Aerobic (jogging/running) and anaerobic (sprint) exercise performed 3×/week for 10 weeks at 50–70% VO_2max (aerobic) and ~95–100% VO_2max (anaerobic) significantly reduced PSQI scores, indicating improved sleep quality compared to control.
Ezati M et al.	2020	67	Moderate aerobic exercise (3×/week, 60 min/session, 45–70% HRmax) over 8 weeks significantly decreased PSQI, while control group showed worsening sleep quality.
Park JS et al.	2020	32	Single-session aerobic exercise (30 min at 40–80% VO_2max) improved sleep parameters (TST, REM, deep sleep) in sleep-deprived individuals, although effects varied by intensity.
F Wang et al.	2021	54	Continuous aerobic walking (60 min/session, moderate intensity) over 4 weeks significantly reduced PSQI scores compared to control in a crossover design.
A Al-Sharman et al.	2019	40	Moderate-intensity aerobic exercise (3×/week, 50–60 min/session, 50–69% HRR) for 6 weeks significantly improved PSQI and increased serotonin levels, with strong correlation between serotonin changes and sleep quality improvement.
R Miyazaki et al.	2021	58	Combined group- and home-based aerobic exercise (≥200 min/week, ≥50% HRmax) over 3 months improved objective sleep parameters (WASO, sleep efficiency) and showed strong correlation between serotonin and PSQI improvement.
C Ji et al.	2022	84	Combined aerobic and resistance training (60 min/session, 1–3×/week) showed significant PSQI reduction ($\Delta \approx -3.78$, $p<0.001$), with exercise intensity (up to 60–95% HRmax) being the main determinant of sleep improvement.
YX Hu et al.	2025	18	Short-term aerobic (70% VO_2max) and resistance training (70% 1RM) over 3 days showed limited direct improvement in PSQI, though participants had baseline poor sleep and psychological disturbances influencing outcomes.

source: primary data

The risk of bias for each study was measured using JBI Critical Appraisal Tools. Different tools were used for analytical cross-sectional studies (Table 3), randomized controlled trials and randomized crossover trials (Table 4), and quasi-experimental and experimental studies (Table 5). The majority of the analytical cross-sectional studies are classified as low risk of bias, with four moderate risk of bias, and one high risk of bias. Most of the studies reported a confounding factor (Q5) but did not report a strategy for dealing with said confounding factors (Q6).

DOI: 10.20527/jbk.v11i1.20982 2026; 12(1): 34-43

Table 3. Risk of bias of included studies (analytical cross-sectional studies).

Author	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	RoB
H. Shihadeh et al.	Y	Y	U	Y	N	N	Y	Y	Moderate
Sedat. Arslan et al.	N	U	U	Y	Y	N	Y	Y	Moderate
E.J. Watson et al.	Y	Y	Y	Y	N	N	Y	Y	Low
D.R. Young et al.	Y	Y	U	Y	N	N	Y	Y	Moderate
G.M. Nasir et al.	U	U	N	Y	Y	Y	Y	U	Moderate
R.A.R. Bautista et al.	Y	Y	Y	Y	N	Y	Y	U	Low
EA. Claydon et al.	N	Y	Y	Y	Y	N	Y	Y	Low
Y. Veronica et al.	Y	Y	N	N	N	N	Y	Y	High
M.A.J. Hermanoche et al.	U	Y	Y	Y	Y	Y	Y	U	Low
R. Alshuramni et al.	Y	Y	Y	Y	Y	Y	Y	Y	Low
S. Turner et al.	U	Y	Y	Y	Y	U	Y	Y	Low
E.H.K. Ikram et al.	N	Y	Y	Y	Y	U	Y	Y	Low
B.N. Aljafen et al.	Y	U	Y	Y	Y	Y	Y	Y	Low
S. Tresnawulan et al.	Y	Y	Y	Y	N	N	Y	Y	Low
J. Schlichtiger et al.	Y	Y	Y	Y	Y	Y	Y	Y	Low
A. Raju et al.	Y	U	Y	Y	Y	Y	Y	Y	Low
M.A. Almalki et al.	U	Y	Y	Y	Y	Y	Y	Y	Low
A.M. Afizi et al.	Y	Y	Y	Y	Y	Y	Y	Y	Low

source: primary data

There were significant variabilities in the risk of bias of randomized controlled trials and randomized crossover studies. The high risk of bias in these studies were caused by most of these studies being either not blinded or only single-blinded, with subjects, administrators, and analyzers fully aware of the grouping and interventions (Q1-Q7).

Table 4. Risk of bias of included studies (randomized controlled trials and randomized crossover studies).

Author	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	RoB
T Kianian et al.	N	N	Y	N	N	Y	N	Y	Y	U	Y	Y	U	High
Park JS et al.	U	N	Y	N	N	Y	N	Y	Y	Y	Y	Y	U	High
F Wang et al.	U	N	Y	N	N	Y	N	Y	Y	Y	Y	Y	Y	Moderate
Al-Sharman et al.	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Low
C Ji et al.	Y	N	N	N	N	Y	N	Y	Y	N	Y	Y	U	High
YX Hu et al.	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Low

source: primary data

Two quasi-experimental and experimental studies were considered low risk of bias (Table 5), with sufficiently rigorous study design, measurement, and reporting for all items in the JBI Critical Appraisal Tool.

Table 5. Risk of bias of included studies (quasi-experimental and experimental studies)

Author	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	RoB
Ezati M et al.	Y	Y	Y	Y	Y	Y	Y	Y	Y	Low
R Miyazaki et al.	Y	Y	Y	Y	Y	Y	Y	Y	Y	Low

source: primary data

DOI: 10.20527/jbk.v11i1.20982 2026; 12(1): 34-43

DISCUSSION

Caffeine or coffee consumption in this study was consistently associated with poorer sleep quality, as reflected by Pittsburgh Sleep Quality Index (PSQI) scores predominantly falling within the poor sleep category (≥5) among most participants. From a physiological perspective, this effect can be explained by caffeine's mechanism of action as an adenosine receptor antagonist, which increases alertness and inhibits sleep initiation. In addition, caffeine influences the sympathetic nervous system through adrenergic receptor activation, leading to increased heart rate and heightened arousal, and may also activate the Renin–Angiotensin–Aldosterone System (RAAS), contributing to elevated blood pressure and a sustained state of alertness. Furthermore, caffeine has been shown to suppress melatonin secretion, a key hormone regulating circadian rhythm, thereby delaying sleep onset and reducing overall sleep quality.

In the studies analyzed, caffeine consumption generally ranged from 130–225 mg/day, which is considered within the safe intake range; however, it still demonstrated negative effects on sleep quality.[9] This finding suggests that even caffeine consumption within recommended limits can disrupt sleep physiology, particularly when consumed close to bedtime. Moreover, differences in caffeine sources may also influence their impact on sleep. Coffee, the primary source of caffeine in most studies, contains various bioactive compounds such as polyphenols that may modulate caffeine's effects. In contrast, energy drinks typically contain higher concentrations of caffeine combined with sugar and other stimulants such as taurine, which may amplify central nervous system stimulation and potentially exert a more detrimental effect on sleep quality compared to caffeine derived from coffee alone.

Conversely, aerobic exercise showed a positive association with improved sleep quality, as indicated by reductions in PSQI scores in most intervention studies. Aerobic exercise was the most commonly investigated form of physical activity and consistently demonstrated significant improvements in sleep quality compared with non-aerobic exercise. Physiologically, aerobic exercise enhances autonomic nervous system regulation by reducing sympathetic activity and increasing parasympathetic tone, thereby promoting relaxation and facilitating sleep initiation. In addition, exercise increases core body temperature, followed by a post-exercise decline, a mechanism known to facilitate sleep onset. Aerobic exercise also promotes endorphin release and helps regulate stress hormones such as cortisol, ultimately contributing to improved sleep quality.

Although some studies reported that anaerobic and resistance training may also improve sleep quality, their effects were less consistent and more variable compared to aerobic exercise. This may be attributed to the high intensity of anaerobic exercise, which can transiently increase sympathetic activation. Therefore, moderate-intensity aerobic exercise (approximately 50–70% VO_2max), performed three times per week with a duration of 50–60 minutes per session, may be considered the most optimal form of physical activity for improving sleep quality, in line with the most commonly observed intervention patterns in the analyzed studies.[21, 22, 23]

STUDY LIMITATIONS

The findings of this study should be interpreted in light of several limitations within the available literature. The number of studies meeting the inclusion criteria was relatively limited compared to the initial pool of identified articles, which may affect the overall strength of the conclusions. Additionally, there was considerable methodological heterogeneity among the included studies, including variations in study design (interventional and non-interventional), types and duration of exposure, and participant characteristics.

Most studies employed observational, survey-based designs, which inherently limit the ability to establish causal relationships. Furthermore, variations in statistical analysis methods ranging from chi-square tests and correlation analyses to regression models and odds ratios led to differences in result interpretation across studies. This heterogeneity poses challenges in synthesizing data comprehensively and highlights the need for more standardized research designs in future studies.

From a theoretical perspective, the relationship between caffeine consumption, aerobic exercise, and sleep quality is complex and influenced by multiple factors that are not consistently controlled across studies. The effects of caffeine on sleep, for instance, are highly dependent on dosage, timing of consumption, and individual metabolic variability, leading to differing impacts on sleep quality among individuals. Similarly, the effects of exercise on sleep are influenced by exercise type, intensity, duration, and timing, which were not uniform across studies. This physiological complexity may introduce bias and variability in outcomes, thereby limiting the generalizability of the findings and emphasizing the need for further research with more rigorous control of variables.

CONCLUSION

This systematic review demonstrates that caffeine consumption, particularly from coffee, is consistently associated with poorer sleep quality among young adults, as reflected by higher Pittsburgh Sleep Quality Index (PSQI) scores, even at low to moderate intake levels that are generally considered safe. In contrast, aerobic aerobic exercise shows a beneficial effect on sleep quality, with moderate to high intensity exercise contributing to significant improvements in PSQI scores through mechanisms related to autonomic regulation, circadian rhythm alignment, and increased sleep pressure. However, current evidence remains limited in explaining the combined effects of caffeine consumption and aerobic exercise on sleep quality, highlighting an important gap in the literature. These findings suggest that lifestyle modifications, including limiting caffeine intake, especially near bedtime, and promoting regular aerobic exercise, may be essential strategies for improving sleep quality in young adults, while further well-designed and standardized studies are needed to better understand the interaction between these factors and to inform more targeted interventions.

AUTHOR'S CONTRIBUTION STATEMENT

The authors' contributions are as follows: KS contributed to conceptualization, literature searching, data collection, data analysis, and wrote the original draft of the manuscript. VM and YS contributed to methodology design, supervision, and manuscript review.

CONFLICTS OF INTEREST

No author of this paper has a conflict of interest, including specific financial interests, relationships, and/or affiliations relevant to the subject matter or materials included in this manuscript.

ACKNOWLEDGMENTS

The authors would like to express their sincere gratitude to the Faculty of Medicine, Universitas Padjadjaran, for providing institutional support throughout the completion of this study. The authors also acknowledge all lecturers and academic supervisors for their valuable guidance and constructive feedback during the research process. Appreciation is extended to all researchers whose published works were included in this systematic review, as their contributions have been essential to the completion of this study. Finally, the authors would like to thank all parties who have directly or indirectly supported this research.

REFERENCES

1. Bull FC, Al-Ansari SS, Biddle S, et al. World Health Organization 2020 guidelines on physical activity and sedentary behaviour. *Br J Sports Med*. *BMJ Publishing Group*. 2020;54(24):1451-1462. doi:10.1136/bjsports-2020-102955
2. Sibuea F, Hardhana B. Kementerian Kesehatan Profil Kesehatan Indonesia 2023. Published online 2023.
3. American Psychiatric Association. *Diagnostic and Statistical Manual of Mental Disorders. 5th Edition*. 5th Edition. 2022.
4. Permata YN, Sriwiyati K, Affanin S. Hubungan kebiasaan minum kopi dan aktivitas fisik dengan kualitas tidur mahasiswa fakultas kedokteran. *Journal of Nursing Practice and Education*. 2023;4(1). doi:10.34305/jnpe.v4i1.957
5. Asari MA, Muhdiana D. *HUBUNGAN MENGKONSUMSI MINUMAN KOPI DENGAN KUALITAS TIDUR PADA MAHASISWA SEMESTER VI FIK UMJ*. 2017.
6. Rodak K, Kokot I, Kratz EM. Caffeine as a factor influencing the functioning of the human body—friend or foe? *Nutrients*. *MDPI*. 2021;13(9). doi:10.3390/nu13093088
7. Pratiwi Aprilia. Hubungan Konsumsi Kopi Sehari-hari Terhadap Kualitas Tidur pada Mahasiswa Angkatan 2018 Fakultas Kedokteran Universitas Kristen Indonesia Tahun 2022. Published online 2022.
8. Bodur M, Barkell J, Li X, Sajadi Hezaveh Z. Does caffeine supplementation affect sleep in athletes? A systematic review of nine randomized controlled trials. *Clin Nutr ESPEN*. *Elsevier Ltd*. 2025;65:76-85. doi:10.1016/j.clnesp.2024.11.007
9. Shihadeh H, Alammouri I, Albdour B, et al. Caffeine Consumption, Sleep Quality, and Mental Health Outcomes among Jordanian University Students: A Cross-sectional Study. *JAPA Academy*

Journal. 2025;3(4):178-185. doi:10.4103/japaj.japaj_30_25
10. Meiranny A, Chabibah AM. The Indonesian Journal of Health Promotion Media Publikasi Promosi Kesehatan Indonesia Pengaruh Konsumsi Minuman Berkafein Terhadap Pola dan Kualitas Tidur Mahasiswa : A Literatur Review The Effect of Caffeine Drink Consumption on Patterns and Sleeping Quality of College Students. 2022;5(2). doi:10.31934/mppki.v2i3
11. Mutiara Sari LPM, Putra IPYP, Adiatmika IPG, Puspa Negara AAGA. PROGRESSIVE MUSCLE RELAXATION DAN OLAHRAGA AEROBIK DAPAT MENINGKATKAN KUALITAS TIDUR PADA MAHASISWA KEDOKTERAN DI MASA PANDEMI COVID-19. *Majalah Ilmiah Fisioterapi Indonesia*. 2023;11(1):58. doi:10.24843/mifi.2023.v11.i01.p11
12. Riskawati YK, Damar Prabowo E, Al Rasyid H. *TINGKAT AKTIVITAS FISIK MAHASISWA PROGRAM STUDI PENDIDIKAN DOKTER UNIVERSITAS BRAWIJAYA TAHUN KEDUA, KETIGA, KEEMPAT*. 2018. doi:10.21776
13. Ballebas TM, Maraon JQ, Janer CD, et al. Cross-sectional Study on the Correlation of Stress and Sleep Quality of Learning Unit III (1st Year) to VII (5th Year) Medical Students from the University of the Philippines College of Medicine. *Acta Med Philipp*. 2024;58(14):41-49. doi:10.47895/amp.vi0.6574
14. Dwina Rahmayani R, Gusya Liza R, Afrainin Syah N. *Gambaran Tingkat Stres Berdasarkan Stressor Pada*. Vol 8. 2019. http://jurnal.fk.unand.ac.id
15. Gardiner C, Weakley J, Burke LM, et al. The effect of caffeine on subsequent sleep: A systematic review and meta-analysis. *Sleep Med Rev*. *W.B. Saunders Ltd*. 2023;69. doi:10.1016/j.smrv.2023.101764
16. Putri Indah Yasinta O, Candrasari A, Sintowati R. *Hubungan Konsumsi Kopi Dengan Kualitas Dan Kuantitas Tidur Mahasiswa Fakultas Kedokteran Universitas Muhammadiyah Surakarta*. 2021.
17. Page MJ, McKenzie JE, Bossuyt PM, et al. The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. *BMJ*. *BMJ Publishing Group*. 2021;372. doi:10.1136/bmj.n71
18. Barker TH, Hasanoff S, Aromataris E, et al. The revised JBI critical appraisal tool for the assessment of risk of bias for analytical cross-sectional studies. *JBI Evid Synth*. Published online March 1, 2025. doi:10.11124/JBIES-24-00523
19. Barker TH, Habibi N, Aromataris E, et al. The revised JBI critical appraisal tool for the assessment of risk of bias for quasi-experimental studies. *JBI Evid Synth*. 2024;22(3):378-388. doi:10.11124/JBIES-23-00268
20. Barker TH, Stone JC, Sears K, et al. The revised JBI critical appraisal tool for the assessment of risk of bias for randomized controlled trials. *JBI Evid Synth*. 2023;21(3):494-506. doi:10.11124/JBIES-22-00430
21. Al-Sharman A, Khalil H, El-Salem K, Aldughmi M, Aburub A. The effects of aerobic exercise on sleep quality measures and sleep-related biomarkers in individuals with Multiple Sclerosis: A pilot randomised controlled trial. *NeuroRehabilitation*. 2019;45(1):107-115. doi:10.3233/NRE-192748.
22. Purnama SD, et al. The Relationship of Hypertension and Diabetes Mellitus with Ischemic Stroke. Berkala Kesehatan J, 2023; 10(2): 179-188.
23. Wiriansya EP, et al. Exploring Lung Histopathology in White Rats After Cigarette Smoke Exposure. Berkala Kesehatan J. 2023; 9(2): 123-131.